OPEN ACCESS GOVERNMENT

JULY 2022 • ISSN 2516-3817

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LEARNING THE LESSONS OF RESILIENCE FOR SMART & SUSTAINABLE MOBILITY

HENRIK HOLOLEI, DG MOVE DIRECTOR-GENERAL AT THE EUROPEAN COMMISSION, OUTLINES THE IMPORTANCE OF LEARNING THE LESSONS OF RESILIENCE FOR SMART & SUSTAINABLE MOBILITY



Gudlaugur Thór Thórdarson, Minister of the Environment, Energy and Climate in Iceland, discusses renewable geothermal energy, which in his opinion, is a climate champion for the clean energy transition



Mariya Gabriel, European Commissioner for Innovation, Research, Culture, Education and Youth, calls attention to building a pan-European innovation potential ecosystem in health served with top-notch infrastructures



Cameron Hawkins, Head of Energy and Environment at NHS Property Services (NHSPS), describes the path to net-zero when it comes to decarbonising the NHS estate

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THE HISTORICAL SIGNIFICANCE OF TOXICOLOGY:
(IN)FAMOUS POISONINGS THROUGHOUT HUMAN HISTORY

Poisons have figured prominently throughout human history, with recorded evidence of domestic poisonings as early as 331 BC, and frequent references to poisoning in the Bible, Shakespeare's works, and fairy tales or myths of diverse cultures…Poisons have also been wielded as tools of assassination or intimidation in quests for political and/or financial gain and crimes of passion. Here, we provide a brief review of (in)famous poisonings from ancient to modern human history.

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Rudolf Kolbe

FOREWORD

Rudolf Kolbe
Co-rapporteur for the EESC opinion on The New European Bauhaus
Member, European Economic and Social Committee (EESC),
Vice-President of the Diversity Europe Group (Group III)

What is the New European Bauhaus (NEB) and how is it inspired by the 1919 movement?

Rudolf Kolbe, co-rapporteur for the EESC opinion on the New European Bauhaus; member, European Economic & Social Committee (EESC); vice-president of the Diversity Europe Group (Group III), shares his thoughts on the New European Bauhaus

In a nutshell, the "New European Bauhaus" can be described as an initiative of European Commission President Ursula von der Leyen to anchor the European Green Deal and climate protection in our built environment and to promote and support attractive, sustainable and inclusive living spaces.

The New European Bauhaus movement

Like the Bauhaus movement in 1919, the New European Bauhaus focuses on interdisciplinary approaches leading to cost-effective and inclusive design combining aesthetics with an everyday function.

Politically, the initiative is embedded in the European Green Deal and its many policies, such as the renovation wave, the Fit for 55 package on energy efficiency, the action plan for the circular economy, the action plan for zero pollution, the strategy for green infrastructure and many more.

As the commission president herself presented the initiative in her State of the European Union address, the political significance of this new approach has been clear from the beginning. This brings a powerful new drive for many important topics, which have been put forward by stakeholders such as architects and engineers for a long time, but which now find politically fertile ground through the New European Bauhaus. This includes, for example, a stronger commitment in spatial planning and spatial planning policy to curb land consumption and sealing but also, of course, promoting alternative building materials that generate less CO_2 emissions and are easier to recycle.

It is important to stress that, thanks to the extensive co-design strategy which has included a broad variety of stakeholders - spanning interested individuals and the full range of civil society organisations, educational institutions, individual professionals and all kinds of professional organisations and many others - it was possible to include a wide variety of important focus points in the implementation measures of the initiative and to create the urgently needed holistic approach to green transition. This is well reflected in the European Commission's New European Bauhaus Communication, published in September 2021.



> "The New European Bauhaus can only become a success if citizens are able to identify themselves with the aims and are able to integrate them into their daily lives."

What is the main EESC contribution in this respect?

The EESC represents a wide variety of civil society groups. Within the participative structure of the initiative, it builds the link between public authorities and the citizens that is necessary to secure the broad, practical inclusion of citizens and to avoid pure elitist top-down approaches. The New European Bauhaus can only become a success if citizens are able to identify themselves with the aims and are able to integrate them into their daily lives. Therefore, projects and implementation measures need to be based on equality, accessibility and affordability for all and the EESC intends to further contribute to this inclusive process in its daily work and by organising an annual conference on the New European Bauhaus and civil society.

It therefore fully supports the plans of the European Commission to further follow its participatory approach and to deepen it by methods such as implementing the New European Bauhaus Lab, which is a co-creation space for implementing the New European Bauhaus in specific, tangible projects.

In what sense should the NEB procurement procedures be based solely on quality rather than price?

The NEB Lab also aims to create enabling conditions for the green transition, such as new tools, frameworks and policy recommendations. Public procurement legislation and practice will need to be an important focus of this work.

With the circular economy approach promoted in the New European Bauhaus and the Green Deal, so called "cheap" solutions will have to be seriously rethought. It is well known that solutions in which savings are made primarily in the planning phase usually entail significantly higher costs in the lifecycle. In addition, clients and the public have to deal with unsatisfactory results of such cheap solutions because they often have to be adapted later - at great financial and other expense.

Whether we will actually manage to implement high-quality and cost-effective sustainable solutions on a broad basis throughout Europe depends heavily on the underlying award procedures. Above all, the awarding of planning services must be open and quality-oriented - and not based on price competition. The mandatory application of the best bidder principle (MEAT) for planning services, which is already provided for in principle in EU procurement law, must be made mandatory throughout Europe.

Based on high-quality procurement procedures, sustainable, inclusive and aesthetic building can very well be reconciled with cost-effectiveness. Adequate procurement legislation combined with measures such as the commission's planned peer learning action to help local authorities to integrate and implement quality principles in the built environment, based on the Davos Baukultur Quality system, will therefore be crucial for the success of the New European Bauhaus movement. ■



Jonathan Miles
Managing Editor

Writers
Steph Hazlegreaves
Emily Warrender
Eskarina Handley
Freya Thomson
Andy Jowett

Production Coordinators
Emma Faulkner-Dunn
Sian Corbett

Designers
Andrew Bosworth
Ben Ellis
Lesley Ellis

Sales
Elena Adirkova
John Hoinville
Debbie Cotterill
Marie Alexander

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Cheshire CW1 6ZF

Registered in England & Wales.
Company Reg No. 8667479.
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OPEN ACCESS

INTRODUCTION

Welcome to the July 2022 edition of Open Access Government. Can you believe we are now halfway through the current year, and that Summer is with us? Where does all the time go? Despite the situation in Ukraine, COVID-19 remaining present, perhaps the start of another pandemic and everything else going on globally, I hope you nevertheless enjoy our latest volume.

Once again, we provide reams of policy analysis starting with many aspects of health and social care. Perhaps you would like to turn to the article by Dr Hans Henri P. Kluge & Dr Natasha Azzopardi Muscat from WHO/Europe, who explain the importance of putting health at the heart of tourism, including a commitment made in this vein by Europe's smallest countries to better health systems?

Heading up our research and innovation focus, we hear from Mariya Gabriel, European Commissioner for Innovation, Research, Culture, Education and Youth, who calls attention to building a pan-European innovation potential ecosystem in health served with top-notch infrastructures. We welcome the return of Anantha Duraiappah, Director at UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development, who this time describes the failed promises of the Universal Declaration of Human Rights on the right to education.

Further on, we enjoy a large focus on many aspects of digital transformation. We learn that digital transformation will play a key role in the future of local government, so why not look at the piece from David Bemrose, Head of Account Strategy for Local Government at Crown Commercial Service, who introduces a new digital transformation guide?

Elsewhere, Cllr Nesil Caliskan, Chair of the Local Government Association's Safer, Stronger Communities Board, explains how councils take terror attack threats very seriously and work hard with partners in keeping communities safe and connected. On transport policy, we hear from Henrik Hololei, DG MOVE Director-General at the European Commission, who outlines the importance of learning the lessons of resilience for smart & sustainable mobility.

In our energy focus, Gudlaugur Thór Thórdarson, Minister of the Environment, Energy and Climate in Iceland, discusses renewable geothermal energy, which in his opinion, is a climate champion for the clean energy transition. We also feature comment from Dave Howell at the U.S. Department of Energy's about EV battery research for transportation. Plus, Will Wepsala from the U.S. Department of Agriculture walks us through the work of intercepting smuggled products to protect animal health.

I trust you enjoy reading this packed volume and that you will join us for many more after the Summer.

Jonathan Miles
Managing Editor

@Jonathan_AdjDig

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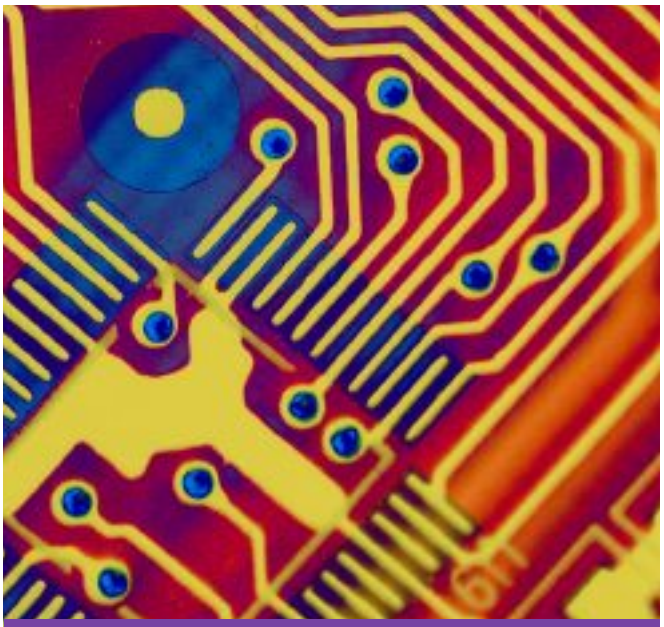
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With over 18,000 staff, treating three million patients a year, Guy's and St Thomas' (GSTT) is one of the biggest and well-known NHS Trusts in the UK. Transforming digital experiences has been at the heart of the website update

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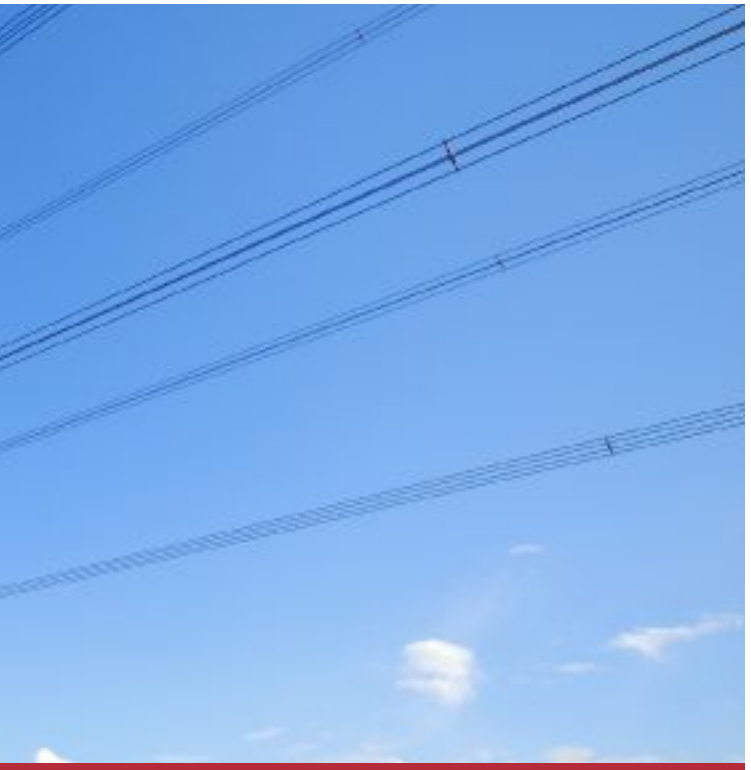
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382 **The city FEEDS the city and FERTILIZES the countryside: sustainable food production.** The circular and sustainable food production system of the future is already here. FaaS - Farming as a Service has been launched in Sweden through ICA Maxi in Sundsvall



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390 **The potential of algae in treating chronic inflammation.** Algae has become a hot topic, however there is a knowledge gap that's resulting in an underused resource that could offer new solutions for the treatment of pain, inflammation, and inflammatory bowel disease (IBD)

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394 **Oceans and the circular economy.** Open Access Government charts the priorities of Virginijus Sinkevičius, European Commissioner for Environment, Oceans and Fisheries, particularly concerning the role of oceans and the circular economy

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398 **Water infrastructure and planning in a climate-changing world.** Maria Alina Rădulescu, Wim Leendertse and Jos Arts, from the Centre for Agroecology, Water and Resilience (CAWR), look towards water infrastructure to plan for better stakeholder engagement

400 **PlanetWatch – An innovative solution to a global problem.** Air pollution is the largest environmental risk factor for disease and premature death in the world. Despite a global push to move away from fossil fuels and harmful emissions, a recent Lancet commission on pollution and health reports stated air pollution is responsible for around nine million deaths per year. PlanetWatch aims to monitor rising levels of air pollution by building a network of air quality sensors around the world

402 **Research priorities for sustainability science.** With the position paper "Research priorities for sustainability science" the German Committee Future Earth (Deutsches Komitee für Nachhaltigkeitsforschung in Future Earth, DKN) highlights pertinent research gaps and suggests forthcoming fields of research in the field of sustainability science.

404 **Uncertainty in sea-level rise & how can we use it as a tool.** Sandy Avrutin, Ocean and Earth Science Postgraduate Researcher, National Oceanography Centre at the University of Southampton, describes the uncertainty in sea-level rise, what it is & how we can use it as a tool

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408 **Shellfish poisoning: A neurotoxic consequence of global warming.** Jeremy MacMahon, Yi-Hua Tsai, and Pamela Lein from the Department of Molecular Biosciences, UC Davis School of Veterinary Medicine, explore how shellfish poisoning is affecting human and animal health

410 **eBOOK FEATURE: The historical significance of toxicology: (in)famous poisonings throughout human history.** Poisons have figured prominently throughout human history, with recorded evidence of domestic poisonings as early as 331 BC. Here, we provide a brief review of (in)famous poisonings from ancient to modern human history.

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416 **Artificial Intelligence: The different approaches to solve complex problems even without data.** Here Jose M. Peña Director at Lurtis LTD explores the ways to address AI problems beyond using Machine Learning



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OPEN ACCESS GOVERNMENT

Better health systems: putting health at the heart of tourism

Dr Hans Henri P. Kluge & Dr Natasha Azzopardi Muscat explain the importance of putting health at the heart of tourism, including a commitment made in this vein by Europe's smallest countries to better health systems

The COVID-19 pandemic has had a seismic effect on the health systems and national economies of all countries across the globe. The effects have been felt particularly acutely by the smallest countries, whose economies often rely on imports and tourism, and whose health systems often struggle with shortages of health workers and equipment.

The needs, challenges and opportunities of small countries are not limited to the pandemic and its aftermath. Back in 2013, WHO/Europe established what is now known as the Small Countries Initiative, a sub-regional platform bringing together the 11 smallest countries of the 53 Member States in the WHO European Region [(1)] – those with 2 million inhabitants or less – as part of an informal network to share experiences and exchange perspectives.

Since then, the initiative has grown into a strong partnership among the countries and a platform for them to speak with one voice in international fora, promoting healthier populations, tackling emergencies and strengthening health systems.

At the latest ministerial summit of these small countries, held in Montenegro at the start of June 2022, the ministers were unanimous in their commitment to 1) better prepare for future emergencies by strengthening the resilience of their health systems; and 2) to place health at the heart of the recovery of their tourism sectors.

Understanding the links between health & tourism

The links between health and tourism are many. The health and well-being of tourists and the tourism workforce alike; safety and security related to travel, water and sanitation, food and hygienic conditions; and socioeconomic and environmental aspects important for health and well-being in host communities – are but some of the most obvious.

Health and tourism promote economic growth and development, creating jobs and providing livelihoods for millions. Globally, in 2019, the tourism sector alone accounted for 7% of the world's exports and U.S. $3.5 trillion measured in direct tourism gross domestic product (GDP).

But the pandemic has changed things. Since the beginning of 2020, the global volume of international travellers has declined by more than 70% to the lowest levels for 30 years. In 2020 alone, global GDP fell by 3% as a result of the pandemic, with 70% of these losses coming from a decline in exports from the tourism sector in host countries around the world.

Among the 11 countries in the Small Countries Initiative, international arrivals plunged from 26 million in 2019 to 8 million in 2020. And despite positive signs, by the end of 2021 international tourist arrivals in this group of countries were still 56% below pre-pandemic levels.

Three steps to a healthy & sustainable tourism sector

The COVID-19 pandemic has added a new and more urgent layer to the nexus between health and tourism. When borders first closed in the spring of 2020, it took months for travellers to regain their confidence in international travel. And when travel did resume, those on the move were concerned about their ability to access COVID-19 testing and affordable treatment in case of illness or hospitalisation while abroad.



Dr Hans Henri P. Kluge



Dr Natasha Azzopardi Muscat

It is with this context and urgency in mind that the health ministers and delegates from the 11 smallest countries in the WHO European Region joined us at the summit in Montenegro and agreed on the importance of health for tourism. Three key ingredients for this emerged.

"The links between health and tourism are many. The health and well-being of tourists and the tourism workforce alike; safety and security related to travel, water and sanitation, food and hygienic conditions; and socioeconomic and environmental aspects important for health and well-being in host communities — are but some of the most obvious."

First, any effort to relaunch the tourism sector needs to include emergency preparedness. What this means in practice is that countries should prioritise infection prevention and control (IPC), patient mobility, preventive measures (such as vaccination), well-trained health workers, and access to essential medicines and adequate, well-functioning diagnostic facilities and technologies. These health services should be accessible without financial hardship, when and where needed by tourists and host communities.

Second, we have learned that quality healthcare can contribute to the growth of the tourism sector. Destinations with solid health systems, good hygienic infrastructure, safe travel conditions and access to trauma care can attract tourists. Tourists today tend to be better informed and more discerning than in pre-pandemic times.

Thirdly, the nexus between health and tourism can only be reinforced. Through our discussions with health ministers and governments from the 11 countries in the initiative, we have learned that there are many ways for this to happen, including by:

- Involving government at all levels in multi-hazard response planning;
- Including tourists' needs in all preparedness and response plans;
- Promoting primary healthcare as the first point of contact for those tourists who don't need hospital care;
- Strengthening communication tools and channels with tourists;
- Identifying vulnerable or disadvantaged groups for economy-wide stimulus packages in small countries.

The outcome statement of the June 2022 summit of the Small Countries Initiative is a blueprint for what actions need to be taken, both for successful emergency response and sustainable tourism. Fostering the sustainability of the tourism sector with health at the centre can improve the social, economic and environmental determinants of health and the overall conditions for health and well-being.

It is our hope that the commitments made by the 11 smallest countries in the WHO European Region can be taken forward, as we seek to exit and recover from the COVID-19 pandemic, across the entire Region and beyond.

(1) The 11 small countries are: Andorra, Cyprus, Estonia, Iceland, Latvia, Luxembourg, Malta, Monaco, Montenegro, San Marino and Slovenia.

Dr Hans Henri P. Kluge
WHO Regional Director for Europe
https://twitter.com/hans_kluge

Dr Natasha Azzopardi Muscat
Director of Country Health Policies and Systems
WHO/Europe
https://twitter.com/natasha_azzmus

WHO/Europe
Tel: +45 45 33 70 00
www.euro.who.int/en

Acoustic Cluster Therapy – A novel ultrasound-mediated drug delivery platform for therapeutic enhancement across multiple diseases

Optimizing a drug's ability to reach diseased body parts in adequate levels while avoiding healthy body parts – its tissue exposure and selectivity – is critical to therapeutic optimization

Targeted drug delivery has been the Holy Grail of the pharmaceutical industry for decades. Managing many diseases remains challenging due to suboptimal penetration of systemically administered therapeutic drugs, such as chemotherapies, targeted small molecules, and antibodies. Systemic administration results in therapy distributing to normal healthy tissue, often inducing toxic effects that can severely limit the doses that can be applied.

Scientists have paid particular attention to externally activated drug delivery systems, such as the use of heat, light, ultrasound, and electric and magnetic fields as external energy sources to activate various drug formulation systems to enhance extravasation and distribution of a systemically co-administered drug. There has been significant interest in utilizing ultrasound and microbubbles which couple strongly to the ultrasound fields to drive targeted therapeutic amplification in recent years. Low-intensity ultrasound in combination with microbubbles has been shown to increase the vasculature's permeability safely and transiently, allowing more drug to reach the target pathology.

Norwegian clinical-stage company, EXACT Therapeutics AS, is enhancing the therapeutic efficacy of medicines with its novel ultrasound-mediated drug delivery technology platform called Acoustic Cluster Therapy (ACT®).

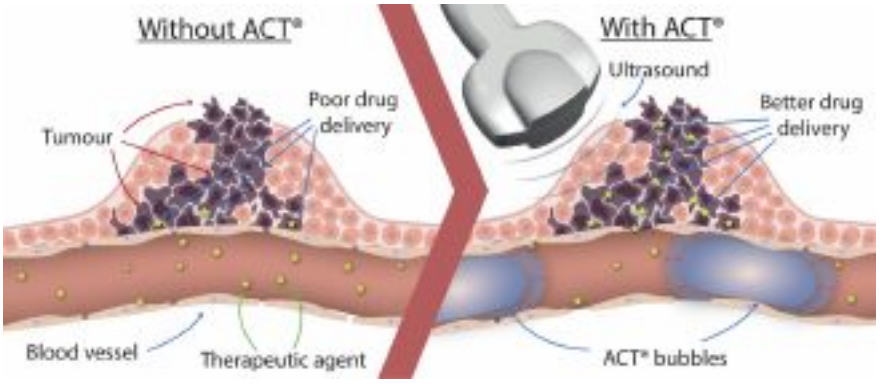


Figure 1: ACT® Mode of Action

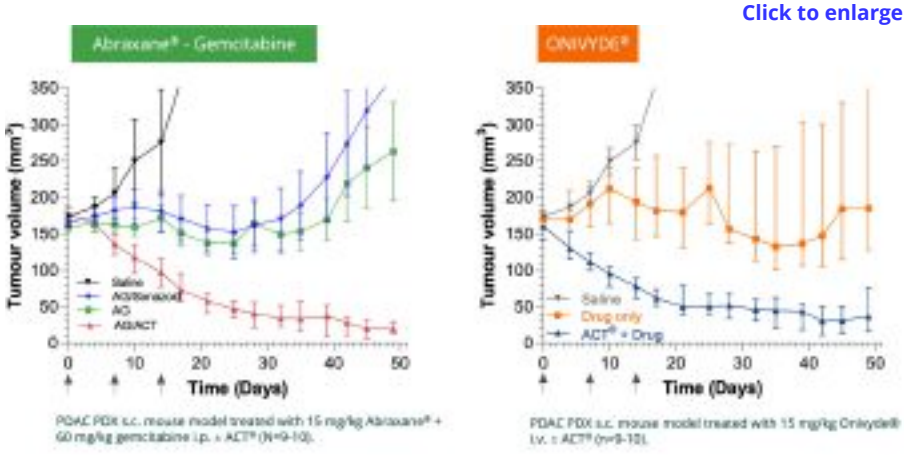
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Ultrasound and ACT® for targeted drug delivery

Microbubbles have been used as imaging contrast agents for decades in a diagnostic setting with ultrasound with an excellent safety profile based on the inert nature of the formulations available. Ultrasound itself is well established in the medical environment including in developing countries, and ACT® is positioned as an add-on without negatively affecting or interfering with therapeutic treatment. Furthermore, the near ubiquitous availability of ultrasound systems in healthcare settings worldwide provides a strong foundation for the future potential and adoption of ultrasound

Figure 2. The study demonstrates significant tumors volume reduction when ACT® co-administered with the Standard of Care (SOC) therapy. Reference in press.

Click to enlarge



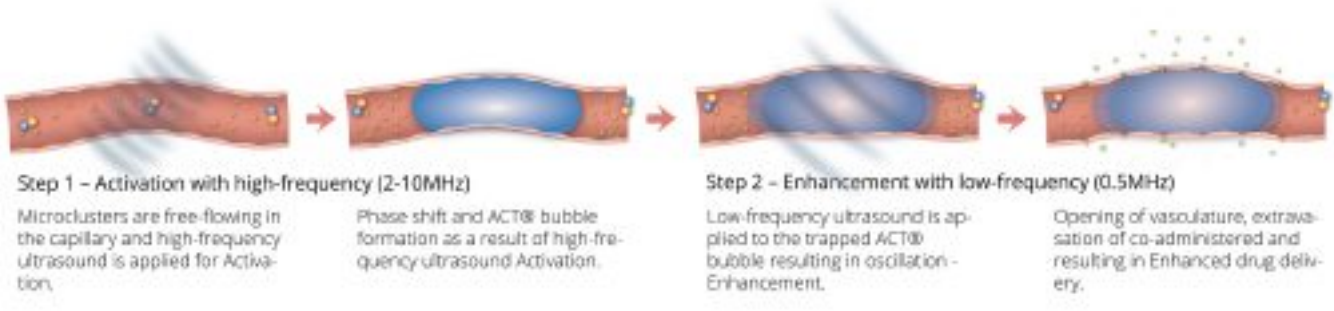


Figure 3: ACT® achieves therapeutic benefit through a 2-step ultrasound process

Click to enlarge

for therapeutics increasing the impact of precision health across geographies.

The power of Ultrasound technology

Ultrasound can also be used outside diagnostic applications to induce local biological effects deep inside the body without surgical intervention allowing spatially specific delivery at desired sites. Combining with microbubbles, ultrasound has shown to enhance drug uptake in a target volume such as tumors.

The ACT® platform is supported by a strong and broad preclinical package demonstrating therapeutic enhancement in multiple oncology models (pancreatic, breast, colon, and prostate), in infectious foci, and to enable controlled blood-brain barrier (BBB) opening with a strong safety profile.

The ACT® bubble

The proprietary ACT® formulation consists of negatively charged microbubbles and positively charged microdroplets and it is co-administered with a therapeutic agent. These highly engineered small (<5µm) microbubble-microdroplet clusters are free flowing in the bloodstream like regular contrast agents before insonation.

The ACT® formulation is optimized to achieve its therapeutic benefit through a two-step ultrasound process. Following the intravenous injection of the ACT® formulation, high-frequency ultrasound is then applied to the target site allowing the microbubbles to transfer acoustic energy to the attached droplets which undergo a liquid-to-gas phase shift, called the Activation Step. Resulting vapor bubbles rapidly expands and get trapped in the next capillary bed they flow into, transiently stopping blood flow for up to 10min. Further application of low-frequency ultrasound, called the Enhancement step, oscillates the bubbles in a controlled manner and induces mechanical effects such as microstreaming and shear stress on the capillary wall that increase the local permeability of the vasculature and improve the transport of the co-administered therapy across the capillary wall and through the extracellular matrix (ECM).

It is important to note that the standard microbubbles have a typical diameter of 2-6 µm and are free flowing, while the ACT® bubbles are up to 3 orders of magnitude larger, allowing them to trap and temporarily lodge at the capillary level affecting a much larger part of the endothelial wall suggesting more efficient biomechanical effects on the capillary wall and the ECM. The approximately 5-10 times larger diameter ACT® bubble and its contact with a large part of the endothelial wall is thought to be critical for optimal targeted drug delivery and enhancement with ultrasound.

The ACT® platform is being developed for use with clinically approved diagnostic ultrasound scanners that are commonly found in hospitals and clinics worldwide. Currently, a Phase I Clinical Trial to investigate safety and toxicity has been initiated at Royal Marsden Hospital in London, treating colorectal cancer patients with liver metastases with standard chemotherapy combined with ACT® (NCT04021277).

This localized drug delivery strategy that is minimally invasive and both drug and disease-agnostic is highly attractive as it could offer a much higher proportion of patients access to treatment and improved therapeutic outcomes.

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(2) https://clinicaltrials.gov/ct2/show/NCT04021277

EXACT TX

Aliisa Paulus
Ultrasound Engineer
EXACT THERAPEUTICS AS
aliisa@exact-tx.com
www.exact-tx.com
https://twitter.com/ExactTx

Who will pay for the precision cancer medicine revolution?

Ketil Widerberg, General Manager of Oslo Cancer Cluster, describes the complexities of implementing precision cancer medicine in Norway and suggests a way forward

Every year, almost 10 million people die from cancer globally. Developments in precision cancer medicine offer new treatments that can give people longer lives, better lives and even save lives.

However, the wave of new medicines is putting pressure on European welfare states and raises the question: How can we afford this cancer revolution?

A recent survey by Kantar of the Norwegian population's stance on health policy showed a majority want more modern cancer treatments with less side effects at public hospitals. It is now up to politicians, health officials, clinicians, and the pharmaceutical industry to work together to make this happen.

Taming the three-headed dog

When talking about giving patients access to new treatments, the key players generally fit into three categories:

- **The public hospitals**, where clinicians wish to give their patients the best possible treatment but are restricted to the medicines that have been approved.

- **The health authorities**, who are tasked with introducing new treatments, while also ensuring there is enough funding to support the entire public healthcare service.

- **The private companies** that produce new diagnostics and treatments, who have spent years of research and development. They need return on investment to be able to continue to attract private capital.

Much like the three-headed dog Cerberus guarding the gate to the underworld in Greek mythology, each head serves different purposes and the three need to work together to grant access to new medicines.



Oslo Cancer Cluster Innovation Park

Image: © Christian Tandberg

The public-private consortium CONNECT was set up to tackle this challenge. The aim is to drive the implementation of precision cancer medicine in Norway. Oslo Cancer Cluster coordinates the consortium and acts as a neutral facilitator between the various stakeholders.

The CONNECT consortium includes all six university hospitals, the Norwegian Medicine Agency, the Norwegian Health Directorate, the Norwegian Institute of Public Health, the Norwegian Cancer Society, the Norwegian Pharmaceutical Industry Association (LMI), 16 pharmaceutical companies and two tech companies. Together they work to address key obstacles and pilot novel solutions to transform the current practice.

Contributing cancer drugs

One of the successes of CONNECT is getting pharmaceutical companies onboard to contribute drugs to the nation-wide clinical study IMPRESS. IMPRESS is an off-label study on advanced cancer and an opportunity for cancer patients to get personalised



Ketil Widerberg, General Manager

Image: © Stig Jarnes

medicine. It has been supported by the Regional Health Authorities with NOK 60 million.

If a patient has an effect of the treatment contributed by the pharma companies after 16 weeks, the Regional Health Authorities have agreed to pay for further treatment. This is an example of a future pay-for-performance model in precision cancer medicine in Norway.

The idea is simple. Cancer patients with no other treatment options can receive precision diagnostics through a national infrastructure called InPreD within the specialist health service. This is currently being set up at all Norwegian hospitals with financial support from the Regional Health Authorities.

The patient's results are then discussed in a weekly national molecular tumour board, which refers the patient either to IMPRESS, other biomarker-defined trials, early-access programmes or back to ordinary treatment.

Trailblazing partnerships

This is an example of what can be accomplished when "the three heads" work together and how the monstrous watchdog can be turned into a trustworthy companion. The areas of research and treatment are elegantly brought together so that new medicines faster can reach patients who need them the most, while the various needs of the stakeholders are cared for.

These interconnected precision medicine initiatives have already gained widespread international attention, including in a Letter to the Editor published in Nature Medicine, presentations at Nordic Precision Medicine Forum 2022 and an abstract at ASCO 2022.

InPreD, IMPRESS and CONNECT spearhead the development of a complete ecosystem for the introduction of precision cancer medicine in Norway. Our hope is that this can inspire other European countries and partners to continue their public-private collaboration efforts and initiate new partnerships within Europe. Then novel cancer research can become not just a distant dream but everyday practice for cancer patients.

Ketil Widerberg
General Manager
Oslo Cancer Cluster
kw@oslocancercluster.no
https://oslocancercluster.no/
https://twitter.com/OsloCancer

Natural vibration therapy to combat osteoporosis

MyBones explores the potential Low-intensity Vibration therapy has as a natural alternative to prevent and combat osteoporosis

Osteoporosis is a global health epidemic that affects millions. A recent report from the International Osteoporosis Foundation (IOF) found that 200 million people across Europe have osteoporosis, a number only set to rise as populations age. [1]

The disease represents a significant cost to healthcare providers, costing the NHS £5.5 billion per year. [2] This doesn't account for the cost to the individual, their family, or the economy.

Many common treatments have side effects and contraindications that mean they are not always suitable for everyone, especially children. Low-intensity Vibration therapy offers a new and innovative way to prevent and combat osteoporosis, using gentle vibrations to stimulate the body's cells and encourage bone growth.



Natural vibration therapy for osteoporosis

Vibrations or mechanical signals dictate many of the body's natural biological processes. When we walk, every step sends a series of vibrations through our bone cells. These stimulate growth and play a key role in building healthy bones.

Ageing, hormones, and underlying health conditions affect how well our bodies respond to these signals and develop bone. Often it is a combination of these factors which reduces bone density and leads to the development of osteoporosis.

Astronauts experience a similar issue. Free from the forces of gravity, their bodies don't experience the mechanical loading required to stimulate bone growth. This puts astronauts at an increased risk of osteoporosis. Recognising this, NASA tasked Professor Clinton Rubin with finding a solution.

He discovered a precise, targeted vibration that will mimic the body's natural signals and encourage the mesenchymal stem cells in the bone marrow to reproduce. [3] Professor Rubin quickly realised the potential this technology had to improve bone health on Earth. After spending 35 years researching and refining the technology, the Marodyne LiV device was developed – a safe, effective, and certified Low-intensity Vibration plate.

Gentle, healing vibrations

When considering vibration therapy, it's important to understand the intensity of a device before using it. Most whole-body vibration plates, typically those found in gyms, vibrate at a high intensity often exceeding 1.0g. This level of vibration has significant side effects and contraindications, making it unsuitable for many users, especially those with underlying health conditions such as osteoporosis. [4,5]

By contrast, the Marodyne LiV device has no contraindications and can be used safely with confidence by both



Alison Millichip, Business Manager

children and adults. Vibrating at exactly 0.4g at 30hz, the device emits a high frequency but low magnitude signal - the exact calibration Professor Rubin found to increase bone density effectively.

Alongside the benefits to bones, Low-intensity Vibration therapy has been proven to deliver additional health benefits; as the plate vibrates, the muscles within the legs contract to stabilise the body. This improves muscle strength and balance, reducing the risk of falls.

Improved circulation is another benefit of using the Marodyne LiV device. As the plate vibrates, the vibrations stimulate muscles and encourage blood flow. (6)

Accessible and natural therapy

Many people can benefit from vibration therapy, especially those who are already at an increased risk of developing osteoporosis.

Whilst osteoporosis can affect anyone, women are most impacted, with half of women over 50 expected to develop the disease. (7) This is largely due to the impact menopause has on the body's hormones. Through perimenopause and menopause, the body's levels of oestrogen, testosterone and progesterone all drop. As these hormones regulate bone density, their reduction increases the likelihood of osteoporosis.

Extensive studies have established that Low-intensity Vibration therapy can prevent and combat osteoporosis. One systematic review concluded, "Low-magnitude whole-body vibration can provide a significant improvement in reducing bone loss in the lumbar spine in postmenopausal women." (8)

Vibration therapy also provides additional benefits for paediatric care. Studies suggest Low-intensity Vibration therapy could aid children with conditions such as idiopathic scoliosis and osteogenesis imperfecta. (9,10) Since many common pharmacological treatments are not used for children due to their side effects, Low-intensity Vibration therapy offers a natural alternative with no contraindications or side effects.

Thousands of people across the world have already benefitted from Low-intensity Vibration therapy and its use by healthcare professionals is growing.

Certified as a class IIa medical device by the British Standards Institution (BSI), the device has the potential to form a core part of clinical guidelines in the future care and prevention of osteoporosis.

Find out more about the Marodyne LiV device at https://mybones.health/liv-device/.

Written by Edward James, MyBones

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MyBones
myhealth, myfuture

Alison Millichip
Business Manager
MyBones
Tel: +44 (0)117 253 0400
info@mybones.health
https://mybones.health/

Impact of teleworking in health, wellness & well-being

Cecilia Van Cauwenberghe from Frost & Sullivan's TechCasting Group, describes the impact of teleworking in health, wellness & well-being, beginning with the implications of this in pandemic & post-pandemic scenarios

Teleworking prevalence has increased due to COVID-19. Although returning to standard, pre-pandemic routings, a hybrid working environment arises two years later. Defined as a form of work at home using information and communication technologies, teleworking has been the matter of several studies during the past two years. This fact supposes some pros and some cons. According to most researchers who have focused on evaluating the impact of teleworking on health, working under confinement has brought challenges. Just to name a few, restricted face-to-face interaction with colleagues and supervisors, limited access to ergonomic resources, amplified social isolation, and distorted role definitions could have adversely affected teleworker safety, health and well-being, overall (Shall and Chen, 2021).

"According to most researchers who have focused on evaluating the impact of teleworking on health, working under confinement has brought challenges."

In terms of physical considerations, teleworking has been associated with prolonged periods in front of a computer, always at home, hence incrementing sedentary lifestyle, holding static and constraining postures, doing repetitive movements and subjecting forearms and wrists to extreme positions (Almarcha et al., 2021). However, workplace disturbances are beyond the effects of virtual or teleworking. Collateral aspects, including the potential lack of infrastructure and systems to support specific tasks and surrounding stressors (childcare, home-school responsibilities, lay-offs, business closings) have dramatically perpetuated concerns for the job positions and financial security for workers (Escudero-Castillo et al., 2021). Consequently, work-life balance has been severely affected (Shipman et al., 2021). Today, some manifestations of that stress are evidenced, especially in health conditions.

Interventions for safety, health & well-being among teleworkers

Evidence-based strategies for improving occupational safety, health, and well-being among teleworkers are crucial in addressing these concerns.

Most interventions aim to increase worker motivation to engage in safe and healthy behaviours, from mental health habits and exercises to more organisational measures, such as safety leadership, role boundaries definitions and interpersonal interaction stimulation. Affordance-responsiveness plays a crucial role in day by day work. This approach must include options for social interaction.

Some solutions such as ergonomic home-office configurations have emerged in compensation for the deleterious effects of sedentary habits related to teleworking. Overall, these solutions intend to contribute to weight control or loss through additional energy expenditure, joint relief, and acute or chronic musculoskeletal pain (Buomprisco et al., 2021). Beyond common signs, changes in habits during teleworking also enhance cardiometabolic health and metabolic functions.

The World Health Organization (WHO), for instance, has recommended a physically active lifestyle, suggesting that adults participate in at least 150 to 300 min of moderate-intensity or at least 75 to 150 min of vigorous-intensity for additional health benefits.

According to the WHO, this amount of aerobic physical activity per week, together with strength and elasticity exercises, would help to reduce the risk of ulterior diseases, such as health failure, diabetes, or even cancer (Almarcha et al., 2021). Regular interruptions of 3-min of light–intensity activities for 20 min of sedentary time have been suggested. Naturally, such a non-personalised, one-size-fits-all approach has been severely questioned. Well-ness should not be limited to aerobic and strength exercises, while the response exercise-benefit should not be precisely linear.

Advanced information & communication technologies

The past two years have seen the onset of many mobile apps with all kinds of options to practice safe home exercises. Because of their non-dependency on specific gym equipment and virtual free interaction with the users, these apps promote training and socialisation through virtual communities. Moreover, data tracking using wearable technology has become popular, facilitating health metrics feedback that can be transferred to healthcare professionals for physical activity improvement (López Peláez et al., 2021).

Beyond monitoring, the use of artificial intelligence (AI) to personalise exercise prescriptions based on both psychological and biological factors via computerised exercise expert systems (CEES) and performance evaluation of a recommending interface (PERI) systems have acted as complementary tools to influence exercise behaviour and movement habits.

Finally, virtual reality (VR) has facilitated user interaction with immersed environments, providing total exploration and movement variability.

Acknowledgements

I want to thank all contributors from the industry involved with developing and delivering this article from Frost & Sullivan.

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More on teleworking: The WHO perspective

During the pandemic, those who were able to work from home got used to teleworking. Working from home created new public health debates.

A recent WHO report published in collaboration with the International Labour Organization looks at the impact of teleworking on public health. The research suggests that improved work-life balance, opportunities for flexible working hours and decrease in air pollution are a handful of positive changes associated with the rise in working from home. It can also improve work productivity.

But if there aren't proper processes in place, teleworking can lead to isolation, burnout, home violence, and musculoskeletal injuries.

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Cecilia E. Van Cauwenberghe, PhD, MSc, BS Eng, BA, MBA
Principal Consultant
Senior SciTech Advisor & Associate Fellow
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
www.frost.com
www.twitter.com/Frost_Sullivan

Promoting the creation of an inclusive workplace

Dr Christine Grant, Associate Fellow at the Coventry University Centre for Healthcare Research, introduces the 'Remote for All' (R4All) research study, discussing disability, neurodiversity, an inclusive workplace, and remote e-working in the UK

During the COVID-19 pandemic, home-working increased rapidly in the UK, with 46% of working adults working from home by April 2020, and with 36% still continuing to remote work two years later. [1,2] Employers are thus keen to accrue the benefits of remote working including staff well-being, and productivity gains and many continue to advocate this new style of working. Whilst these new work arrangements might seem ideal, it is important also to consider that there are both positive and negative effects for those remote working and it is not necessarily an easy option for all. For example, workers with disability/ neurodiversity (WDN) have reported feeling lonely and experienced isolation during the pandemic more frequently than others. [3] Remote e-working may help employers to be more inclusive [4] and address some of the struggles experienced by WDN when facing office-based working practices. [5] However, adjustments and ameliorations are required to optimise remote working for all.

According to a recent survey, 52.1% of WDN (16-64 years) are in employment, which equates to 20% of the working-age population. [3] Unfortunately, two years on from the start of the pandemic, latest figures by the Institute for Employment Studies indicate that the employment gap is widening for WDN. [6] Reports are mixed as to whether remote working has aided or hindered this community of remote workers. As such, the author has gained funding* to initiate a qualitative research study 'Remote4All' to explore the key factors affecting remote WDN, and to provide guidance and impact policy in this area. The results of the 'Remote4All' project will be published later in 2022.

"Managers need to consider the impact on those staff that are unable to adopt this more flexible style of working."

Different remote working definitions

There are many terms that describe remote working, e.g., homeworking, teleworking, telecommuting, agile working and flexible working. We define remote workers as individuals who use 'technology to work remotely from the main group office at any time or place.' [7] Not all roles can be undertaken remotely, and the proportions of time-spent working remotely may differ. Hybrid working is also a term that has emerged through the pandemic and relates to combining in variable proportions working from home, and from the main office. Many employers are adopting this 'blend' of working to gain the benefits from both on and off-site working. Managers need to consider the impact on those staff that are unable to adopt this more flexible style of working.

Positive and negative effects of remote working

Remote working has many benefits to individuals, including greater flexibility with open access to work at any time and for some the ability to work around personal/caring needs. [8] There are also negative effects though, including working longer hours (reducing the amount of time for recuperation from work) increased work stress/pressure, reduced communication with co-workers, and social isolation, especially in those remote working longer term. These issues can be further exacerbated for WDN. WDN may also have different preferences for how the remote working environment can be configured to best suit their needs. Whilst working remotely may have helped ameliorate some issues for them, it may well have exacerbated other challenges.

Disability and Neurodiversity definitions

According to the Equality Act 2010 [9], a person has a disability if "they (a) have a physical or mental impairment, and (b) the impairment has a substantial and long-term adverse effect on their ability to carry out

normal day-to-day activities." In the 'Remote4All' project, the definition is extended to the broader spectrum of Neurodiversity, including Attention Deficit Hyperactivity Disorder, Autism, Dyslexia, Dyspraxia/Developmental Coordination Disorder, Tourette Syndrome, Dyscalculia and Dysgraphia. (10)

What can be done to support an inclusive work environment?

Remote working seems to be a mixed bag for WDN. For some it may have made life easier, reducing the commute to work and using technology more effectively, being able to factor in breaks and look after individual needs. For those needing personal contact to enhance their communication with others, it may have increased the challenges. In considering the downsides it is necessary to understand what can be done to support WDN. Creating an inclusive and empathetic environment can enhance and support remote workers' well-being. This means being in touch with workers' needs and ensuring that there is regular dialogue to reassess as necessary. A risk assessment and reasonable adjustments including appropriate IT equipment installed remotely may not always be forthcoming and these are essential for productive remote working, and importantly well-being. WDN may also prefer a blended approach to working so that they do not feel cut off from the office environment and the support this can provide. Therefore, we need to acknowledge and treat all remote workers as individuals to ensure their needs are fully met.

The future of work looks interesting

There is a distinct lack of guidance and policy for WDN. The 'Remote4All' project is interviewing WDN employees, employers and key stakeholders to identify creative ways to support and enhance remote working for this group. The project will result in guidance that will support employees and employers to better support the remote working experience.

Remote working is clearly here to stay and for many, it offers benefits for their well-being and work productivity. However, for this style of working to be optimised the negative effects need also to be fully considered and ameliorated. All remote workers require an individual approach and the purpose of the 'Remote4All' project is to help find out what type of environmental and psychological adjustments the WDN population of remote workers need. This will help employers create an inclusive and empathetic remote working culture for all.

Acknowledgements

Dr Carlo Tramontano and Dr Maria Charalampous

***Funding statement**

As part of the Digital Futures at Work Research Centre (Digit), this work was supported by the UK Economic and Social Research Council [grant number ES/S012532/1], which is gratefully acknowledged.

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digital futures at work research centre

UKRI Economic and Social Research Council

Coventry University

Dr Christine Grant
Associate Fellow, Centre for Healthcare Research
Coventry University
Work mobile: +44 (0)7974 984 667
christine.grant@coventry.ac.uk
https://twitter.com/grantmsc

Social care at the heart of post-pandemic health & economic recovery

Mitesh Dhanak, Chair of the Organising Committee of Championing Social Care and Founder of Precious Homes, states the case for putting social care at the heart of post-pandemic health and economic recovery

The social care sector has been under pressure for many years, but the strain upon the sector has increased significantly over the course of the pandemic. There have been numerous reports about the backlog in the NHS during and post-COVID-19. The lack of sufficient capacity in the sector meant that hospitals could not safely discharge patients, resulting in bed shortages and treatment delays.

Nearly 300,000 people were waiting to access adult social care in 2021 and the sector faced a "deluge" of new requests as restrictions were lifted last year. The number of adults needing social care in England alone has been projected to increase by 50% up to nearly 1.5 million in 2039. This makes social care a central part of any national, regional and local discussion on public health in the years to come.

The rising demand for social care, however, is not offset by a rise in staff working in the sector. On the contrary, around 410,000 care workers quit their jobs last year. Vacancies in the sector nearly doubled to 10% in the same period as many professionals faced burnout from the pandemic and grappled with funding challenges.

Despite the integral role the care sector played during the pandemic – and still plays – its role in the public eye is marginal in comparison to that of the NHS.

The future of social care

Social care is not a priority for most people until they themselves reach an advanced age or have a relative who needs to access social care. Even the Queen's Speech did not include any mention of social care – a small yet unmistakable sign that social care does not enjoy high priority in national conversation.



Mitesh Dhanak
Chair

But with effective utilisation of social care and investment in the sector, the backlog in the NHS can be cleared more swiftly. Investment in social care can thus improve health outcomes for not just older adults, but for a much wider population.

It is clear that greater attention and value for social care needs to stem from its present and future users, especially among those who believe that care homes do not provide a positive and fulfilling experience. It is also essential to address the labour shortage by showing how the managerial path offers tremendous career prospects in the sector.

Much of the recent focus has been on workers who are quitting jobs in social care. But we also need to put the spotlight on the number of professionals entering the



Image: © Katarzyna Bialasiewicz | Dreamstime.com

sector. We need to tell the stories of care workers who enthuse about how much they love their jobs and the positive change their work has brought to not just the lives of their patients, but also to their own.

Care Home Open Week

This is why Championing Social Care is hosting Care Home Open Week – a weeklong event targeted at prospective residents and their families, potential employees and policymakers.

Through the event, we will be celebrating the value of social care and connecting care homes across the country with their communities. We aim to present the facilities, services and activities care homes can offer, showcase career opportunities in the sector, and encourage greater community engagement and volunteering.

Last year's event received engagement from Helen Whatley MP (Minister for Social Care), Sir Ed Davey MP (Leader of the Liberal Democrats) and Dr Rosena Allin-Khan MP (Shadow Minister for Mental Health). We aim to forge deeper connections between the sector, policymakers and the public, and establish social care as central to recovery from the pandemic.

Interested participants can register for Care Home Open Week 2022 or learn more by visiting www.championingsocialcare.org.uk/care-home-open-day/.

Mitesh Dhanak
Chair
Organising Committee of Championing Social Care
Founder of Precious Homes
championingsocialcare@caretechfoundation.org.uk
https://championingsocialcare.org.uk/
https://twitter.com/ChampioningCare

Child and family counselling during the COVID-19 pandemic

Kayoko ITO, a professor at Osaka Prefecture University, looks at child abuse among families during COVID-19 and the measures taken to combat it through child and family counselling

In April 2020, a state of emergency was declared by the Government of Japan following the spread of the COVID-19, with requests for absence from work and refraining from going out, leading to isolation and seclusion of child-rearing families, unemployment and insecurity in their lives, as well as concerns about the escalation of child abuse, parenting anxiety, domestic violence and other issues – this led researchers to survey trends of child and family counselling.

In particular, the increased contact time between parents and children due to the closure of schools and day-care centres has increased tension and stress within families, making domestic violence and abuse not only more serious, but also more latent and difficult to detect.

Furthermore, the consultation sections of child guidance centres and government agencies were unable to respond promptly and appropriately due to restrictions such as the inability to make home visits due to the COVID-19.

In other words, COVID-19 did not affect all families equally, but had a stronger impact on vulnerable families who had problems to begin with, such as poverty, abuse and domestic violence.



Clarifying trends in child and family counselling

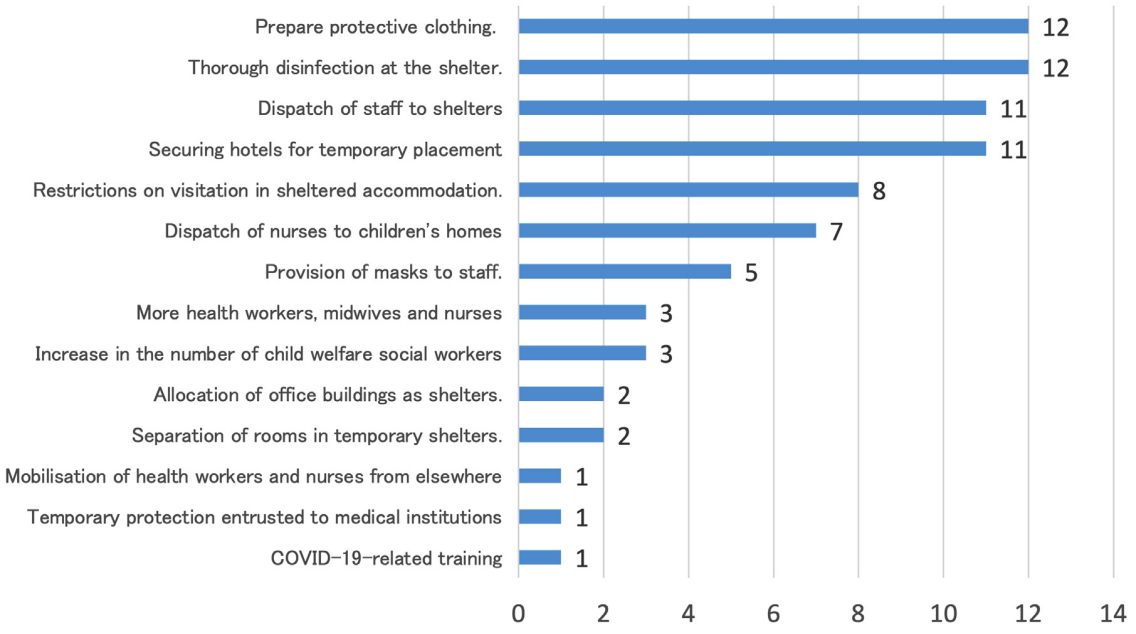
In view of this situation, a questionnaire survey was conducted in this study with the aim of clarifying the actual situation and trends in child and family counselling and support provided by the administration in the COVID-19 pandemic. Based on the results of the survey, the study would like to look ahead to the future of the child and family counselling and support system.

A survey on the actual situation of the child and family consultation system was conducted in 39 municipalities in the Kinki region of Japan. The survey covered the period from March to November 2020.

An increase of abuse consultations

First, the number of child and family consultations was slightly lower than in the same period before the COVID-19 pandemic.

However, looking at the number of cases by type of consultation, only abuse consultations increased. Among abuse consultations, psychological abuse, including domestic violence in front of a child, was on the increase.



Child guidance centres: details of systems in place to respond to COVID-19 (16 locations)

With regard to temporary protection, the number of temporary protection consignments to foster carers decreased, while the number of cases in sheltered accommodation increased.

The most common response to the COVID-19 pandemic in the implementation of child and family counselling was the provision of protective clothing to social workers. It was also evident that all local authorities struggled to secure emergency temporary protection space or facilities for children.

What are the future challenges of child and family counselling?

From the survey results, the following were identified as future challenges for the child and family support system under the after COVID-19 pandemic.

1. Securing places to receive temporary protection: it is necessary to make agreements with nearby accommodation facilities, etc., but how to do this in areas that are not tourist destinations and have few hotels, etc., is a challenge.

2. Resolving chronic manpower shortages in each municipality.

3. Active use of online and telephone consultations: it is necessary to develop and strengthen ICT systems, including online visits between children and parents in institutions, etc.

4. Watching over children and checking their safety during school holidays and school closures: during school holidays, it is more difficult for eyes from outside the home, such as schools, to reach the home, and problems such as abuse can become clandestine and latent. Cooperation with local child welfare volunteers and with private support agencies, such as local children's cafeterias, is important.

5. How to support families in need of outreach: there is the problem of how to check the safety of children while home visits are made difficult by COVID-19. For example, home visits from the government under the guise of 'delivering relief supplies' may be effective.

Osaka Metropolitan University

Kayoko ITO
Professor
Osaka Metropolitan University
Tel: +81 72 254 9796
itokayo@omu.ac.jp
https://kyoiku-kenkyudb.omu.ac.jp/html/100002038_ja.html
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The path to net-zero: Decarbonising the NHS estate

Cameron Hawkins, Head of Energy and Environment at NHS Property Services (NHSPS), describes the path to net-zero when it comes to decarbonising the NHS estate

The NHS is responsible for around 4% of the UK's carbon emissions every year, and therefore, decarbonising the NHS is a part of the UK's overall net-zero strategy.

In fact, all four UK health services have recently made pledges to become net-zero by 2050 which is of huge significance as this is in line with the Government's ambition set out in its Build Back Greener strategy.

The NHS estate itself is integral in supporting the NHS reduce its environmental impact and realise its ambition of becoming the first net-zero national health system. This is only possible with a clear estates strategy, effective communication and collaboration with key stakeholders, coupled with a commitment to reducing reliance on fossil-based resources.

Challenges of decarbonising the NHS estate

Establishing a greener NHS estate requires ongoing dialogue with stakeholders, including the building occupiers themselves who play a key role in ensuring efficient energy usage.

As most of the tenants of the NHS estate are healthcare providers whose primary focus will be patient care, the topic of sustainability may not be at the forefront of their minds. It is therefore critical to instil the benefits, as well as the importance of sustainability, and the role it plays in creating a safe, energy-efficient and green environment. This, in turn, will have a knock-on positive impact on patient care.

A further challenge is finding ways to decarbonise the NHS estate's heat sources. It is particularly difficult to implement technologies such as solar power and heat pumps in an ageing estate, as the condition of existing buildings often limits the feasibility of installing these alternative heat sources. Alongside this, for hospitals in constant use, a reliable, uninterrupted source of energy is essential.

A more sustainable, energy-efficient NHS

Having a clear sustainability plan and strategy with achievable goals is vital to creating a greener NHS estate. NHS Property Services (NHSPS) launched its energy and environment strategy in 2019.

It included around 200 actions, such as improving transport efficiencies, increasing recycling, reducing waste and single-use plastics, improving water efficiency and, importantly, reducing carbon emissions. In the 2021/22 NHS Standard Contract, it is mandated by NHS England that all healthcare services need to have a Green Plan in place. In accordance with this, NHSPS has developed a three-year Green Plan, due to be launched in June this year. This Green Plan will encompass different focus areas with eight clear objectives and is a critical part of its 'Delivering a Greener NHS' programme'.

One of the major achievements since establishing the plan is the introduction of the Environmental Management System, which provides a structured methodology, including legal requirements, processes, assessment, and reporting functions, to manage the NHS estate's environmental impact. This system provides the data needed to track and ensure progress in reducing the NHS estate's environmental impact, all of which is helping to realise the vision of a net-zero NHS by 2040.

Energy consumption is a significant component of decarbonising the NHS. This requires an agile approach to reducing energy. For instance, NHSPS is developing a decarbonisation process to enable the transition away from gas as the main heating source.

It also negotiated a new energy supply deal that introduced 100% renewable electricity across its building portfolio, with the additional benefit of creating no extra cost to customers. The procurement strategy has delivered significant benefits, with cost savings of over £10 million in 2021 – money that can be invested back into the NHS for the benefit of patients and their communities.

Additionally, NHSPS has invested nearly £14.8 million in LED lighting over the last three years, with projects typically paying back in just over two years, saving even more money for the NHS.

Creating more space sustainably

As demand for NHS services grows, so too does the need for increased capacity. This requires the NHS estate to expand in a sustainable way, as demonstrated by a ground-breaking development that will be one of the first net-zero health centres in England – the Devizes Health Centre. With building underway, it will provide an important space for the Bath and North - East Somerset, Swindon and Wiltshire Clinical Commissioning Group to offer primary care to the local community.

This centre is paving the way in sustainable design, as heat pumps and solar panels will be among the green technology used at the site and will enable the building to generate its own heating and electricity. These renewable technologies will not only help conserve resources and optimise energy efficiency but will sustain the site in the long term.

Additionally, it is important to continuously assess how estates across the NHS portfolio can benefit from net-zero strategies. For example, NHS leaders can always lookout to see if there is scope to remove equipment using fossil fuels and work with partners to replace them with renewable energy sources instead.



Cameron Hawkins

Making sustainability a key component of the NHS

Having a continuous assessment process in place ensures that disruption at the site is minimised and project costs are reduced (as project management costs are combined). It can also encourage colleagues to make sustainability a key component of their decision making and therefore help drive a greener NHS.

The achievements made so far to decarbonising and creating a greener NHS estate have been significant, but there is still a long way to go. It is critical to remain committed to finding alternative, renewable energy sources, reducing waste, and instilling a sustainable mentality across the NHS. With continued collaboration and a clear plan ahead, the ambition of a net-zero NHS can be achieved.

Cameron Hawkins
Head of Energy and Environment
NHS Property Services (NHSPS)
energyandenvironment@property.nhs.uk
www.property.nhs.uk
https://twitter.com/NHSProperty

Operationalising decarbonisation in the surgical pathway

The majority of businesses supplying products and services into the NHS through surgical pathways cannot have failed to be aware of the declared intent by the NHS to decarbonise the health system

To provide some impetus to this ambition, the Small Business Research Initiative (SBRI), sponsored by the NHS, launched a national competition last summer seeking solutions from innovators, with the ambition to develop technologies focused on decarbonisation of the surgical pathway. This being a well-known, (at least anecdotally), generator of significant and unnecessary waste.

TCC-CASEMIX Limited was one of the ten award winners of that competition for our PredictOR© proposition. It is focused on the unmet need, which is to transform patient consent, and in doing so provide total visibility concerning the potential carbon impacts of a decision to either undergo surgery or alternatively choose a non-invasive therapeutic intervention.

This need may seem to some readers to be somewhat irrelevant when they have been suffering for years through the pandemic, awaiting surgery. From the many that would have consented to surgery, there would be a significant proportion of them who may have lamented that decision. Indeed, we understand that in a survey undertaken by one NHS trust asking patients about how they felt about their surgery 12 months later on, 37% of respondents replied that they regretted the decision, because they were wholly unprepared for the consequences of the surgery. This is borne out by findings from research.[1,2]

Ongoing pain, disfigurement, anxiety, depression and poor mobility have been cited as significant reasons. It follows that better informed decision-making, could itself lead to decarbonisation. For example, some therapeutic interventions for back-pain have proven to be equally effective, when compared to surgery, 12 months later.

> "Consider the impact on carbon emissions, Net Zero targets, and waiting lists, were 40% of all surgeries in specific specialties to result in non-surgical alternatives."

Informed patient choice

The underlying need is to have much better-informed patients, supplied with comprehensive information, concerning the clinical choices available to them. Being served with a pamphlet, as is the current modus operandi of the National Institute of Clinical Excellence, is never going to be sufficient in this regard. One only has to read the report of the Cumberlege Committee, *First Do No Harm*[3], to understand that there is a substantial body of patients that have suffered hugely because they were either misinformed, or never informed. But what does better-informed mean in reality?

- It means understanding the opportunities for non-surgical interventions, where there is a body of evidence approved by NICE that demonstrates the efficacy of the alternatives for certain patient cohorts.

- It means understanding the measured patient reported outcomes for the surgery being recommended. The body of knowledge is in this area, is highly diffuse, and largely inaccessible to most patients. Dame Cumberlege advocated that it shouldn't be, but two years after her report was first published, the situation has not changed. Change in the NHS is like that of a glacier she lamented.

- It means understanding the risk of each of the options available to the patient. To manage risk effectively, pertinent information and data is required. The significant unmet need today is that many surgeons and anaesthetists simply do not have access to a sufficient body of information to help inform those risks. Likewise, patients certainly do not.

This varies considerably amongst different surgical specialities. If we are to take decarbonisation of the surgical pathway seriously, then it must be recognised that neither do the professional teams have the data required to inform the patient



Image credit: TCC-CASEMIX Ltd.

Szeged University Hospital, Hungary

concerning the risk of the planned procedure to the environment. This is another unmet need delivered by PredictOR©.

A medical device information system

As a direct response to the Independent Medicines and Medical Devices Safety Review (IMMDS Review) by which the Dame Cumberlege review is more formally known, TCC-CASEMIX Ltd has also designed and developed a medical device information system. The review advocated routine data acquisition in surgery. It advocated complete transparency of medical device performance data, and most notably it advocated transparency of medical device failures. But where does medical device performance data currently exist? It is out with the manufacturers. Consequently, our strategy is to engage medical device manufacturers in collaborating with us to address these unmet needs.

> "TCC-CASEMIX® delivers to all of these needs because it provides total traceability of medical device performance used in every surgical procedure."

TCC-CASEMIX® offers clinicians, surgical service providers, and importantly it offers patients too, the total democratisation (and thus visibility) of medical device performance data. Perhaps it can now be appreciated, how PredictOR© fits into this mould. It does so, because embodied carbon performance stored in the medical device information system, is simply another aspect of the functional performance of medical devices with which to inform patient choice.

NetZero for surgical pathways and services providers

PredictOR© thus enables the assimilation of the aggregated carbon in all the resources used to deliver the care to the patient on the surgical pathway. It is not difficult to conceive how all of the accumulated theatre lists, comprising all of the completed surgeries, will then present a picture of the aggregated embodied carbon and operational carbon emissions of the surgical services provider (an NHS trust for example).

It achieves this visibility through another major innovation, one that we refer to as an Open Registry Infrastructure (ORI). It is a unique means to enable patients and surgeons alike to query medical device performance from across Europe. It is a means for patients to become much better informed. Through PredictOR©, NHS Trusts will have access to all of the data required to make new operational policy decisions in the drive towards their surgical carbon reduction targets.

This capability now becomes the basis of 'bottom-up' performance reporting challenging 'top-down' system wide assumptions from our health system leadership. The dawn of a new era of democratisation of surgical performance data is upon us.

1. See also AMA J Ethics. 2020;22(5):E352-357. doi: 10.1001/amajethics.2020.352.
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PredictOR Carbon Analytics

Dr Matthew Bacon
Chief Executive Officer
TCC-CASEMIX Limited
Tel: +44 (0)7812 754 171
matthew.bacon@tcc-casemix.co.uk
http://www.conclude.org.uk/research-development/

It is time to replace single-use medical textiles with sustainable alternatives

Charlie Preece discusses Revolution-ZERO's mission to displace the global single-use PPE and medical textiles market with more effective, economic and sustainable alternatives

Over the last few decades, increasing single-use dependence for medical textiles has created supply chains that do not stand up to stressors, such as pandemics and war, combined with high environmental and monetary costs.

Eradicating single-use medical textiles utilised in the NHS

With 88,000 tonnes of single-use medical device textiles utilised by the NHS annually (derived from gov.uk) their mission is no mean feat, but one they have made huge strides in since their first reusable mask trial with NHS England stakeholders in the summer of 2020.

In 2021 Revolution-ZERO delivered, in partnership with the Royal Cornwall Hospitals NHS Trust, the world's first in hospital clinical rollout of certified reusable fluid resistant surgical masks. Over the 12 months ending 31 March 2022 their initiatives have displaced more than 3 million single-use items and saved more than 36,000 kilograms in CO_2 emissions. Revolution-ZERO revenues have also been used to fund the restoration and preservation of carbon capturing and biodiverse seagrass ecosystems.

The aspirations for Zero Waste and Zero Carbon targets to be met by Revolution-ZERO is through the utilisation of a carefully engineered circular economy system design (see diagram below). The aim is for resources to be continuously cycled in a controlled and increasingly efficient manner. All services offer highly adaptable and readily tailored solutions. Revolution-ZERO's total system offering means they can cover all aspects of product, service, logistics and technical support. This allows both transferability and scalability across the NHS and a wide range of other sectors and regions.

Revolution-ZERO projects and partnerships with the NHS and beyond

Revolution-ZERO in partnership with NHS stakeholders continues to develop reusable medical textile solutions which are more effective, economic and environmentally sustainable that their single-use counterparts. Their work is focused on empowering health systems to have increased control over supply chain, quality, cost and the environmental impact of medical textiles.

Revolution-ZERO have been working onsite with Royal Cornwall Hospitals NHS, supported by SBRI Healthcare, a programme funded by Accelerated Access Collaborative, and the Greener NHS Programme. This work is displacing single use medical textiles in orthopaedic operating theatres with customised, reusable and circular economy Revolution-ZERO alternatives.

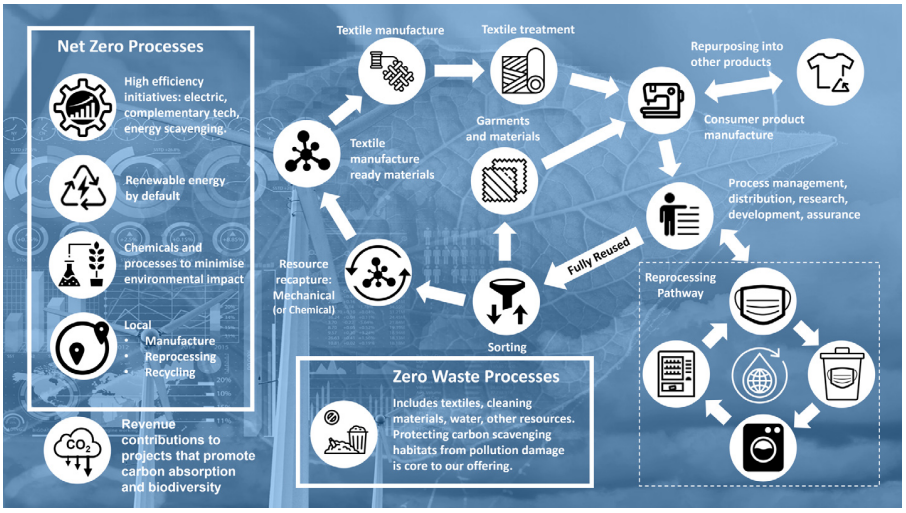
The SBRI Healthcare funded project is actively addressing decades of reliance on the single-use model within the NHS and health systems globally where there are product, infrastructure, logistics, procurement, culture and workflow challenges to overcome. For this work the Revolution-ZERO team have been working with the Royal Cornwall Hospitals, Royal Devon Universities, Sandwell and West Birmingham, Cardiff and Vale and Highland NHS Trusts and Boards along with the University of Exeter and University College London, Anze Ltd and other suppliers.

They have been developing the systems and demonstrating the feasibility of replacing single-use textiles in operating theatre environments. They are now planning for a larger scale rollout over four orthopaedic operating theatres utilising their state-of-the-art ZERO-DECON net zero focused decontamination and sterilisation hub.

Significant projects pushing for a greener medical industry

Complementing this work are multiple other transformative projects across the NHS including the recent delivery

Click to enlarge



of four exciting projects through the NHS Wales Shared Services Partnership including:

1. Reusable surgical theatre textiles demonstrated during major colorectal surgery. This utilised highest quality UK made and customised gowns, drapes and other surgical textiles with local decontamination and sterilisation to 2022 standards. This model gives increased control over supply chain, operations, monetary and environmental costs;

2. Establishing the commercial and environmental feasibility through co-design of reusable Type IIR Surgical Masks (FRSM) within NHS environments in Wales;

3. The specification and implementation plans for the ZERO-DECON modular decontamination units which can be rapidly built and operational offering local employment and industrial growth with high potential for further innovation and value add over time;

4. The NHS Circular Textiles Net Zero Road Map for Wales to 2030 delivered in partnership with the University of Exeter Circular Economy Hub. This built on and integrated findings from the other three projects; establishing targets to deliver environmental, social and economic sustainability benefits. At the centre of this was the Revolution-ZERO circular systems design focusing on multiple cycle of reuse followed by repurposing and eventually recycling into medical textiles or other products.

Measurable impact is key to the Revolution-ZERO journey to Net Zero by 2030 with the focus on circular medical textiles. Revolution-ZERO is enaging widely at national and international level with several organisations including the World Health Organisation, World Bank (IMF) and Médecins sans Frontières.

The environmental impact of 2022 and beyond

In the first three months of 2022, Revolution-ZERO doubled their 2021 environmental impact savings. They are well on course to exceed their 2022 targets of reducing 120,000 kg of emissions along with the displacement of 10 million single use medical textile items.

Revolution-ZERO recognise the huge opportunity to make a significant impact to our future. They are creating and driving national, regional, provider and supplier partnerships to enable them to offer products, services, logistics and technical solutions as part of their total systems approach.

The ongoing and future success for Revolution-ZERO is much needed to realise optimum sustainability within the healthcare medical textiles sector. Close partnerships and collaborations with shared positive outcomes will continue to be critical for the realisation of Revolution-ZERO's vision. To join them on their journey please get in touch below.

Revolution-ZERO
Protecting you and your world

Charlie Preece
Partnerships Director
charlie.preece@revolution-zero.com
https://www.revolution-zero.com
https://twitter.com/RevolutionZERO1



Diagnostic hubs: A short-term fix for a long-term problem?

Collette Johnson, Head of Marketing at Sanome, turns the spotlight onto diagnostic hubs. Are they a short-term fix for a long-term problem, she asks

The idea of a national network of NHS 'one-stop shops' for scans and tests in shopping centres and sports stadiums sounds like a potential solution to the diagnostic bottleneck that has been exacerbated by the COVID-19 pandemic.

But anything involving millions of patients, expensive diagnostic equipment and thousands of highly trained medical staff is never going to be that simple.

Will diagnostic hubs help tackle the NHS backlog?

It's clear that something needs to be done to identify life-threatening diseases such as cancer and diabetes sooner and drive efficiency to tackle the NHS's huge treatment backlog. But will community diagnostic hubs cure the problem or simply move the bottleneck elsewhere?

There's no doubt that many patients will like the convenience of getting their X-ray or MRI scan done during their weekly shopping trip. It's a good opportunity to reach people who can't or won't go to hospital – the elderly or people in rural areas, for example, who may face transport issues.

But there will be others who will be put off by the very public setting of a shopping centre or sports stadium at a time when they may already be feeling vulnerable if they're suffering from worrying symptoms.

Visiting a breast cancer screening van in a supermarket car park is generally accepted because it's something most women of a certain age do, even when they're perfectly healthy. Running the gauntlet of shoppers in your local mall for a CT scan when doctors suspect a serious problem is a very different scenario.



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Another stumbling block is the fact that patients will still need to see their GP in the first instance for a referral to one of the diagnostic hubs – and we all know what a challenge that can prove to be, particularly in the wake of the pandemic.

> "When it comes to tests for serious conditions like cancer, most people would probably prefer to be in a medical centre rather than a shopping centre."

To take the pressure off GPs and really make an impact on waiting lists, the community hubs would work better as walk-in centres where patients are triaged on arrival. That would also ease the pressure on over-stretched A&E departments as people would have an alternative for worrying but not immediately life-threatening symptoms.

There is also the question of whether clinical commissioning groups and primary care providers will actually want to open diagnostic hubs in shopping centres because of the cost involved. It will be far more convenient – and cheaper – for them to link the hubs to their existing sites. And perhaps that is more appropriate anyway – when it comes to tests for serious conditions like cancer, most people would probably prefer to be in a medical centre rather than a shopping centre.



Collette Johnson

Progress hindered through staff shortages

Staffing the community hubs is another challenge. The Department of Health and Social Care has said the 100 centres planned by early 2025 will need an extra 3,500 radiographers to carry out diagnostic tests and 2,000 radiologists to interpret the results, as well as 500 advanced practitioners – radiographers with additional training to report on images.

But the Society and College of Radiographers claims the extra 6,000 specialists do not exist and says the centres will be staffed with people who are only available because they have left jobs elsewhere in the

How the NHS can reduce waiting times for patients

Professor Sir Mike Richards, Chair – Independent Review of Diagnostic Services for NHS England said on diagnostic services, "The COVID-19 pandemic has further amplified the need for radical change in the provision of diagnostic services, but has also provided an opportunity for change." One of his main recommendations is separating acute and elective diagnostics to make them more efficient. [1]

Elective diagnostics are those required directly by general practitioners and on a patient basis by a specialist. Many of these tests in the future will be requested following virtual consultations. Acute diagnostics are those relating to patients presenting to emergency departments and for inpatients in acute hospitals.

"The health service will build more than dozens of community diagnostic centres as part of the new elective care recovery plan."

"The health service will build more than dozens of community diagnostic centres as part of the new elective care recovery plan."

In October 2021, the NHS announced the creation of 40 new community diagnostic centres in the UK, setting out to achieve quicker and a greater degree of direct access to the complete spectrum of diagnostic tests. Patients can be referred by GPs to local centres directly for the earlier diagnostic tests which also helps to reduce hospital visits and potentially aims to reduce COVID-19 transmission [2].

"By 2025, the NHS will increase its capacity to deliver more scans and procedures in each of the next three years to nine million more tests and checks."

In February 2022, NHS Chief Executive Amanda Pritchard and Health and Social Care Secretary Sajid Javid announced that the health service will build more than dozens of community diagnostic centres as part of the new elective care recovery plan. Through the "Delivery plan for tackling the COVID-19 backlog of elective care," patients can be in more control of their own health plus where to seek care when they are waiting too long for treatment. By 2025, the NHS will increase its capacity to deliver more scans and procedures in each of the next three years to nine million more tests and checks. [3]

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NHS. The Royal College of Radiologists has warned this could have a knock-on effect on waiting times for tests in hospitals – creating a new bottleneck that could delay the start of treatment and potentially lead to poorer outcomes for patients.

"For patients' sake, let's hope it doesn't turn out to be a short-term fix for a long-term problem."

It's encouraging that the NHS Long Term Plan has recognised the crucial role played by rapid access to diagnostic tests. But it remains to be seen whether the new diagnostic hubs will expand capacity rather than just lead to services being transferred from hospitals into the community. For patients' sake, let's hope it doesn't turn out to be a short-term fix for a long-term problem.

Collette Johnson
Head of Marketing
Sanome
hello@sanome.com
https://sanome.com/

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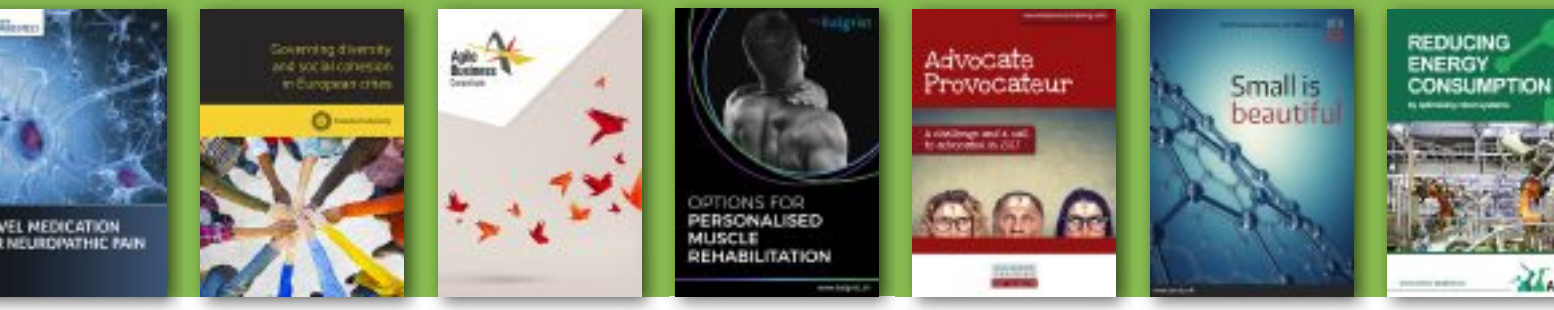
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ScanBox: Thinking inside the box for NHS diagnostic services



NHS diagnostic services have been placed under immense pressure by the COVID-19 pandemic, now, Fairford Medical's CT ScanBoxes can ease up resource burdens

As well as the devastating effects of the virus itself, the Covid-19 has caused significant disruption to NHS diagnostic services, and urgent services such as cancer and cardiac services.

Pre-pandemic, the United Kingdom already faced a severe lack of provision of imaging equipment and had one of the lowest number of MRI units and CT scanners per capita among EU countries.

When the Covid-19 pandemic was declared, these shortfalls only grew

Scanners were commissioned and rented out, and funds and staff were redirected to Covid-19 wards. Now that the NHS' management of Covid-19 has improved, the NHS is grappling with a backlog of 5.45 million people currently waiting for hospital treatment – patients for whom imaging diagnostics will be a crucial part of their care.

Faced by this shortage of equipment, staff and funding, NHS England announced plans in October 2020 to radically overhaul the way NHS diagnostic services are delivered for patients in a bid to improve outcomes for patients and deal with the huge backlog of scans for cancer and other serious conditions.

What is the NHS' new approach to diagnostic services and what does it mean for equipment providers?

As part of its Long Term Plan, NHS England has recommended focusing on community diagnostic hubs – so-called 'one-stop shops' - away from healthcare facilities, so that patients can receive vital checks faster, closer to their homes and in a safe environment. NHS England said it wants to double the CT scanning capacity over the next five years to meet increasing demand.

To implement this strategy, the NHS will require significant investment in facilities and equipment which should be available on high streets, parking lots or retail parks. By separating diagnostic checks in A&E from tests taken ahead of routine procedures, the NHS hopes that every patient will be "able to get a scan on the day".

With the NHS looking for a nimbler and more affordable model to deliver its services, including community-based can relocatable equipment and services help the NHS manage the upsurge in demand for diagnostic services?

Fairford Medical's vision for the future of the NHS

Founded in 2016, Fairford Medical understood mobile and relocatable MRI and CT scanners would be an answer to the UK's chronic shortage of imaging equipment. Today, the

company focuses on providing individualised, mobile and relocatable scanners as suitable solutions to the sector's multi-faceted problem.

Because building relocatables has traditionally been expensive, Fairford Medical created the CT ScanBox. Made available to the NHS at a reduced cost through a procurement framework for short, medium- or long-term use, savings are thus passed on to hospitals and clinics.

Instead of being craned into a hospital, compact CT Scanboxes can be driven into place and installed in less than an hour. Their hydraulic legs ensure they can be easily dropped into place, effectively saving precious time for healthcare practitioners and patients.

CT ScanBoxes are packed with state-of-the-art personalised features tailored to the needs of any service or facility. All maintenance is provided directly with the original equipment manufacturer of the machines.

Relocatable modular solutions allow for flexibility in healthcare

This is why the Liverpool University Hospitals NHS Foundation Trust ordered a CT ScanBox in 2020 after realising that its new CT Scanner from Siemens had no designated site.

The trust decided that a relocatable modular solution would allow the flexibility to put the CT into service faster than identifying and equipping a static setting – and that it could redeploy the system in future to another site if needed, with minimal impact and down-time.



The quality of the ScanBox meant there would be no compromise in staff comfort, efficiency and overall patient experience. After the relocatable was built at Fairford's coachbuilders in the UK, an area at Aintree Hospital was identified as the ideal site.

Be it in a hospital car park or outside a clinic, the CT ScanBox supports a wide range of the latest CT scanners and additional support modules can include waiting areas, changing facilities and spaces for after-care and private meetings.

Because of their affordability, mobility and adaptability, ScanBoxes represent an opportunity to assist with Community diagnostic hub roll out, the recovery and renewal of the NHS, and improve outcomes for patients with serious conditions that have sadly been on waiting lists since Covid-19 hit in 2020.

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Matthew Bradfield
Managing Director
Fairford Medical Ltd
Tel: +44 (0)207 317 3000
matthew@fairfordmedical.com
www.fairfordmedical.com
https://www.linkedin.com/company/fairfordmedical



Are Community Diagnostic Hubs the way forward?

Medispace, a provider of fully equipped MRI trailers and CT trailers, looks to the future of community diagnostic hubs, advocating for much-needed changes to be implemented

Medispace is a provider of fully equipped MRI trailers and CT trailers, providing both modular and hybrid units for hospitals and private clinics. We also provide staffing services, if needed.

In the upcoming years, we will expand our fleet with more high-end systems. We want to be the supplier, of choice, for diagnostic solutions with added value, as well as constantly searching for new, innovative solutions with an open and entrepreneurial mind.

"Hospitals and clinics in the United Kingdom are continuously requesting Medispace to provide mobile and modular units and related services. They are doing this when they temporarily need extra capacity due to a renovation or an increased demand for care" said Sander de Mooij, CEO of the Medispace Holding BV.

Additionally, the paper "Diagnostics: Recovery and Renewal" by Professor Sir Mike Richards highlights the need for radically overhauling the way MRI, CT and other diagnostic services are delivered – which is greatly increasing the request for diagnostic imaging equipment. [1]

Change is needed to cope with the increase of patients and diagnostics services needed

Many community diagnostic hubs (CDHs) or 'one stop shops' could be created across the country away from hospitals, so that patients can receive life-saving checks close to their homes. These centres could be set up in free space on the high street or retail parks.

The question we need to ask is if the CDHs are the way forward or not? Many hospitals want to keep the patients close to the hospital site but are also realising that a change is needed to cope with the increase of patients and diagnostics services needed. We all agree that a service should be created that is quicker, as well as being still being a safe environment for the patients.

Looking at the statistics, the amount of MRI and CT's scanners per 10,000 population within the UK is still very low. New investments will be needed to handle all patients that need diagnostic imaging in the future.

The most important step forward, in my opinion, is to separate the acute and elective patients and diagnostics. This is the first step.

Diagnostic possibilities and services

The creation of a CDH with all diagnostics possibilities is the optimum solution but are we not creating small hospitals outside hospitals again. A small CDH that targets specific elective diagnostics services could be and can be managed in a much better and accurate way.

For all the CDH's new investment is needed for imaging and equipment, which is possible however the biggest challenge we have is the imaging workforce. The imaging workforce will need to be expanded with 2,000 additional radiologists and 4,000 radiographers, as well as other support staff. Hospitals are struggling with staff shortages already now as not a lot of people are interested working within the healthcare due to long working hours and night shifts.

The training of new radiologists and radiographers will take up to 2-3 years and only after this training and education of the workforce, we will see an impact on the reduction of waiting lists. We also should start to think out of the box and use technology that is available.

Radiologists are already using artificial intelligence (AI) for diagnostics and are sharing reporting workloads between hospitals and gaining access to specialist opinions.

For radiographers, there is also technology available that could assist them, but are we ready for that?

Siemens Syngo Virtual Cockpit:

Highly qualified staff is hard to come by and a relevant cost factor. In addition, some procedures are just less common than others. This leads to a situation in which not all technologists can confidently realize all examinations at the same high standard. As one result of this, not all procedures can be offered at all sites at all times.

Siemens syngo Virtual Cockpit, a software for remote scanning assistance, lets you make the most of your imaging devices. With remote scanning assistance, you can transform care delivery and achieve a higher level of standardization that leads to more accurate diagnoses. [(2)]

Medispace is discussing with Siemens how to implement the Siemens Syngo Virtual Cockpit on all the units. This will enable radiographers to be supported in making MRI and CT scans from a central location, meaning that all radiographers within the virtual cockpit platform can learn and assist each other.

More senior radiographers will be able to assist junior radiographers. In the future, we could even think of using trained healthcare assistants to position the patients on imaging equipment and the actual scanning can then be done remotely by a senior radiographer.

Medispace has already tested this software, and it shows that a senior radiographer can operate three scanners at one time. This is the way forward.

Looking at the current regulations we need two full-time radiographers during contrast imaging and one radiographer and one healthcare assistance during non-contrast imaging, therefore if we wanted to use the virtual cockpit software regulations for this need to be changed and implemented.

As Medispace, we are ready for it, but will there be an acceptance on national, regional and or local level scale? This change can only be implemented if it's driven by highly skilled and committed managers and clinicians, who will need to be supported by administrative and support staff. Without this, there is a real risk that the much-needed changes will not be implemented.

Community Diagnostics Hubs are the way forward but can only be achieved if changes are implemented.

We are ready for it, but are you?

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Sander de Mooij
CEO Medispace
Medispace Diagnostics Ltd.
Tel: +44 (0)192 566 1704
info@medispace.eu
www.medispace.eu

The changing landscape of primary care data sharing

NHS Digital's Programme Head for GP Data, Eva Simmonds, discusses the benefits and challenges of health data sharing and looks to the future for the GP Data for Planning and Research programme



Every time patients come into contact with the NHS, we could learn a little more about the nation's health and about the NHS services we provide. By safely and securely collecting and analysing this information across all patients, we could build up a detailed picture which is crucial to research new treatments, deliver the right services and improve the NHS.

The use of patient data, to both help plan the right public health and NHS services and to drive clinical research, has the power to transform our understanding of what causes ill health and, importantly, what we can do to prevent or treat it and provide better care.

You don't need to look far to see the benefits of this in practice; the pandemic has shown us just how critical this data is, enabling us to identify and protect the most vulnerable.

It also helps local NHS bodies to plan their services effectively, becoming far more responsive to the needs of the patients they serve.

"The service aims to protect the privacy of those whose data it holds, so patients can rest assured that their health records are handled safely, and privacy and confidentiality risks are minimised."

The benefits extend beyond these, of course, as Dr Marion Mafham, NHS consultant kidney specialist and researcher at the University of Oxford, wrote in her piece last year.

However, while the benefits are well understood, using GP data for uses beyond an individual patient's care is a sensitive area. It is crucial that patients and the public understand that they have choices about the way their

data is used, and we must be transparent about the safeguards we have put in place to keep data safe.

And so, having reflected on the feedback, we have strengthened our governance and decision-making processes in response.

> "The use of patient data, to both help plan the right public health and NHS services and to drive clinical research, has the power to transform our understanding of what causes ill health and, importantly, what we can do to prevent or treat it and provide better care."

Three main priorities for primary care data sharing

When the GP Data for Planning and Research (GPDPR) programme launched in spring 2021, it was met with concern from some patients, public and professionals about what security and controls on access to data would be put in place.

Such was the level of concern, it prompted a redesign of the programme to address the issues raised and to meet the conditions subsequently set out in a letter to GPs from Jo Churchill MP, the then Parliamentary Under Secretary of State for Primary Care and Health Promotion.

We've been working hard with a range of key stakeholders to redesign the programme since then. However, a lot of this work takes place behind the scenes and so it isn't immediately obvious to the public, how far we have come.

It has taken some time for us to work through the practicalities of meeting the minister's commitments. We reflected on the feedback and strengthened our governance and decision-making processes, organising ourselves around three key areas of work.

Our first key area is communications. We made sure we developed an ongoing conversation with both stakeholders and the public about patient data that



continues to this day. We learn from the feedback we gain from this and use it to shape our approach.

We've also been working hard to address the concerns around data sharing, and how it will be managed and governed, by working towards providing secure access to data within Trusted Research Environments.

These provide approved researchers from authorised organisations with timely and secure access to health and care data, enabling collaboration within the same research project.

This keeps the data fully within our control and only provides access to the data the researchers are authorised to access, within the security perimeters of the Trusted Research Environment. The service can then monitor and track who has accessed the data and it can never be shared with unauthorised people or linked to other datasets without our approval.

So, by its very design, the service aims to protect the privacy of those whose data it holds, so patients can rest assured that their health records are handled safely, and privacy and confidentiality risks are minimised.

Finally, there was the burden of 'Type 1 opt-outs' on GPs and practice staff. We've been engaging with the profession to identify ways in which we could reduce that burden, while also providing a good customer experience for anyone who chooses to apply a 'Type 1' opt-out.

Three critical friends to assure consistency

Having expert, independent opinions is crucial to ensure that our work remains on the right track. With this in mind, we set up three external assurance groups to act as 'critical friends' and to check our thinking as we work.

For independent advice about information governance and legal issues, we set up the Information Governance Expert Liaison Group. This is made up of representatives across a range of stakeholders including NHS England, the Department of Health and Social Care, the Information Commissioner's Office, the Office of the National Data Guardian, the Confidentiality Advisory Group and the Independent Group Advising on the Release of Data (IGARD).

The Patient, Public Engagement and Communications Advisory Panel gives a patient and public perspective on our work, providing a regular forum to share ideas, concerns and best practice around data sharing, as well as inviting views on the best ways to engage with patients and the wider public in an accessible way. They ensure that the voice of the patient is clearly heard as we continue to refine the programme.

Finally, the Check and Challenge Assurance Group is made up of experts who are able to scrutinise our ideas and plans as they develop. Valued stakeholders such as the British Medical Association, the Association of Medical Research Charities and the Office for National Statistics, amongst many others, can represent the views of the profession, data usage, data sharing and wider data community and challenge where the approach of our programme is thought to be diverging from the commitments and conditions made over the last year.

All of these groups ensure that the new GP data for planning and research programme remains on course to deliver the clear benefits that it will bring to patients, the public and the NHS, itself.

Onto the future

We are absolutely committed to improve how we use data in an open, transparent, and inclusive way, to help us understand how and where to improve health and services and treatments. The voice of the public and stakeholders will be used to shape how we progress at every stage.

We will only move toward data collection when we are confident that we have met all the terms in the minister's letter. While we paused our public engagement to work out the proper programme approach, we now hope to see a lively conversation and debate in this vital area. We're looking forward to working with you.

Eva Simmonds
Programme Head for GP Data
NHS Digital
Tel: +44 (0)300 303 5678
enquiries@nhsdigital.nhs.uk
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Simplifying the purchase of medical monitors in the NHS



Ingo Aicher, managing director at Jones AV Ltd., promotes the easy-to-use online specialist medical monitors which will transform British hospitals

The launch of the new online shop has established a new and easy to use resource for medical practitioners and the NHS to simplify the purchase of medical monitors and specialist hardware.

The devices on offer include surgical displays for use in operating theatres, clinical review monitors for use in MDT meetings or doctors' surgeries and high-end radiology monitors for diagnostic purposes.

As any medical technical engineer, radiologist, surgeon, or purchase specialist knows, getting your hands on one of these devices has traditionally been marred by a string of hurdles to purchase.

Medical specialist devices in the time of the internet

Whilst in 2022 most things can be easily obtained on major web portals, the increased usage of online purchasing during the pandemic has still not touched the world of medical specialist devices. It continues to be elusive to the ease of one-click shopping or price comparison.

> "Our portfolio of surgical displays is designed for real-time imaging in the operating room."

Anyone having been involved in the purchase of such devices knows how hard it is to find a specialist dealer, enquire about stock and pricing, obtain quotations, raise purchase orders and then finally having to deal with long lead times when you need a device urgently.

Traditionally the pricing on these devices is a well-protected industry secret, as to allow each of the sellers to make up their pricing as they go along. This makes price comparison difficult prior to the lengthy purchase.

Offering buyers and the NHS a transparent one-stop-shop

The shop features prominent and trusted manufacturers such as BARCO, LG, and Advantech and brings some newcomers to the UK market.

High quality diagnostic and clinical review monitors designed for health-

care professionals ranging from 21" to 31.5" and up to 12MP resolution.

Check out Barco's extensive line-up of high-precision medical monitors brings accuracy and efficiency to a broad range of healthcare disciplines. Confident diagnoses while guaranteeing perfect image quality over time, and across displays.

Our portfolio of surgical displays is designed for real-time imaging in the operating room. It comprises near-patient and large-screen displays for use in any environment where surgical procedures are carried out, including the endoscopy room, interventional suite, or hybrid OR. Available in high definition or 4K ultra-high definition, and in 2D or 3D.

We also offer an array of inwall PACS consoles for theatres, which are optimized for cleaning and infection control. These displays offer Dicom grade image reproduction and can be equipped with specialist medical computers to easily access PACS images on the hospital network.

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Jones AV are a leading supplier of cutting-edge medical systems integrations across Europe and the Middle East for the past 14 years.

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> "We are trusted experts in bringing technology to the operating theatre, helping to improve clinical workflows and patient outcomes."

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Framework reference: SBS/18/CR/WCN/9343

Find out more about Jones AV on www.jonesav.co.uk

Ingo Aicher
Managing Director
Jones AV Ltd.
Tel: +44 (0)151 675 0675
info@jonesav.info
https://jonesav.net



Interoperability and integration to future proof healthcare

How VitalHub UK is leading the way in supporting the way to become fully interoperable through digital transformation.

By Lisa Riley, VP of Strategic Product and Partnership Development

Integrating care has long been a challenge and a priority for the NHS, and with new models of care emerging and evolving, there is a distinct need for more effective information sharing between care settings, organisations, and across boundaries, as well as between professionals and patients, to optimise outcomes, improve services and enhance the quality of care.

This is heavily reliant on the ability of systems across health and social care to be interoperable with one another, a key factor for the future vision of care in England.

Advancing models of care to enable cross-system working, with open and transparent sharing of data across whole-health systems, is necessary to enable care professionals and patients to better manage care and improve patient flow.

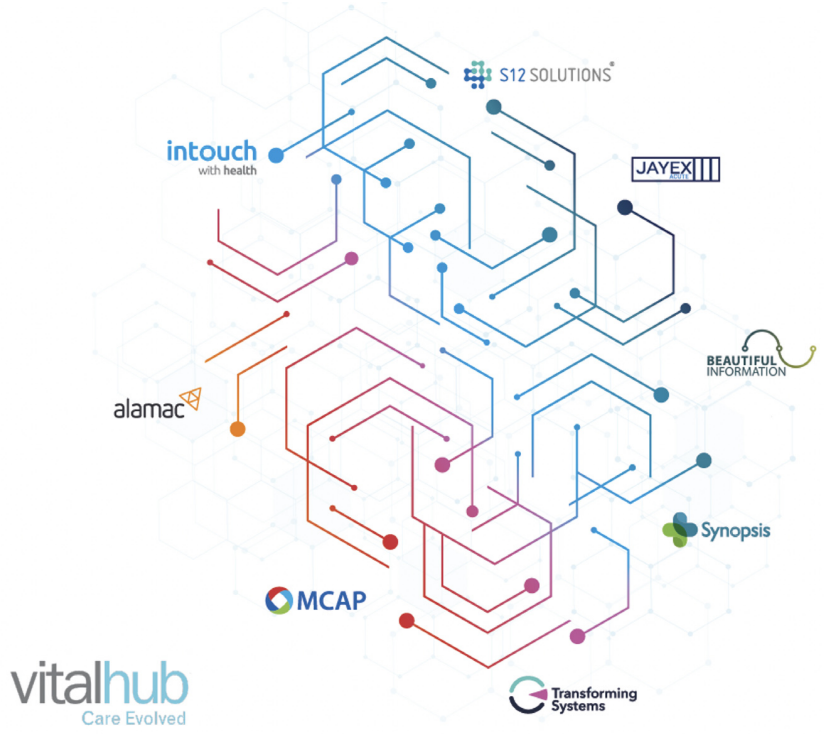
The benefits of successfully delivering an interoperable healthcare system are significant: improved patient safety through reduced errors; more integrated care by making the right information available at the right time in the right place; enhanced pathway management to heighten both patient and service provider experience; patient empowerment with the ability to manage to access their information; and supporting the use of data to improve and future proof care services. Interoperable systems save valuable time, time that we cannot afford to waste in terms of efficiency, but more critically, time for patients.

Ensuring interoperability across health and social care systems

Ensuring interoperability across health and social care systems inevitably means that delays can be avoided, speeding up the patient's time for treatment and care. By 'joining the dots' and linking NHS organisations through real-time technology, we can move away from the typical historic siloed working practices, transforming care provision through digital integration.

The VitalHub UK group, integration of 8 leading health technology companies, is providing a unique and powerful suite of solutions that supports the NHS to exploit the potential of digital technologies and transform the delivery of care and patient outcomes through interoperability.

Vitalhub UK, comprising Transforming Systems, Intouch with Health, Synopsis, Beautiful Information, MCAP, Alamac, Jayex Acute and S12 Solutions, understands the complexities of integrating disparate systems between organisations and across boundaries, to create the one single version of the truth, thus painting the bigger picture. Our expert knowledge of where to join the dots, allows us to support organisations to digitally connect services and systems, allowing us to play a pivotal role in whole-system integration.



Exploring the range of innovative solutions

The range of innovative solutions within the VitalHub UK group includes data sharing tools to effectively manage patient flow, demand and capacity, discharge optimisation, whole-system visibility, remote care, patient tracking and operational processes. This utilisation of live data sharing helps to deliver the prescriptive intelligence required to empower decision-makers with key information to better coordinate and streamline patient care services across any geographical footprint.

Transforming Systems: a live operational management platform, SHREWD, that provides instant visibility of whole-system data, supporting improved patient flow and safer, more effective care for patients.

Intouch with Health: a holistic platform for elective care services, supporting hospitals to manage entire patient workflows and optimise flow in outpatient care in an efficient manner.

Synopsis: a digital pre-operative assessment platform for elective surgery, reducing risk and optimising patient throughput to the theatre.

Beautiful Information: a real-time solution to help plan and track each step of every patient's journey and next steps, from admission to discharge and into the community via our live patient tracking lists.

MCAP: Making Care Appropriate for Patients – a clinical decision support tool that determines the appropriateness of reasons to reside and acuity of care in medical, surgical and mental health settings.

Alamac: a performance reporting service that collates and interprets healthcare performance information to support improvement initiatives and better planning and understanding of pathway capacity and demand.

Jayex Acute: A patient flow platform, streamlining outpatient services and elevating the patient experience, utilising easy-to-access data.

S12 Solutions: a platform that supports the mental health assessment pathway, from patient referral for Mental Health Act assessment to admission to hospital, connecting AMHP and s.12 doctors more efficiently.

Through the implementation and utilisation of our intuitive, agile solutions, we are creating a joined-up technological infrastructure at the trust, ICS, a regional and national level that is helping to support the future vision of integrated care in the NHS.

To learn more about VitalHub UK please get in touch at ukgroup@vitalhub.com

vitalhub
Care Evolved

Lisa Riley
VP of Strategic Product & Partnership Development at VitalHub UK
Lisa.riley@vitalhub.com
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The Case for 'Best of Breed' Collaborative Solutions in Digital Health



Phil Evans, EIDO's Director of Partnerships, writes about the crucial importance of collaborative solutions in digital health and the healthcare sector

It is becoming something of a cliché to say so now, but the pandemic has driven the pace of innovation like never before. The digital health marketplace is flourishing with a bewildering array of software, applications and services, catering to every patient and clinical need, thanks to collaborative solutions in digital health.

No more is this the case than for the newly formed Integrated Care Systems (ICSs), for which innovation is both a key driver and a key challenge. Born out of 'a plan for the health needs of the population', their remit is to identify and take advantage of the opportunities for healthcare transformation.

On the face it therefore, this has opened the door to new opportunities, both for NHS providers, but also smaller supplier organisations who are seeking to make their mark in the digital health world. Previously (in STP's and earlier incarnations), such opportunities may have been restricted to a handful of 'big name' clinical systems providers. The opportunity now is for a paradigm shift in thinking and procurement; one which puts much clearer emphasis on a 'best-of-breed' approach to patient care, delivering benefits in efficiency, clinical effectiveness and value for money.

For SMEs at the forefront of digital innovation, this presents a golden opportunity to create a shared vision, and bring expertise and innovation together to deliver better patient outcomes and seamless clinical experiences.

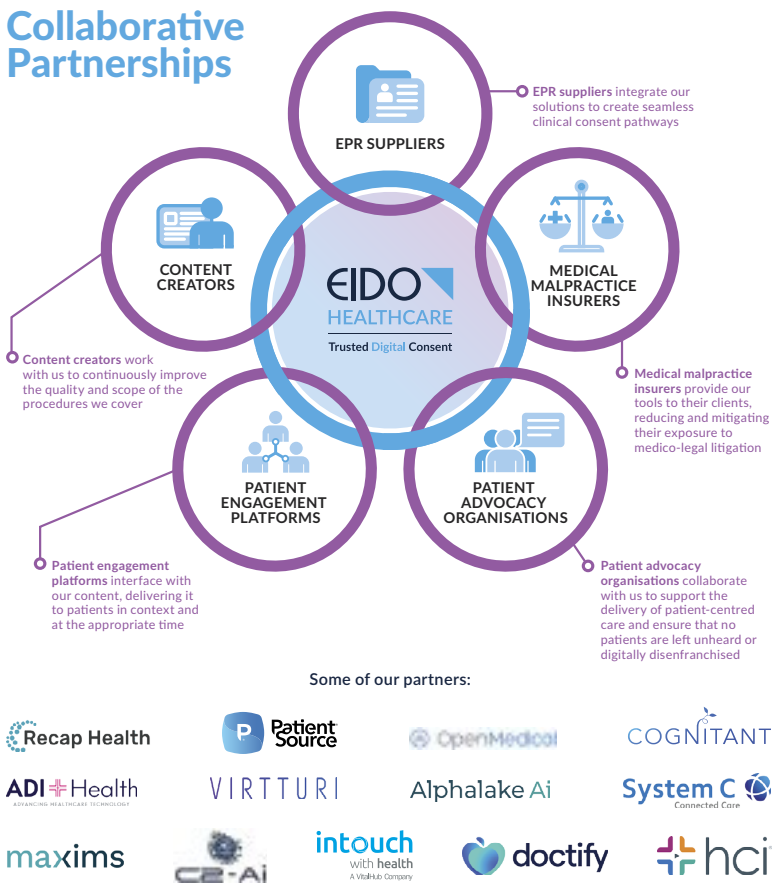
Bringing organisations (and minds) together in this way across the healthcare sector can deliver demonstrably better results than any single supplier can deliver by itself. It can accelerate digital transformation, enable better multi-disciplinary working and improve patient care.

How, then, can the NHS leverage the power and clear benefits of this collaborative approach?

The first step is to accept that there is no single system which can solve every problem straight out of the box. Clinicians, administrators and purchasers must collectively buy into the truism that suppliers working in their respective areas of expertise can deliver a whole that is much greater than the sum of its parts.

Trust is a necessity in this vision. The famous phrase 'nobody gets fired for buying IBM', originally coined in the technology industry, is equally befitting of healthcare. It comes from a time where deploying an IBM system was seen as the safest bet. Stick with the megabrands…play it safe…maintain the status quo. Hardly a fertile environment for innovation. All of which means that the NHS, a traditionally risk-averse organisation, must be willing to trust smaller suppliers and give them a chance to prove their worth.

The NHS wants to be open to new ways of working, but at the same time will frequently only procure tried and tested solutions. It cannot do both. And the great irony is that smaller, specialist suppliers (who are typically perceived as riskier) may actually be better-equipped and more responsive to their client's needs than their larger counterparts.



So, what about SMEs?

How do SMEs make the pitch for collaborative solutions in digital health in an environment that, traditionally, has been dominated by larger suppliers?

A proactive and open-minded approach is crucial. Digital health companies cannot be reactive and simply wait to see what requirements come out of the newly formed ICS structure. They are culturally well attuned to solving complex problems such as those presented by the ICSs, and must take the initiative in forming the solutions.

Not only can they provide a much richer solution which delivers value across the whole patient pathway, but more importantly they can evolve responsively and innovate continuously to meet the constantly changing needs of their users. The onus is on them to present this vision proactively, before the NHS can fall back into the evolutionary dead-end of old, rigid procurement patterns.

The new ICS structure will present challenges not seen before.

Therefore, in addition to being integrated care systems, they will need to be *innovative* care systems. An alignment of vision amongst suppliers and a truly collaborative environment will allow this innovation to flourish.

When it comes to delivering joined-up 'best-of-breed' collaborations, EIDO thinks outside the tick box, and is ready to play its part in meeting the challenges the NHS now faces.

About EIDO

EIDO Healthcare provides trusted digital consent solutions to successfully obtain and manage informed consent.

Proven over 20 years, our solutions are deployed across five continents and over 1,000 hospitals, supporting more than eight million surgical consent decisions annually. EIDO is committed to supporting health professionals in achieving excellence in this vital area, to enhance ways of working for clinicians, and improve patient understanding, experience and outcomes.

At EIDO we know that informed consent is a cooperation and partnership, not just in the shared decision-making between patients and clinicians, but also with partners who understand that no single system can optimally do everything.

With digital informed consent becoming a standard requirement of a joined-up healthcare ecosystem, technology suppliers are collaborating with EIDO on 'best-of-breed' patient-centred solutions to support wide-ranging clinical workflows and cross-specialty patient journeys.

To find out more about EIDO's partnership activities, and how you can be involved in a growing collaborative partner ecosystem, please view our partner webpage or contact phil.evans@eidohealthcare.com.

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Phil Evans
Director of Partnerships
EIDO Healthcare LTD
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How language and communication barriers affect UK government organisations

Joe Miller, Pocketalk General Manager of the Americas and Europe, explores how language and communication barriers affect UK government organisations & the solutions available

The latest stats on immigration show that there are now 9.5 million people living in the UK who were born outside of the country. Data from the ONS shows that net international migration will account for almost three-quarters of UK population growth over the next 25 years.

Although not a new problem, events over the last few years have seen a growing number of those who have English as an additional language (EAL) relocate in the UK.

For example, the recent Ukraine invasion has seen the UK government open up its 'Homes for Ukraine' scheme which has granted over 95,000 visas. This volume of refugees with little time for preparation can put pressure on already strained resources when it comes to communication.

So how is this impacting government departments?

Health & social care

Recent research conducted by Pocketalk shows that more than a third of healthcare workers agreed that language barriers make it more difficult to assess a patient's needs. It also found that healthcare workers are losing as much as half a working day every week – four and a half hours - overcoming communication challenges.

Healthcare and social workers are reliant on individuals' ability to communicate with them to help. Interactions with people who have English as an additional language (EAL) can create confusion, delays and worryingly, misdiagnosis.

Additionally, communicating with loved ones can also be challenging and create upsetting situations.

With health and social care services already facing delays following the pandemic, the added pressure of communication barriers can put additional pressure on time and resources.

Education

For parents and guardians who have fled war zones or difficult living situations, establishing children within education as quickly as possible is a priority.

Settling in any new student won't happen overnight, but when that child has EAL it adds a dynamic that requires extra time and attention. Fostering friendships with classmates is often a primary focus for new students, but with a language barrier, it can be extremely difficult to facilitate, leading children to feel isolated and lonely.

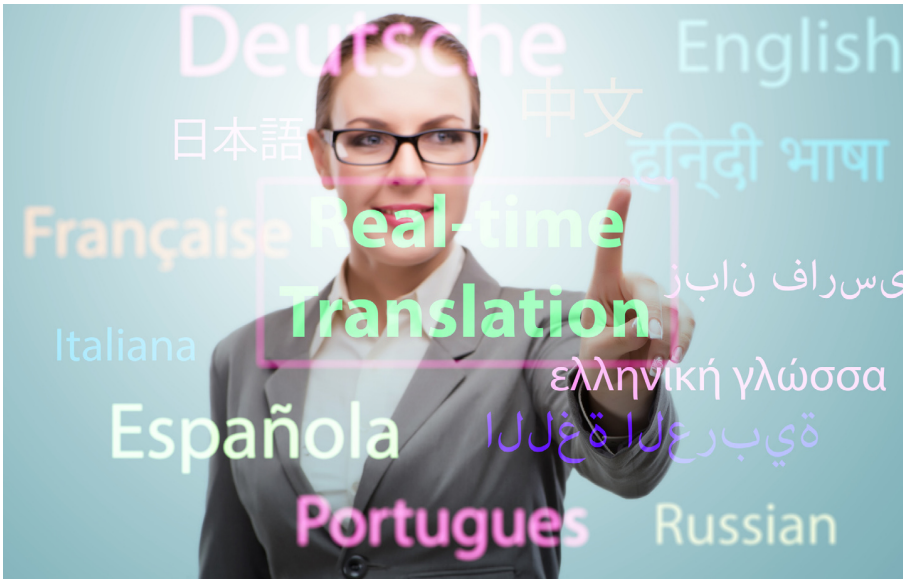
It also impacts learning. When learning is conducted in a foreign language, it's almost impossible for students to keep up and even if they do have English skills it can be very tiring to translate everything all day.

Save the Children's research found that whilst it's important children learn in their adopted language, it's also really vital that they are taught in their native language to aid better learning - something most teachers in the UK are unable to do.

Housing

Refugees and migrants will often need housing support when they first arrive in the UK. Or they may need new accommodation as needs change.

Many housing associations are faced with the communication challenges that come with non-English speakers and, therefore, it can take longer to accommodate their needs.



Having recognised that customers and employees in the housing sector come from diverse backgrounds and have a diverse range of needs, we partnered with Together Housing, a housing association which manages over 36,000 social housing properties in the north of England to understand the services they use and the limitations they have.

How are these needs being addressed?

In person interpreters are favoured by many departments as they can meet the needs of different languages and dialects. Having someone in the room can make the non-English speaking individual feel more comfortable.

But, it's expensive. Interpreters needing to physically be somewhere require travel as well as the time to conduct the translation. If there is an immediate need, they can't always be there on time. Some may also feel unsure about divulging personal information in front of a stranger.

Another solution that's widely used is telephone translations. Users can speak to an interpreter, across many languages, faster and cheaper than in person services.

However, as Together Housing explained to us, the interpreter acts as a go-between the officer and the client to ensure both parties are understood. Inevitably, there's a natural stiltedness in conversations and a free-flowing discussion can be challenging.

Given the skills involved, a 20-minute call costs around £30, which seems reasonable, but, with the growing numbers of people with EAL, those costs can mount up over the course of a busy year.

Technology meets the demands

Today, technology is aiding better communication across languages. These platforms can offer faster and cheaper translations. Platforms including Google Translate allow users to instantly translate just needing a smart device and internet.

However, these solutions, whilst great for basic translations often don't have the extensive range of words and phrases needed. Due to this there can be issues with accuracy and regional dialects. It also requires a smart device being available for the team. In sensitive situations, using a personal device is not appropriate and brings additional problems such as infection control.

Standalone devices such as Pocketalk take this technology one step further. Focused primarily on providing accurate and instant translations, our device can translate up to 82 languages in both audio and text. The Pocketalk Plus was specifically developed to offer users a larger sized device for healthcare settings as its large screen means users can social distance.

Pocketalk means that any interaction be it patient and caregiver, teacher and student is now enhanced by the individual's ability to communicate directly with one another. Our users within these environments such as Together Housing have told us just how valuable this is for both parties.

Of course, the solution each department uses will be dependent on their specific needs and budgets. Often a mixture of services are used to ensure all scenarios are covered.

One thing is for sure, the requirement to communicate with those with EAL is growing and needs addressing to ensure no one gets left behind.

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Sourcenext, Inc
bizdev-us@sourcenext.com
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UK medical records success

Dr Vijay Magon, Managing Director of CCube Solutions, demonstrates here how their project successes and expertise working with the NHS is providing cost-effective and scalable solutions, tailored to meet individual requirements

Designed and built with NHS practitioners using latest technologies, CCube's award-winning solutions deliver electronic health and medical records to clinicians, secretaries and administrators in the format they require, when and where they are needed.

CCube Solutions, an independent UK SME, has been working in the NHS (secondary care) for over 20 years. We have recently attained BSi certifications for ISO Standards – 9001, 14001, 2700, 27701, and BS 10008 – demonstrating our commitment to abide with established standards for protecting sensitive patient data held in our solutions in widespread use in the NHS.

CCube Solutions help Trusts and Health Boards alike digitise legacy patient medical records and make this information available to clinicians and other health professionals at the point of care. It supports the Government's drive that the NHS should be using technology to improve productivity, reduce costs and ultimately enhance patient care.

CCube Solutions specialises in providing Electronic Document and Content Management (EDRM) and Workflow solutions, based on the CCube software suite which holds and manages some 450 million documents containing over 52 billion pages for 32 million patients across 30 NHS organisations around the UK.

Some of our NHS sites have been using the solution for over 18 years. Data on realisable benefits, from just three key sites, shows a collective saving of c.£35M over ten years.

In-house scanning: St Helens & Knowsley Teaching Hospitals NHS Trust

St Helens & Knowsley Teaching Hospitals NHS Trust started a project in early 2009 to digitise and deliver electronic patient records files to guarantee notes availability, improve the quality of patient care and - of course - save money. Its IT resource - Health Informatics Service - created its own in-house scanning bureau along with CCube Solutions EDRMS. The results are impressive:

- 1st Trust in the UK to stop using paper records in clinical practice
- £1.4M annual savings from £1.2M investment
- 500 doctors and 130 secretaries trained after a staged rollout taking 22 months
- Over 175,000 medical records digitised (c.52M pages) stopping 7,000 files per week being hand delivered
- Innovative scan-on-demand model developed - only files needed are actually scanned, resulting in huge cost savings

Outsourced scanning: Aintree University Hospital NHS Foundation Trust

Aintree University Hospital decided to outsource to an external scanning services provider. Again, CCube Solutions EDRM software was installed and used to deliver the digital records at the point-of-use:

- First Trust to use forms recognition technology to automate the recognition and classification of pre-printed medical forms which make up 95% of medical files
- £1M annual savings from £1.5M investment
- Scan-on-demand with a third party - 290,000 patient files digitised
- 30% space gained in a new £45M building from removing paper records so a £13.5M estate benefit
- Access required information within three mouse clicks!

Hybrid model: North Bristol NHS Trust

North Bristol NHS Trust approached the whole transition from paper to digital medical records by both setting up its own in-house scanning bureau and working with a third-party outsourcing specialist, to do the back scanning. The in-house bureau is used for day-to-day scanning. Returns from the project have been significant:

- A scan-on-demand model to digitise patient medical records will save over £1.3M within four years
- EDRMS is an 'invest to save' initiative with the system paying for itself based on a reduction in operating costs
- Outsourced digitisation of over 295,000 active patient records, amounting to c.55M pages
- In house scanning of day-forward patient records
- 24/7/365 notes availability for multi-disciplinary clinical teams
- Project delivered on time and to budget
- Auditing and information governance improved as medical records are tracked

Avoiding scanning legacy paper in the first place – the Papworth Hospital model

Tertiary Trust, Papworth Hospital, installed EDRM, workflow and eForms from CCube Solutions to create an electronic medical records system (EMR). Papworth's EMR is not concerned with scanning legacy records. The focus has been to concentrate on the patient's pathway from the moment an individual is referred to the hospital so that referral paperwork and medical notes are indexed, shared and information automatically routed to boost efficiency, reduce costs and enhance patient care. Return on investment has been significant:

- The whole project including software and project management cost under £250K.
- Significant reduction in operational costs by removing physical paper records storage and management (cost over £200Kpa.)
- Assists meeting Government targets to see patients within the set timeframe of 18 weeks from GP to final treatment
- The first deployment of a registration and referral system where letters are scanned and then handled electronically using workflow

Medical records in primary care: The GPs

Turning to GPs, we launched our eLG solution – a secure and hosted platform for electronic Lloyd George (LG) records. A typical practice with 11,000 patients is likely to have around 13,000 wallets given some patients will have more than one. And, on average, each wallet will contain around 80 pages. This means over 1M sheets of paper per practice - in larger surgeries, the numbers will be considerably higher.

Following on from an initial launch of eLG (within the NHS) currently holding some 2.5M records comprising of 90M pages, for 620K patients, accessed by 100 GP practices, CCube Solutions has deployed a secure and hosted platform for the storage, access and lifecycle management of electronic LG records. The upload process of Lloyd George files is free, fully automated, and meets agreed SLAs. Access to this information is via a standard Internet browser using any device, no need to install any software in the practice!

Contact CCube to discuss how we can look after every stage of your information strategy, from capture and life-cycle management to delivery:
info@ccubesolutions.com
www.ccubesolutions.com

ccubesolutions
delivering digital healthcare

Vijay Magon
Managing Director
CCube Solutions
Tel: +44 (0)1908 677 752
info@ccubesolutions.com
www.ccubesolutions.com
linkedin.com/in/vijaymagon



Interoperable health systems needed for digital future & improved patient care

Professor Peter Bannister, Executive Chair of the IET's Healthcare sector explores the need for interoperable health records to ensure a digital future for healthcare

Interoperability is a term that has been widely associated with healthcare for several years and for many people it brings to mind the challenges we all experience as users of health and care services. For example, seeing nurses having to refer to physical binders of notes, which cannot exist at the GP practise and the specialist clinic at the same time, or the diagnostic odyssey that befalls those with rare diseases: having to tell the same story - previously extensively documented by other healthcare professionals - over and over again in the hope of someone being able to piece together the data to form a diagnosis.

However, like all buzzwords, it is essential that we dig deeper and understand what is really meant by interoperability in the eyes of those who need it most: patients and the people who deliver their care. It is clear from decades of trying that there is no quick fix to the disjointed architecture of healthcare systems, which in turn hinders innovators from realising the potential of personalised healthcare based on a comprehensive understanding of an individual's many encounters with clinical professionals. The world will not converge on a single supplier of electronic patient records, were it that easy - in fact it has become increasingly well known that the concept of "paperless" in even the most advanced healthcare systems is a pipe dream.

> "The concept of "paperless" in even the most advanced healthcare systems is a pipe dream."

Finding a united way to share data

So, if the common factor is not a communication standard, or a top-down mandate for a common data format, what does interoperability need to stand for? In short it entails a common understanding of the real-world constraints present in today's healthcare systems combined with a balanced appreciation for the role that technology and data could play in enhancing it. Healthcare systems will always be extremely heterogenous in terms of their many components, both physical and digital, and therefore it is essential that we are able to empower those closest to the problems with the knowledge and skills to lead the development of effective solutions, while supporting them with policy that encourages good behaviour and with more detailed guidance that fertilizes success.

Key to achieving this is a robust understanding of how to deploy technology within real-world settings, while remaining cognisant of the requirements for clinical accuracy, data protection and cost-effective

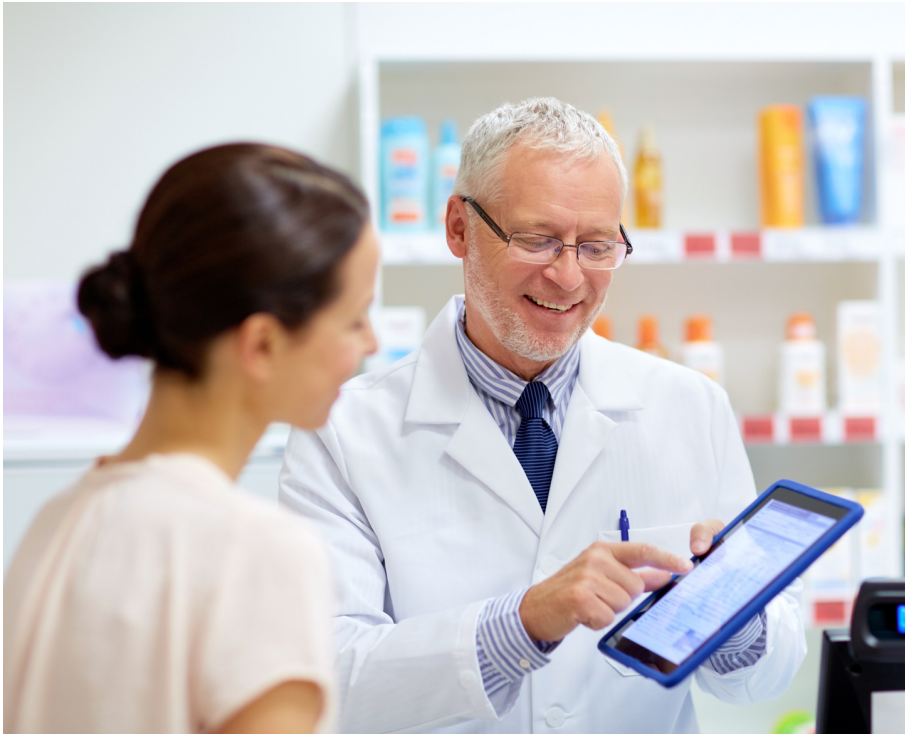
health economic delivery. Specifically, established engineering practices such as Agile and design thinking approaches can ensure we engage the patients and clinical professionals (who best understand the environment they operate in) early and often thereby accelerating the development of effective solutions.

In that case what specific role can we play at the intersection between policy, technology and skills? Consider that interoperability should not only address current inefficiencies in today's reactive healthcare delivery but aspire to facilitating a preventative model of healthcare in the near future, one where people, technology, data and the physical environment are aligned to promote sustained good health and trigger early, effective interventions.

The continuing impact of COVID-19

As a result of the COVID-19 pandemic, the digitisation of the UK's health and care services has been hastened in various ways. An example of how persistent barriers, such as poor interoperability, privacy concerns, and difficulties getting data to flow in real time, have continued to restrict the ability of the UK to use Healthcare Information Technology to support policy and planning is the development of mobile applications to support contact tracing.

It will be possible to improve healthcare quality, safety, and efficiency by leveraging lessons learned from the COVID-19 pandemic. This will be an exciting decade for healthcare information systems. However, as it stands many NHS staff within the system find it extremely difficult to adapt to changes in the healthcare system.



Interoperable health records are key to a digital future

We have a need that we can't meet unless we change our processes and become more effective and efficient. Therefore, having the digital advantage in this domain allows us to move from being a reactive health service to one that is much more focused on preventative health as we drive innovation at scale, where it can improve care, and this will allow citizens to do more for themselves in a constructive, helpful, and beneficial way.

A number of issues need to be addressed, including enhancing the usability and compatibility of healthcare information technologies and systems, increasing data processing and analysis capabilities and safeguarding personal information, as well as increasing financial support and promoting digital inclusion. Healthcare information systems are complicated interventions that need to be adapted to local circumstances, and the UK should learn from its past mistakes as well as from global exemplars. An ideal balance between bottom-up and top-down implementation will be necessary for this process to succeed, which should lead to tangible benefits.

In conclusion, interoperability is not a standard or a protocol: it is a far more holistic mindset and a methodology which can facilitate cross-sector collaboration. At the IET, we look forward to championing this technology-agnostic approach starting with the recommendations presented in our Digital Advantage report.

Peter Bannister is also Vice President Life Sciences at Ada Health GmbH and Honorary Chair at the University of Birmingham Centre for Regulatory Science and Innovation.

The Institution of Engineering and Technology

Accelerating design & manufacture in the eye care sector

Nick Walsh, Head of Corporate Development of the Association of British Dispensing Opticians, updates us on the fast-moving developments in the eye care sector, specifically on the design & manufacture of both frames and lenses for glasses

In my most recent article for Open Access Government, there was mention of changes in the eye care and eyewear sector based around additive manufacturing, 3D printing by its better-known name. In this article, I revisit this area to show that things are moving fast both in the design and manufacture of both frames and lenses for glasses.

Additive manufacturing

Materialise is an example of a company that pioneers in many areas in the use of 3D printing technologies. A brief look at their timeline shows how great the scope for additive manufacturing has increased in the last 30 years. Concentrating on eyewear alone, the benefits of 3D printing can be split into:

1. Customisation with 3D printing can take on many elements, including the choice of materials used, finishes of the materials, design features, aesthetic features, and co-creation with eyewear designers, all whilst ensuring the basic function and fit of a spectacle frame are maintained. The use of a facial scan of the patient enables the frame fit to be fully bespoke. Yuniku by HOYA is an exciting example of how this can work.

2. By printing to order, an optician can eliminate the financial risk of holding large numbers of frames in stock, which was often to be able to showcase the size and colour variables of a single style.

3. The sustainability credentials of additive manufacture versus subtractive manufacture have been known for some time. These credentials include the reduction of water used, and the reduction of waste material produced. A recent collaboration between Materialise and Arkema has seen the introduction of ARKEMA Rilsan® Clear polyamide (Polyamide 11 - PA11) into the 3D printing of frames. The material is nylon bioplastic derived from a renewable source of castor beans. The G850 grade has been specially designed for injection moulding applications, ideally suited for eyewear frames.

The 3D printing of a frame to a patient's precise facial characteristics presents exciting new possibilities for opticians to offer their own bespoke ranges in the future with the benefits already mentioned.

Remaining with the theme of additive manufacturing, another powerful development is seen with Luxexcel. Their technology allows the additive manufacture of ophthalmic quality lenses for use in glasses. Whilst the possibilities for the design and manufacture of lenses could be seen as endless, a resurgence in interest in smart eyewear has seen Luxexcel show why 3D printing is the preferred method to integrate smart technologies into prescription lenses. Guido Groet, Chief Strategy Officer states, "our 3D printing technology integrates smart technologies, such as waveguides, holographic optical elements, and more, into 3D printed prescription lenses. Now there's no need for smart eyewear developers to become opticians, and vice versa. We make prescription lens integration in smart eyewear a reality today at the push of a button." [1]

This resurgence in interest in smart eyewear has also seen Apple Smartglass and Ray-Ban Stories products, amongst others, being teased and launched to the public. And don't forget that the 3D printing process for frames is also favourable for smart eyewear design and production.

Smart eyewear offers another route to fulfilling a patient's needs that opticians may not have considered previously but should be more aware of and abreast of the technologies involved.

E-commerce development

Away from materials and manufacturing technologies, another interesting development has been regarding e-commerce. For many years, we have seen an e-commerce offering in the eyewear industry that is predominantly focused on contact lens supply, and to a lesser extent the supply of glasses due to the inherent issues of remote supply of a product that needs to not only look good but also must fit perfectly. Arguably, due to COVID-19, many bricks and mortar opticians have had to consider how e-commerce can fulfil the patient journey in a world where a visit to the practice may not be viable.

"Smart eyewear offers another route to fulfilling a patient's needs that opticians may not have considered previously but should be more aware of and abreast of the technologies involved."

To this end, we are now seeing more blended approaches with several well-known names going omnichannel. Warby Parker, Specsavers, Vision Express, and Lenscrafters are all now omnichannel players with the likes of Warby Parker now moving into bricks and mortar environments as the others named venture more into the e-commerce arena.

As mentioned in my previous article, e-commerce providers have been reliant on technology to deliver their offering and traditional opticians need to ensure that they offer an equivalent technology in the practice to appeal to a section of the patient base who value this and seek it out. Be that through omnichannel or through having skilled staff using the technology in practice, will be a decision of the business owner. A given though is that professionally qualified and well-trained staff are still needed. Their roles may change some, but their knowledge will still be vitally important.



Nick Walsh

Things to keep an eye out for

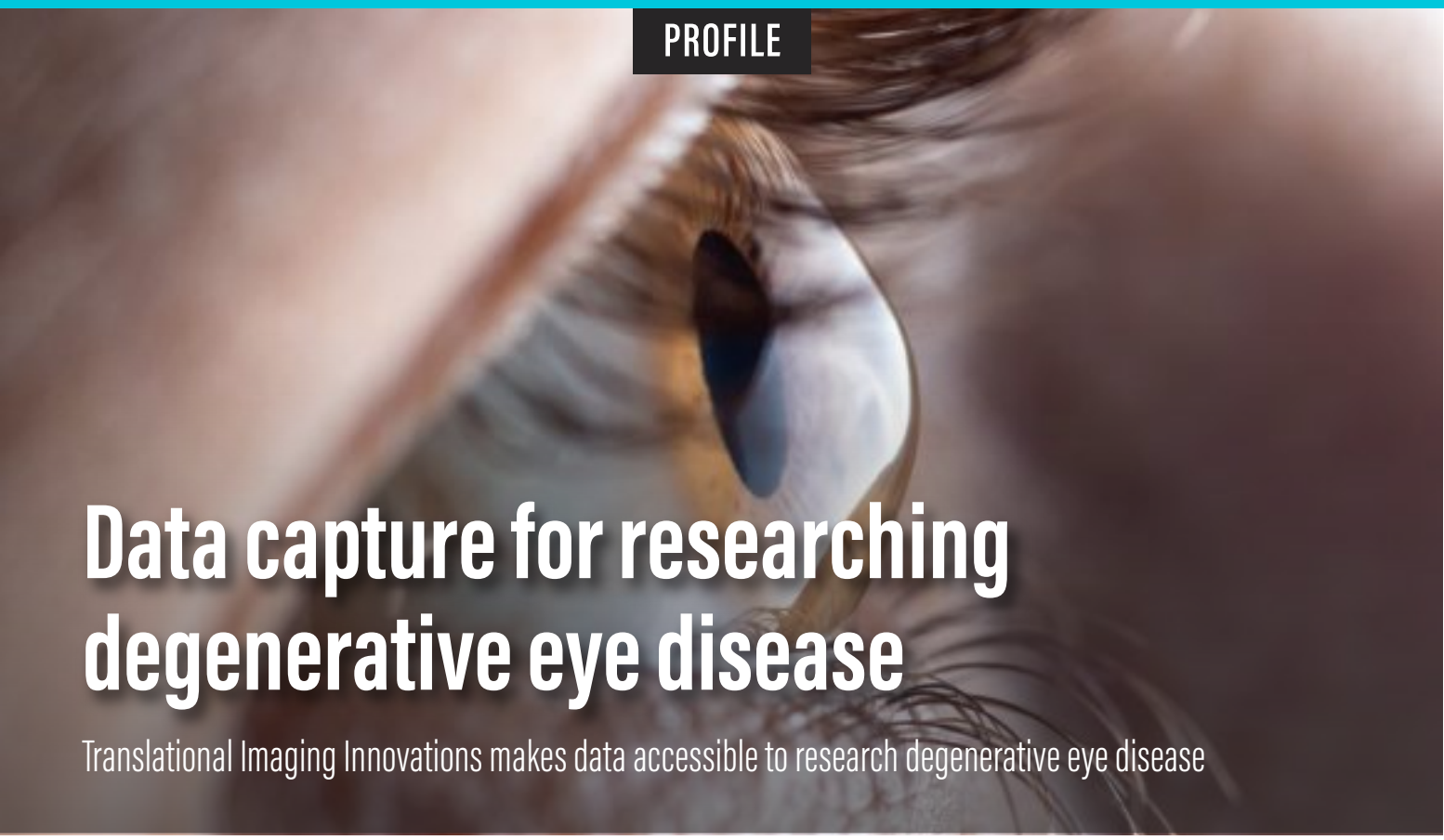
In summary, the design and manufacture elements of eyewear are seeing a shift towards sustainability and mass customisation enabled by additive manufacturing techniques and new materials.

Opticians need to stay informed of the new techniques and materials being used so that they will understand how to identify them and how to adjust or repair them, and importantly to advise patients in aftercare and correct cleaning products.

Omni-channel will continue to grow, not just in eyewear, but in many sectors to fulfil the needs of the public.

(1) https://www.luxexcel.com/reality-today-prescription-lens-integration-for-smart-eyewear/

Nick Walsh FBDO MCMI MLMinstLM
Head of Corporate Development
Association of British Dispensing Opticians (ABDO)
nwalsh@abdo.org.uk
www.abdo.org.uk/
https://twitter.com/ABDOMembership



Data capture for researching degenerative eye disease

Translational Imaging Innovations makes data accessible to research degenerative eye disease

Age-related macular degeneration, glaucoma and diabetic retinopathy are examples of progressive eye disease that lead to vision impairment or blindness over a lifetime. These conditions are unfortunately common and are caused by a combination of intrinsic factors, including genetics and aging, and extrinsic factors including lifestyle and environmental factors.

Inherited retinal diseases are another class of degenerative eye disease directly tied to genetic factors. These diseases are rarer but are associated with significant blindness and complications that magnify their impact on patient lives from an early age.

Precision medicine for degenerative eye disease

New treatments such as gene therapy are bringing precision medicine to the management of degenerative eye disease. Precision medicine requires increased focus on precise patient-centred outcome measures, with commensurate demands on data and analytics.

Translational Imaging Innovations (TII) is supporting development of next generation therapies for eye disease with a new paradigm in clinical image and data management designed for the discovery of insights that accelerate the development of successful new treatments. TII's goal is to enable investigators to develop better therapies for the treatment of degenerative eye disease with more predictable benefits – faster, at a lower cost and with less frustration.

Our retina is a digital sensor that records light from our environment that our brain processes into our three-dimensional view of the world that we often take for granted.

Degenerative eye disease arises from processes that degrade the ability of photoreceptors – our sensors - to respond to light. Researchers have identified 270 genes that play a role in eye disease. The new science of gene therapy is demonstrating promise in slowing progression of gene-related disease, and even in recovering vision. Successful translation of gene therapies to effective treatments for patients requires the development of biomarkers that reliably measure the safety and effectiveness of the therapy in clinical trials.

Clinical biomarkers to measure disease symptoms

In the language of clinical trials, these biomarkers are clinical endpoints - measures of disease or symptoms that are explicitly identified and tracked as evidence of the safety and effectiveness of the treatment for the target patient population. Clinical endpoints may include measurements of images that indicate change in structure and may include measures of change in visual function, for example using standard clinical tests for visual acuity.

An important class of endpoints are

those that impact activity of daily living of patients. This is a particularly important type of endpoint for gene therapy, as the number one goal of for sufferers of degenerative eye disease is to improve quality of life. Developing reliable clinical endpoints for emerging treatments of eye disease is a critical component of the drug development process.

Rigorous, secure, data collection is a pre-requisite to discovering effective biomarkers and validating acceptable clinical endpoints. The best clinical endpoints for a given therapy may not be obvious early in the clinical development process. Early on, the research team will analyse data from a large amount of images and tests that are collected on a small number of patients, developing and confirming hypotheses based on the symptoms of the disease, the mechanisms of actions of the new treatment and the expected response to the treatment.

As the process proceeds, the team will identify a primary endpoint that is supported by one or more secondary endpoints. Exploratory endpoints may be used for research purposes. By the time of the pivotal trial - the trial which is expected to lead to regulatory approval of the treatment - the endpoints must be unambiguous and approved in advance by the regulatory agency.

Collection and analysis of images and patient data

Achieving this approval and progressing from an exploratory endpoint to an approved primary or secondary endpoint requires the collection and analysis of large amounts of images, test data and even patient questionnaires. To build effective support for an endpoint, the data capture must be consistent throughout the development process, must contain complete sets of metadata (data about the data) and must be free from tampering. Translational Imaging Innovations developed ocuVault™ specifically to harness the complex data streams that lead to the discovery and validation of strong clinical endpoints for emerging therapies of degenerative eye disease.

ocuVault™ is a flexible data capture and transport application for the secure transfer of images and data. ocuVault is standards-based and provides harmonisation with DICOM even for images and data that are not available in DICOM format. The value of ocuVault is that it allows the capture and management of data that may lead to the discovery of new biomarkers and clinical trial endpoints from the earliest stages of the development of a new treatment for eye disease. Every piece of data captured by ocuVault carries a unique, traceable identifier that is separate from the protected health information of the patient. Patient privacy is preserved. Data security is ensured. ocuVault maintains data provenance and security, ensuring accessible, actionable and auditable data throughout a project lifecycle.

ocuVault data elements are the building blocks of the TII Data Genome. The TII Data Genome is a standards-driven ontology for defining the data elements required to curate images and data for collaborative research and clinical trials. The Data Genome relies on standardised libraries and templates including Logical Observation Identifiers Names and Codes (LOINC), Systemised Nomenclature of Medicine (SNOMED), the Global Medical Device Nomenclature (GMDN) and Digital Imaging and Communications in Medicine (DICOM) to ensure an extensible, scalable and FAIR data structure. Each specific image, test or questionnaire becomes a gene of the Data Genome. As images and test results are accumulated throughout the lifecycle of a project, they automatically populate a master catalogue, or database, that is ready for analysis and provides traceability for regulatory validation and audits.

ocuVault is the data core of the TII Integrated Translational Imaging™ suite of software products. Lattice© is an online electronic record keeping application for research studies and clinical trials. All source data and medical records are captured and encapsulated with ocuVault. ocuLink™ is the data visualisation application that allows investigators to curate and annotate image and data collections for analysis. Curated and annotated collections are analysed in Mosaic, a computational environment for systematic biomarker development. TII's mission is to make data more accessible and actionable for investigators, empowering images to accelerate innovations in eye care. By unleashing the power of the eye, we can transform medicine.

TRANSLATIONAL IMAGING INNOVATIONS

Eric Buckland
+1 (828) 234 1761
eric@tiinnovations.com

Children's mental health in Africa

OAG examines the state of investment in and provision of adolescents and children's mental health services in Africa

In recent years, there has been increasing acknowledgement about the importance of children's mental health and the role it plays in achieving global development goals, as illustrated by the inclusion of mental health in the Sustainable Development Goals.

Depression is one of the leading causes of disability. Suicide is the fourth leading cause of death among 15-29-year-olds. People with severe mental health conditions die prematurely – as much as two decades early – due to preventable physical conditions.

Despite progress in some countries, people with mental health conditions often experience severe human rights violations, discrimination and stigma.

Many mental health conditions can be effectively treated at relatively low cost, yet the gap between people needing care and those with access to care remains substantial. Effective treatment coverage remains extremely low.

Increased investment to become a priority

Increased investment is required on all fronts: for mental health awareness to increase understanding and reduce stigma; for efforts to increase access to quality mental health care and effective treatments; and for research to identify new treatments and improve existing treatments for all mental disorders. In 2019, WHO launched the WHO Special Initiative for Mental Health (2019-2023): Universal Health Coverage for Mental Health to ensure access to quality and affordable care for mental health conditions in 12 priority countries to 100 million more people.

In sub-Saharan Africa, at least one in seven children experiences significant psychological hardship.

Children and adolescents are always at risk of developing mental health problems, especially vulnerable children facing poverty, discrimination and violence. The lack of access to basic social, health and education services, combined with wide-ranging structural inequalities, are all known to be aggravating risks for mental ill-health.

Outside factors impacting children's mental health

The effects of climate change, compounded by high rates of HIV infection, adolescent pregnancies and humanitarian emergencies, are also ongoing threats for the mental wellbeing of children and adolescents in Africa. Research shows that 50 per cent of mental health conditions start by age 14 and 75 per cent by the mid-20s.

"Addressing child and adolescent mental health in Africa is urgent. Over the years, millions of young people have been exposed to challenges most adults would find very difficult to cope with, often having to deal with the psychological impacts on their own. Our systems are still failing them," said Mohamed M Fall, UNICEF regional director for eastern and southern Africa.

In order to respond to this growing crisis, UNICEF and the WHO committed to a 10-year Joint Programme on Mental Health & Psychosocial Wellbeing and Development of Children & Adolescents in Africa. Signed in 2020, this decade-long collaborative effort is working with local governments to strengthen mental health and psychosocial support systems for children, adolescents and their caregivers. This would also help bring mental health into national preparedness efforts and take away any stigma that might come with mental health issues.

Investment in mental health remains extremely low in Africa, with average government expenditure across the continent at less than one US dollar per capita.

"We simply cannot afford to let millions of children needing care go without help," said Dr Matshidiso

Moeti, WHO regional director for Africa. "It is time to make a difference and ensure that children grow into adulthood free of the potentially lifelong and devastating impacts of unaddressed mental health challenges."

The impact of COVID-19 on mental health care

Covid-19 has further shone a spotlight on global inequalities, including mental health care. The well documented statistics regarding vaccine availability in Africa compared to high income contexts is a stark reminder.

Children in Africa have been exposed to even greater threats with school closures, increased exposure to armed conflicts and lack of opportunities to play and socialise with their peers. The long-term lockdowns have reportedly increased early marriage, teenage pregnancies and sexual and domestic violence towards children – especially girls.

Despite this high burden, availability and quality of mental health services for children and adolescents in Africa are greatly lacking. Even in countries where specialised child and adolescent clinical psychologists and psychiatrists exist, on average there is only one per 4 million population, with health and social care professionals skilled in mental health often concentrated in larger cities, unreachable by most of the population at risk.

Preventative measures and policies on mental health

Preventive measures remain key, most notably promoting healthy lifestyles including exercise and good nutrition, and protection against harmful practices and violence, including strengthening skills in communication and conflict resolution.

Updated and costed child and adolescent policies on mental health do not exist in many of the countries in Africa. Out of 39 countries that responded to the Mental Health ATLAS 2019, 11 countries indicated they had standalone child and adolescent mental health policies and/or strategies. Nine countries out of the 39 that responded indicated they had in-patient services for children and adolescents, while 12 indicated they had out-patient services for children and adolescents. Only five out of 39 countries that responded had community-based child and adolescent mental health.

The most recent data indicates that on average, African ministries of health allocate about 90 US cents per capita to mental health, up from 10 US cents in 2016. This is often allocated to large psychiatric institutions in the bigger cities, with only about 15 per cent getting to the primary and the community health levels.

Yet the evidence shows that investing in child mental health in Africa will pay off in the future. The UNICEF State of the World's Children Report reveals that schools-based interventions addressing anxiety, depression and suicide provide a return on investment of US$21.5 for every US$1 over 80 years.

"Covid and the response measures have created an environment on uncertainty, isolation and anxiety. The number of children targeted for mental health and psychosocial support across West and Central Africa since the pre-Covid period has almost doubled (87 per cent) from just below 1.1 million in 2019 to almost 2 million in 2021. Sadly, these estimates are probably only part of the real need. Long-term investments for child and adolescent mental health care in Africa is needed to turn recent donor support into sustainable services," said Marie-Pierre Poirier, UNICEF regional director for West and Central Africa.

"We urge member states and regional bodies to prioritise and commit to further investing in the mental health of children and young people across Africa. This is an essential part of our care for children."

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AI-Enabled Assessment of Adult ADHD

Prof Marios Adamou OBE and Prof Grigoris Antoniou discuss the problems and solutions of adult ADHD, using an AI-enabled assessment of data

Within the UK, adult ADHD occurrence is increasing, affecting about 3-5% of children and now, 2% of adults.

Attention-deficit hyperactivity disorder (ADHD) is characterised by a persistent and inappropriate pattern of inattention, hyperactivity, and/or impulsivity that causes significant impairment across domains.

Along with these three core symptom domains, people with ADHD also present with deficits in executive functions, behaviour and emotional regulation and motivation.

The problem in the UK is predominantly under-treatment and under-diagnosis

Demand for diagnostic assessments of adults with ADHD has been growing for the last 15 years. This is because there is more awareness amongst the population and health professionals about this condition. Because of this high demand, but also difficulties with recruitment and retention of health professionals across healthcare in the UK, the time people need to wait to receive an ADHD assessment is very long.

We know that this delay to receive a diagnosis and treatment for ADHD is harmful to people. For example, untreated ADHD is linked to more mental health problems, relationship problems, employment problems and substance misuse.

Deploying better technology as a solution to ADHD diagnosis

The bottleneck at the root of the mismatch between demand and supply for diagnosis in adult ADHD is the time of specialist senior doctors and other professionals who are sufficiently trained to diagnose adult ADHD.

The authors have co-developed a new AI technology that identifies clear-cut cases and delivers a proposed diagnostic decision based on patient data while referring the more difficult cases for further assessment by senior clinical specialists. Less reliance on the time of senior clinical specialists will increase the throughput of cases and will reduce waiting lists. **(Figures 1 and 2)** As a result, deployment of this technology will shorten the time people will need to wait, because a broader range of health professionals will be able to complete the diagnostic assessments quicker.

Figure 1: Current assessment practice



Figure 2: Assessment with new AI technology. *Note that clear-cut cases are dealt by more junior healthcare professionals, easing the burden on senior clinicians and thus increasing throughput of cases.*

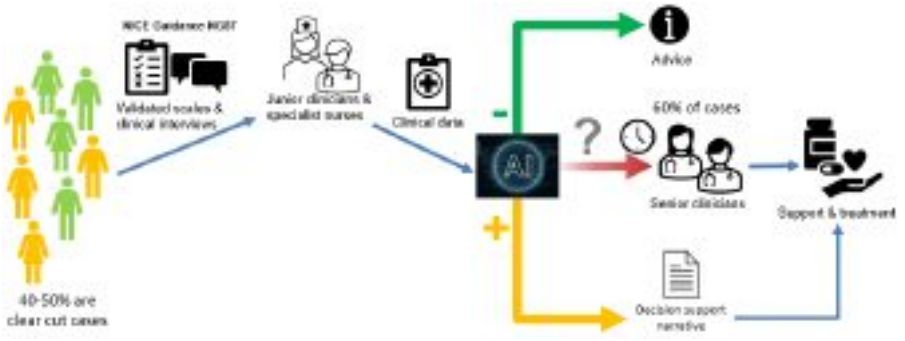


Figure 3: Hybrid AI solution



This is because, using clinical data as input, the AI will be able to guide health professionals about who requires extra assessment by whom, and who doesn't.

A unique aspect of our solution is that relies on a hybrid AI algorithm that uses a hybrid AI algorithm which combines a machine learning model and a knowledge model: **(Figure 3)** A machine learning-based model analyses the data that the NHS Trust holds in its computing systems – the same data a clinician would have access to – and produces a diagnostic outcome of ADHD, along with a confidence factor (a measure of confidence). A variety of machine learning algorithms were used, but the best performance was delivered by a decision tree algorithm. Predicted diagnostic performance of this model is around 85%.

In addition, in a number of in-depth interviews with experienced clinicians, knowledge acquisition was used to capture medical knowledge about how the AI system should reach a decision based on the data collected for a particular case. This implicit knowledge was represented as a number of rules (which use the same case data as an input) with three possible outcomes: positive, negative or consult expert.

Clinical and technical validity of AI

The technology was co-developed through a partnership between South-West Yorkshire Partnership NHS Foundation Trust and the University of Huddersfield. After initial development, our team received funding from the NHS AI lab under its inaugural call on AI for Health and Care. This project, which was successfully finalised in April 2022, demonstrated clinical and technical validity through a trial at an NHS adult ADHD service. The accuracy of our hybrid AI was shown to be around 95% which is an excellent result since the solution is designed to provide decision support, not autonomous decisions.

Further developments in the area of AI for mental health

We are now in the process of publishing the validation results. Next steps will be to identify NHS sites for further trials. We are also looking for opportunities of commercialisation, either through a spin-out company or through collaboration with digital healthcare providers.

Finally, we have further developments in the area of AI for mental health, addressing autism and suicide risk assessment.

More information

You can contact us by email at marios.adamou@swyt.nhs.uk or g.antoniou@hud.ac.uk.
Information can also be found at https://selene.hud.ac.uk/aeaaa/neurointel/
An illustrative video is found at: https://www.youtube.com/watch?v=tygLmWAwBbU

University of HUDDERSFIELD
Inspiring global professionals

Prof. Grigoris Antoniou
Centre of AI for Mental Health
University of Huddersfield
Tel: +44 (0)1484 472 147
g.antoniou@hud.ac.uk
https://pure.hud.ac.uk/en/persons/grigoris-antoniou

The impact and recovery from COVID-19 for children in custodial settings

Dr Charlotte Lennox from the University of Manchester illustrates the health challenges for children in custodial settings and highlights a research project designed to develop health improvements and policy recommendations for future major incidents/pandemics

Children remanded or sentenced to custody in England and Wales can be placed within one of three types of custodial setting.

Young Offender Institution (YOI) – large 'prison-like' settings run by Her Majesty's Prison and Probation Service (HMPPS) or private providers, for boys aged 15-17 years old, as well as 18-year-olds who are coming to the end of their sentence or awaiting a transfer to the adult prison estate.

Secure Training Centre (STC) – smaller than YOIs, run by private companies, for children aged 12-17 and provide 30 hours of education and training a week, following a school timetable.

Secure Children's Homes (SCH) – smallest of the three setting types, run by local authorities, for children aged 10-14, provides a therapeutic environment and 30 hours of education and training a week, following a school timetable.

As of March 2022, there were 422 children (under 18's) in custody. The custody population is overwhelmingly male (96%), and the majority (95%) are aged 15 - 17. The custody population has fallen dramatically, by nearly 70% in the last decade.

Vulnerable children in a challenging environment

It is well documented that children in custodial settings have much higher rates of trauma, mental health problems and neurodiversity, in comparison to the general population of children [1]. In an earlier study [2] we found that on admission to custody, 60% of children had at least one physical health need, 37% a mental health need, 93% a substance use need and 81% a neurodiversity need. Children in custody face a multiplicity of need, associated with poverty, deprivation, marginalisation, and stigma. They are also more likely to have experience of the care system and ethnic minority status.

Many children in custody are involved in aggressive and violent behaviour, self-harm and/or have attempted suicide [3]. Due to the prevalence of vulnerability, children's violent behaviour should be reframed as distress behaviour which highlights the levels of unmet need.

Prior to the COVID-19 pandemic distress behaviour indicators such as rates of restrictive physical interventions (RPI; where force is used to overpower or with the intention of overpowering a child), assaults and self-harm had all been increasing rapidly, despite the falling population. For example, the number of self-harm incidents had increased by 35% since 2018-19 [3].

Children in custodial settings and COVID-19

COVID-19 has been an unprecedented public health crisis. In March 2020, like the rest of the country children in custodial settings were also 'locked down'. Changes to legislation meant that children in YOIs and STCs could be confined to their rooms for up to 22 hours a day, in the same way adult prisoners were. Access to education and health was reduced or stopped and visits from families cancelled. The picture within the SCHs was different, with greater flexibility for not being under HMPPS and prison legislation.

Children, and in particular children in custody are very often a forgotten and unheard group. For example, when the terms of reference were drawn up for the government's upcoming COVID-19 public inquiry there was no specific mention of children; when the roadmap for easing COVID-19 restrictions in prisons were published, secure settings (YOI/STC) featured very little; and when the Ministry of Justice (MoJ) and Public Health England published an interim assessment of the impact on COVID-19 containment



of various population management strategies in prisons, it did not include children in custody.

The needs of children in custodial settings are vastly different to those of adults in prison, and therefore separate plans and processes are needed in recognition of their extreme vulnerability and complex needs. Our research plans to capture what has happened for children in custody in relation to their health and how COVID-19 was managed to inform policy decisions on recovery, but also to mitigate the longer-term impacts on children's wellbeing.

What does our research involve?

Funded by the National Institute for Health and Care Research (NIHR; Grant number 202660) and approved by Wales Research Ethics Committee 4 (21/WA/0380).

In phase 1 we will obtain centrally held anonymised NHS data on COVID-19 rates, distress behaviour and health needs, for YOIs, STC and SCHs pre COVID-19 and during COVID-19.

In phase 2 we will conduct a series of semi-structured interviews with health and other professionals working in the YOIs, STC and SCHs, children who experienced being in custody during COVID-19 and family members.

In phase 3 we will combine the data from phase 1 and phase 2 to create several explanations for any changes in distress behaviour and health across different groups, with a focus on recommendations for health practice and service delivery. These will be presented at stakeholder events to develop a consensus to produce policy recommendations for health improvement.

The next steps

We have started data collection and will share our findings with you early next year. In the meantime, if you would like to contact the research team to discuss this research, or are a member of staff, child, young person, or family member who would like to participate, please get in touch.

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Note: *This project is not supported by Youth Custody Services.*

The views expressed are those of the author and not necessarily those of the NIHR or the Department of Health and Social Care.

MANCHESTER 1824
The University of Manchester

Dr Charlotte Lennox
Lecturer
The University of Manchester
Tel: +44 0161 306 8014
charlotte.lennox@manchester.ac.uk
https://sites.manchester.ac.uk/hjrn/

Support the mental wellbeing of young people

Laura Marchetti, Policy Manager at Mental Health Europe, states the case for supporting the mental wellbeing of young people

Mental Health Europe released urgent policy recommendation calling for a mental health system change.

Numerous reports and data have pointed to the fact that young people have been disproportionately impacted by the COVID-19 pandemic, which has put a considerable strain on their mental health and well-being. Research from the Organisation for Economic Co-operation and Development (OECD) suggests that experiences of mental health problems during the pandemic were more prevalent among young people compared to other age groups and that overall mental health problems have doubled among people aged between 15 and 24 in the past two years.

The reasons for this widespread increase are many. First of all, mental health support was not fully available and accessible to all already pre-pandemic and this has been further disrupted across the board after March 2020. Closures of educational institutions such as schools and universities have also put young people in front of an uphill path for their future. On the one hand, their opportunities for adequate employment and an adequate transition into the labour market have decreased, with the implication that the overall well-being of a generation has become more precarious. On the other, the closures of schools and universities have also interrupted those daily routines and social interactions that used to function as protective factors for young people's well-being, which used to contribute in detecting the early stages of distress and ensure that support was sought earlier. The results were therefore that young people were left isolated and started to look for support later than usual, when the levels of distress and discomfort had already become severe.



Laura Marchetti
Policy Manager

The misconceptions around mental wellbeing of young people

This might seem like a contradiction, given the in the past years mental health has emerged as a more prominent topic of discussion both at the political level as well as in everyday life. After two years of pandemic, more people are now better informed about how poor mental health can impact a person's wellbeing and how many different factors can positively or negatively impact a person's mental health.

However, it is also still true that stigma and misconceptions around mental health continue to be prevalent and are a barrier for people to be comfortable to speak about the topic and seek support when in need. When we ignore mental health issues in our society, we reinforce stigma and prevent those seeking the help they need. Moreover, mental health continues to be perceived as less important than physical health: while we are at ease with seeking solutions to overcome physical health problems and are motivated to take care of our physical health, we also remain sceptical, fearful or neglectful rather than doing the same when it comes to our mental wellbeing.



This is why the third European Mental Health Awareness Week that took place between 9th and 13th May focused on young people and on the importance of breaking the stigma around mental health. The week-long campaign, rolled out through a series of activities including events and Instagram Lives, and ended with the publications of MHE's policy recommendations to EU and national policy makers.

The recommendations focused on the fact that:

*Mental health system change requires joint action to ensure adequate **prevention** of mental health problems, meaningful **empowerment** and active **engagement** of young people in decisions about their mental health, and targeted mental health support at every stage of life.*

What can the EU do next to benefit mental health?

The European Union (EU) and its Member States already have a variety of instruments that could be used to address the challenges and barriers that young people face and that impact their mental health. Initiatives and instruments such as the European Semester Cycle, the Child Guarantee, the European Pillar of Social Rights and its Action Plan, various funding streams are just some examples of tools where mental health should be better integrated and mainstreamed to maximise impact.

However, the EU does not currently have an action plan dedicated to mental health to ensure such integration. It would be appropriate for the European Commission to develop a European Mental Health Strategy, as it has been recommended by the Council of the EU, the European Parliament and various civil society organisations.

Tangible actions, appropriate investments and systems are needed to support our youth. The time is now to prevent, empower, and support young people. Mental Health Europe calls on policymakers at European and national levels to commit to youth mental health and build a brighter future for the individual and society. Now more than ever, it is evident that immediate policy action is needed.

Laura Marchetti
Policy Manager
Mental Health Europe
www.mhe-sme.org
www.mhe-sme.org/emhw
https://twitter.com/MHESME

The power of micro-coding parent-infant and parent-teen multi-domain behaviours

The MHINT team has developed a fully open access operationally defined manual and observer syntax coding scheme in Observer XT and micro-coding scheme syntax

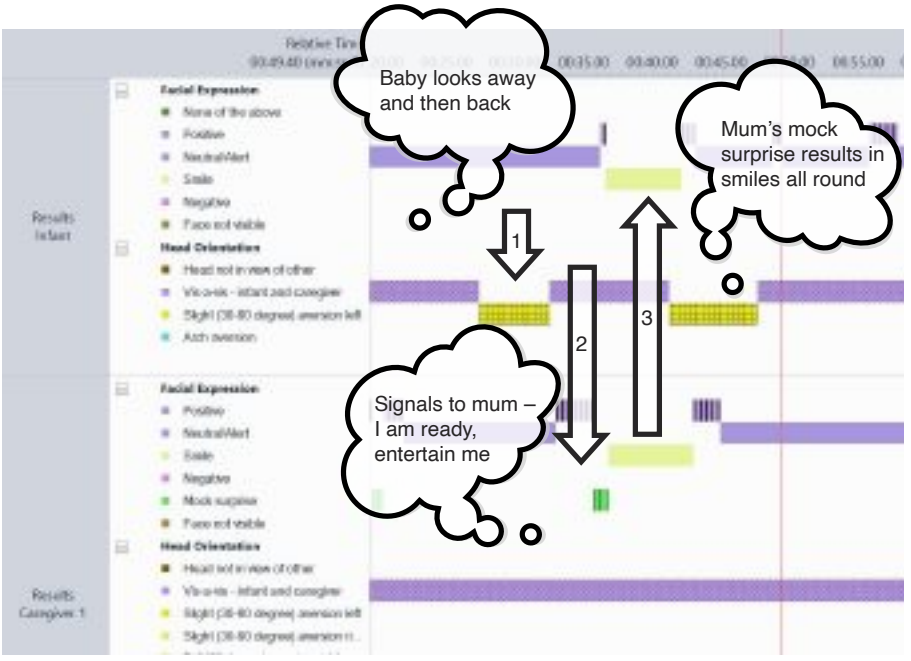
Humans are sophisticated decoders of human behaviour through micro-coding. At any one time we simultaneously process and face, movement, position, audio and much more information from those around us. With this we rapidly, and effortlessly, compute our interpretation and respond. We have no idea what we are computing.

Take the reaction to a goal. Just by watching the reaction, we know a goal has been scored and which team it belongs to. In this case, it's movement, synchronised movement that tells us that; facial expressions and vocalisations confirm it.

As it's so effortless and unconscious it can be hard to understand the underlying components of behaviour that are important or how they are interpreted by others. Understanding is key when subtle changes in our behaviour can make important differences to our relationships.

Parenting research in parent-child interaction

In parenting research, the concept of parental 'sensitivity' is well known and is predictive of future positive child outcomes. Given that even for psychology researchers, it requires specific and time-consuming training to be able to assess reliably, for parents themselves such concept is somewhat opaque and unachievable and thus not be helpful if they want to improve their relationships.



Every parent-child interaction has strengths, further understanding of the building blocks of varied interactions will facilitate learning. Understanding the behaviours that precede desirable or less desirable target behaviours can aid understanding and behaviour change in more person-centred and strengths-based parenting support.

We have developed a fully open access operationally defined manual and observer syntax coding scheme in Observer XT.

OSF Preprints | Mental Health Intergenerational Transmission (MHINT) Process Manual

Micro-coding to capture subtle behaviour

This coding scheme aims to capture as many relevant behaviours as possible, with the underlying hypothesis that individual differences in behaviours can occur subtly and that micro-behaviours provide specific targets for person-centred, strengths-based parenting support. The work, funded by the ERC, took five years and several researchers contributed to the process in an iterative process using existing coding schemes in the literature, applying to real data and going back to the coding scheme until everything observed could be captured.

This resulted in 27 behavioural groups with up to 12 options, 38 modifiers (subcategories within behavioural

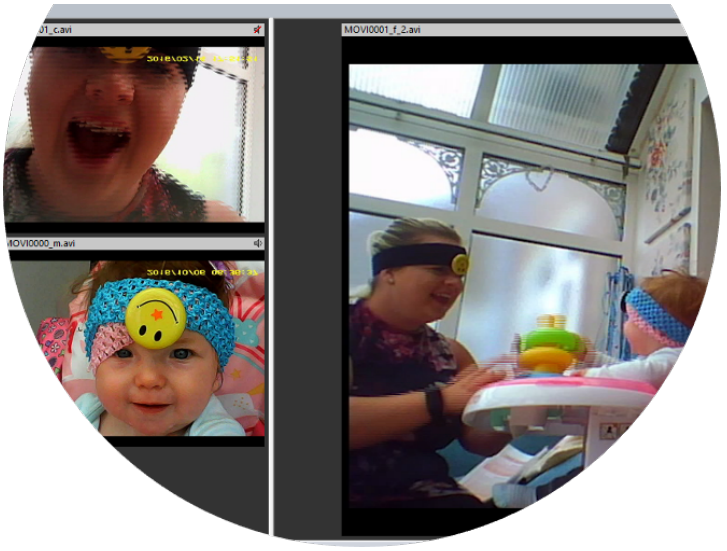
groups such as within speech the tone of voice), with up to five options. At any one time, both members of the interaction will be coded within each 27 behavioural domains. Even without modifiers, that results in a minimum of **729** possible combinations of dyadic behaviour at any one time. Not to mention the role of the preceding and following behaviours.

The visualisation of just two domains of behaviour, in the figure to the left, for 30 seconds, we learn so much. We can see here what drives the interaction, how the baby 'instructs' the mum to repeat a game of mock surprise and re-enforces the mums attempts with a smile.

Current work on micro-coding behaviours

Our ongoing work is exploring how the micro-coded interaction behaviours map on to the global constructs such as parental "sensitivity" using both mother infant moment by moment behaviours, importantly across behavioural domains (ie mirroring of facial expressions, as well as vocalisations or across behaviours where the affect tone is matched in face in mum and vocal in baby), and with quantification of duration of behaviours and time between behaviours.

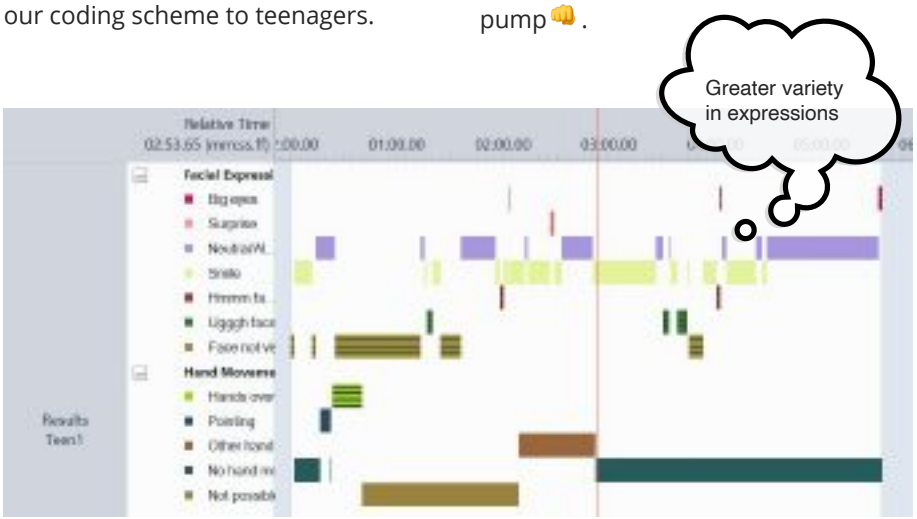
Current work is also ongoing to adapt our coding scheme to teenagers.



Interestingly, in infancy-specific facial expressions are used 'Mock Surprise'. In our manual defined as "a surprised facial expression which does not represent an actual surprise. Mouth is open and eyebrows are slightly or evidently raised (Beebe et al, 2016). It usually occurs in playful interactions as 'peekaboo', example above."

Mock surprise is very commonly occurring in our data, with 67 % of five-minute mother-infant interactions including a mock surprise face.

No doubt there are specific examples of adolescent faces. In our initial work with A-level Psychology students, we utilised the current teen vocabulary in the form of emojis and well-known text speak including 'Big eyes/Rolling eyes'🙄, 'hmmm/thinking'🤔, 'eek'😬 and hand gestures such as a fist pump👊.



Initial coding of teenager behaviour (see figure below) demonstrates the greater variety of emotional expressions than infants and some initial demonstrations of so-called 'teen emotions' and hand gestures.

The MHINT team has provided training for teams internationally, please contact the research team, a brief video showing the coding scheme is below:



Contributors: Adele Bryce (Psychology A-level Student, Cheshire College).

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme. (Grant agreement No. 758813)

Rebecca Pearson
Professor of Psychology
Manchester Metropolitan University/
University of Bristol
R.pearson@mmu.ac.uk
https://twitter.com/RebeccaMPearson

Studying the exposome concept for a healthier future for all children



Dr. Irene van Kamp, from the National Institute for Public Health and the Environment, discusses the exposome concept to study the role of the environment in human disease

Mental health is the result of complex interplay between genetic, psychological, environmental factors and experiences. The exposome concept, referring to the totality of exposures from conception onwards, is emerging as a very promising approach to studying the role of the environment in human disease.

The EU funded Equal-Life project, which is part of the European Human Exposome Network employs the exposome concept in an integrated study of multiple exposures in relation to a child's development and life course mental health. A novel approach is used which looks at exposure data at a high spatial and temporal resolution combining physical and social aspects to understand influences on mental health and cognitive development at different ages and developmental stages. The goal is to propose the best supportive environments for children.

Mental Health is of growing concern

Mental ill health is one of the fastest growing public health issues in Europe and awareness about this has increased. Its contribution to the burden of disease weighs heavily on societies and economies. In Europe, the cost of mental ill health was estimated to be over 4% of GDP[1] in 2018. Children's mental ill health predicts to a large extent mental ill health in later life with impacts on quality of life and work situation. It is therefore of growing concern that at school age, one in ten children has a mental health problem that warrants support and treatment. These figures vary in time. More recently, for example, research shows that there is mixed evidence that children and adolescents have experienced significant anxiety and depression during the coronavirus pandemic and that these symptoms increased as compared to the pre-pandemic period.

Sensitivity and Child development

Children are sensitive for a whole range of social and physical influences from the moment they are conceived up until adulthood. Not because they are vulnerable per se, but because they are in a sensitive period for their development. As mental health, neurodevelopment is also affected by complex interplay between genetic, psychological, environmental factors and experiences. This has become painfully visible during the pandemic as well: there is growing evidence that the Covid-19 situation has had strong effects on children's development. There are claims that the environmental changes associated with the pandemic have negatively affected infant and child cognitive development. These effects would be stronger in children born into lower socio economic families. Underlying causes one could think of are parental stress,

lack of parental attentiveness, lack of physical activity, poor indoor climate, anxiety and depression, lack of guidance, crowding, chaotic circumstances all together forming the child's exposome.

What is the exposome and why is it important?

The exposome is an umbrella term for all the environmental exposures throughout the life course of a person. It encompasses all types of exposures. Some exposures arise from internal and external processes at individual level (e.g., smoking, diet, physical activity, infectious agents, psychosocial stress, parental support). Other exposure sources are shared at population level (e.g., climate, air quality, built environment, green space, noise and social capital). The exposome concept serves as a counterpart of the human genome and strives to map every exposure an individual is subjected to from conception to death, providing a DNA-like detailed level of exposure information.

Equal-Life discerns the external (physical, social) and internal exposome. The physical exposome is directly related to the description of the state of the environment - such as green spaces, sound and air quality, access to high quality and safe public spaces and playgrounds.

The social exposome focuses the social and psychosocial environment as well as on social (in)equities on mental health and cognitive development. This pertains to (in)equities in exposure distribution and accumulation across generations, vulnerability to exposures and potential equity impacts of urban (planning) policies on different societal groups.

Internal exposome is a consequence of external exposome filtered by personal vulnerabilities and lifestyle. It is measured in the person and can include biomarkers (i.e., indicators of exposure, susceptibility or outcome) but can also include processes that happen in the body and that can be analysed as a whole. Biomarkers are biological indicators measurable in saliva, hair, blood or urine. A well-known example is cortisol as a marker of stress.

The exposome contains a vast number of possible exposures during various phases of life. To reduce the complexity and make the broadness of the concept manageable, Equal-Life poses the questions: what is needed for a child /person to realise his or her own potential? What setting (e.g., kindergarten, school, recreational and sports facilities) and activities are relevant in view of mental health and development and at what age/life phase? From this we assess the possible mechanisms linking the exposome to mental health and cognitive development. Key mechanisms studied are stress and restoration, sleep and self-regulation.

How do we study this?

For a distinct set of outcomes related to cognition, mental symptoms and behaviour, well-being and diagnosed mental illnesses, the role of the exposome and underlying mechanisms is studied by making use of data from almost 250.000 EU children.

What will we do with this knowledge?

Equal-Life will develop and test interventions, such as improving housing environment, based on results of analyses and in close collaboration with stakeholders. Interventions and best practices will be included in a tool and a guidance document primarily aimed at context specific policies that affect children in Europe, thus contributing to healthier environments for European children. Intervention at an early age could benefit society as a whole by enhancing mental health and education outcomes, thus also addressing the contextual and root causes of social inequalities.

The EU Charter of Fundamental Rights states: The EU and EU countries must respect, protect and promote children's rights. All EU policies that have an impact on children must be designed in line with the best interests of the child. Compliance to this will depend heavily on national and local policy actions as well. Our tools will therefore primarily be aimed at them.

Reference: 1 Gross Domestic Product

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 874724

European Human Exposome NETWORK

Equal-Life

Dr. Irene van Kamp (and team)
Senior researcher
National Institute for Public Health and the Environment
Tel: +31 (0)88-6893222
irene.van.kamp@rivm.nl
www.Equal-Life.eu
https://twitter.com/EquallifeEU
https://www.humanexposome.eu/

True or false? Can we improve mental health through diet and physical activity

Unraveling the short-term effects of diet and physical activity on their ability to improve mental health – the Eat2beNICE APPetite study

'You are what you eat.'

Very true: We all know that what and how much we eat has a large impact on our physical health. Approximately 11 million deaths worldwide in 2017 were related to dietary risk factors, such as low intake of whole grains [1].

'Sport ist Mord' (a German saying, meaning exercise kills).

Quite false: Physical activity is a well-known contributor to good physical health. The World Health Organization (WHO) recommends at least 150 to 300 minutes of moderate aerobic activity weekly for adults, as regular physical activity can prevent and support to manage heart disease, type-2 diabetes and cancer. On the contrary, sedentary behavior can increase the risk of these diseases, which cause almost three quarters of deaths worldwide [2].

However, what is still less well known is that diet and physical activity also play a curial role for mental health. In Europe about 27% of individuals are affected by one or more mental disorders [3]. Contrary to other risk factors of mental disorders, diet and physical activity can be modified. The high prevalence of mental disorder and the modifiability of lifestyle highlight the need to better understand the link between mental health, diet and physical activity to formulate evidence-based lifestyle recommendations promoting mental health.



Physical activity and mental health

It has been suggested that aerobic exercise renders the brain more efficient, plastic and adaptive, which leads to improved memory [4]. Despite the positive effects of exercise on cognition, there is also increased evidence that exercise can improve mood and reduce the risk of depression [5]. Interestingly, the findings of a positive association between physical activity and mood seem to be particularly robust, when physical activity is measured objectively via an accelerometer – as in the APPetite study - and is not only assessed by self-report [6]. Physical activity also seems to have beneficial effects on symptoms associated with Attention Deficit Hyperactivity Disorder (ADHD), although there is only a small number of studies so far. One of these studies has shown that physical activity is associated with reduced impulsivity in adults with ADHD [7]. Overall, physical activity is good for our brain and our psychological well-being.

Relating diet to mental health

With regard to dietary habits, a Western-style diet that is characterized by high intake of saturated fat and sugar, seems to be associated with a higher vulnerability for mood disorders [8]. Our diet strongly influences our gut microbiome that is connected to the brain via the gut–brain axis. Thus, the food we eat influences all aspects of physiology, including gut–brain

communication, brain function and even behaviour [9]. Dietary patterns influence our behaviour, but this is not a one-way street. There is some evidence, that individuals high in impulsivity also show different dietary patterns. Within the Eat2beNICE consortium we showed that ADHD is characterized by an increased intake of sugar and saturated fat [10]. So far, it is unclear whether this dietary pattern contributes to ADHD symptoms such as impulsivity.

The short term effects of living healthier

Lifestyle factors, such as exercise and diet, have the potential to maintain or even improve mental health as discussed above. However most research has focused on how diet and physical activity influence mental health in the long term. Less is known about how diet and physical activity can improve mental health and well-being within the next minutes or hours – hence in the short term. Can an apple or a workout improve our mood immediately or shortly after? Does a cookie make us feel more anxious? Knowing what improves or impairs mental well-being in the short term can have important implications for patients to decrease disease-related burden in everyday life.

The Eat2beNICE APPetite study

In the APPetite study which is part of the Horizon2020-funded project "Effects of Nutrition and Lifestyle on Impulsive, Compulsive, and Externalizing behaviours - Eat2beNICE" (No 728018) we are interested in how diet and physical activity influence impulsivity in daily life. To study this, we developed a smartphone application which is used to track what our participants eat and drink [11]. Physical activity is captured by a wrist-worn accelerometer. Additionally, 8 times per day the smartphone asked the participants how impulsive they are. In this way we can study whether eating specific foods and/or engaging in physical activity can have a positive or negative short-term effect on impulsivity in daily life. May the consumption of foods high in sugar and/or fat increase momentary impulsivity? Can eating vegetables or a 20-minute jog help decrease impulsivity? Answers to these questions are needed to formulate recommendations and have the potential to improve mental health and well-being.

More information about the Eat2beNICE project:
www.newbrainnutrition.com

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This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 728018

Alea Ruf
PhD student
Department of Psychiatry, Psychosomatic Medicine and Psychotherapy
Goethe University Hospital Frankfurt
Tel: +49 69 6301 83348
alea.ruf@kgu.de
https://www.kgu.de/einrichtungen/kliniken/zentrum-fuer-psychische-gesundheit/psychiatrie-psychosomatik-und-psychotherapie/team/wissenschaftliche-mitarbeiterinnenmitarbeiter/alea-ruf
https://twitter.com/AleaRuf

Silke Matura
Senior Clinical Research Scientist
Department of Psychiatry, Psychosomatic Medicine and Psychotherapy
Goethe University Hospital Frankfurt
Tel: 0049 69 6301 84501
Silke.Matura@kgu.de
www.newbrainnutrition.com
https://twitter.com/NewBrainNutri

Is large-scale systemic change viable in mental healthcare?

Dr Sophie Dix, VP of Content and Nicola Hemmings, Workplace Scientist at Koa Health, discuss the potential for large-scale change in mental healthcare & why it's needed

There's no avoiding the truth of the current situation: existing systems (public and private) for mental health are overloaded and failing people across the full range of mental health – from those who need urgent 1:1 attention to those who could use access to preventative and self-guided resources to maintain their mental wellbeing. [1] To become the accessible, inclusive source of support that the British public needs it to be, mental healthcare in the UK needs a significant overhaul.



Last year, the estimated cost of mental health-related expenses across private and public sectors was £53-56 billion. [2] Wait times for mental health services via the NHS are 18 weeks or longer, with 1.5 million people in England waiting for mental health treatment. [3]

This impacts the majority of the population: 74% of UK adults have felt overwhelmed or unable to cope over the last year, [4] and they are not able to seek the help they need as 70-75% of people with a diagnosable mental illness receive no treatment whatsoever. [5]

However, making the large-scale change needed to truly address the situation requires careful consideration, significant planning and perhaps most importantly, consistent but flexible action over time – the willingness and ability to pivot quickly due to new insights must not be neglected. Then there are the barriers to address and overcome – from budgetary and time concerns raised by organisations to individuals' worries around privacy, inconvenience and the stigma associated with seeking out care.



So how can organisations (CCGs and others within the NHS, private health insurers, and employers) transform mental healthcare?

1. Incorporate inclusion into every step

Issues of access to mental healthcare disproportionately affect minority populations. [6] So, as you work towards large-scale change to make mental healthcare more accessible and effective, consider any actions and key themes to address from diverse perspectives. Ensuring that people from different socioeconomic and cultural backgrounds have visibility and a voice in the change process will help ensure your 'big picture' is as complete and inclusive as possible.



No one solution or modality will address everyone equally. Mental health ranges across a continuum from mentally ill to mentally well. Global, regional and personal circumstances impact it, and individuals' needs will vary depending on all of these factors at any given moment in time. But inclusion becomes much more possible with flexible, accessible resources. This has the added benefit of helping everyone, not just those in the greatest need of adjustments.

2. Gain momentum with a quick-fix approach

While large-scale change is 100% a long-term project, focusing on small, quickly implemented steps and feedback loops can help sustain forward motion and keep your organisation from getting stuck on minor details. Instead of spending months or years creating a down-to-the-letter plan for mental health that may become irrelevant by the time it is released, keep it simple. Select a few first steps that align with your budget and set a deadline to roll them out and collect insights for future iterations.

Ideally, your initial actions involve something your organisation feels will resonate and return fast results. It could mean implementing a well-being check-in policy between line managers and employees or doctors and patients or offering free access to a mental health resource or tool.

3. Monitor your results

To ensure you can evaluate what's working or not, put systems in place to track your results and gather quantitative data. This data can also help you decide where to allocate further resources. If your initial steps involve third-party tech, you're likely to have access to data from the provider to leverage.

Qualitative feedback also offers an essential perspective, so include additional ways for those affected by your initiative to share their thoughts. Google forms, surveys, or a contact email or phone number are good places to start. Be sure that however you're monitoring your results you're keeping in mind confidentiality and data security concerns.[7]

4. Learn, pivot and repeat as needed

After taking your first steps, evaluate your results. What's resonated and what hasn't? Has the initiative driven progress in notable ways? What key themes have emerged around mental health needs at your organisation?

Use any lessons or insights obtained from your initial effort to decide on the next steps. After each step and subsequent evaluations and iterations, you'll have more information to help you continue elaborating your long-term plan.

Large-scale change is by definition challenging to implement, and without resilience, it becomes nearly impossible. For more on how to build strength and wellbeing at your organisation, download our 30-page resource, Building organisational resilience: The business case for employee wellbeing.

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Koa Health

Dr Sophie Dix and Nicola Hemmings
VP of Content and Workplace Scientist
Koa Health
info@koahealth.com
https://koahealth.com
https://bit.ly/3lHqrVb
https://twitter.com/koahealth

Mental health challenges and encouraging help seeking behaviours among rural residents

Lakshmi Mahadevan, Associate Professor and Extension Specialist at Special Populations, looks toward helping rural residents seek appropriate and timely help for mental health challenges

Beginning March 2020, Texas A&M AgriLife Extension Service (AgriLife Extension) launched the "Reducing Opioid Use and Misuse through Mental Health First Aid in Rural Texas" (MHFA_RTX) project funded through a Rural Health and Safety Education grant awarded by the United States Department of Agriculture (USDA).

MHFA_RTX seeks to teach people to identify and address mental health challenges, or substance use disorder among fellow rural citizens by implementing ALGEE safely and responsibly.

How do Mental Health First Aiders help tackle mental health challenges?

- Assess for risk of suicide or harm.
- Listen nonjudgmentally.
- Give reassurance and information.
- Encourage appropriate professional help.
- Encourage self-help and other support strategies.

MHFA for adults takes the fear and hesitation out of starting conversations about mental health and substance use problems by giving individuals experiencing mental health challenges their sense of autonomy and decision-making power back.

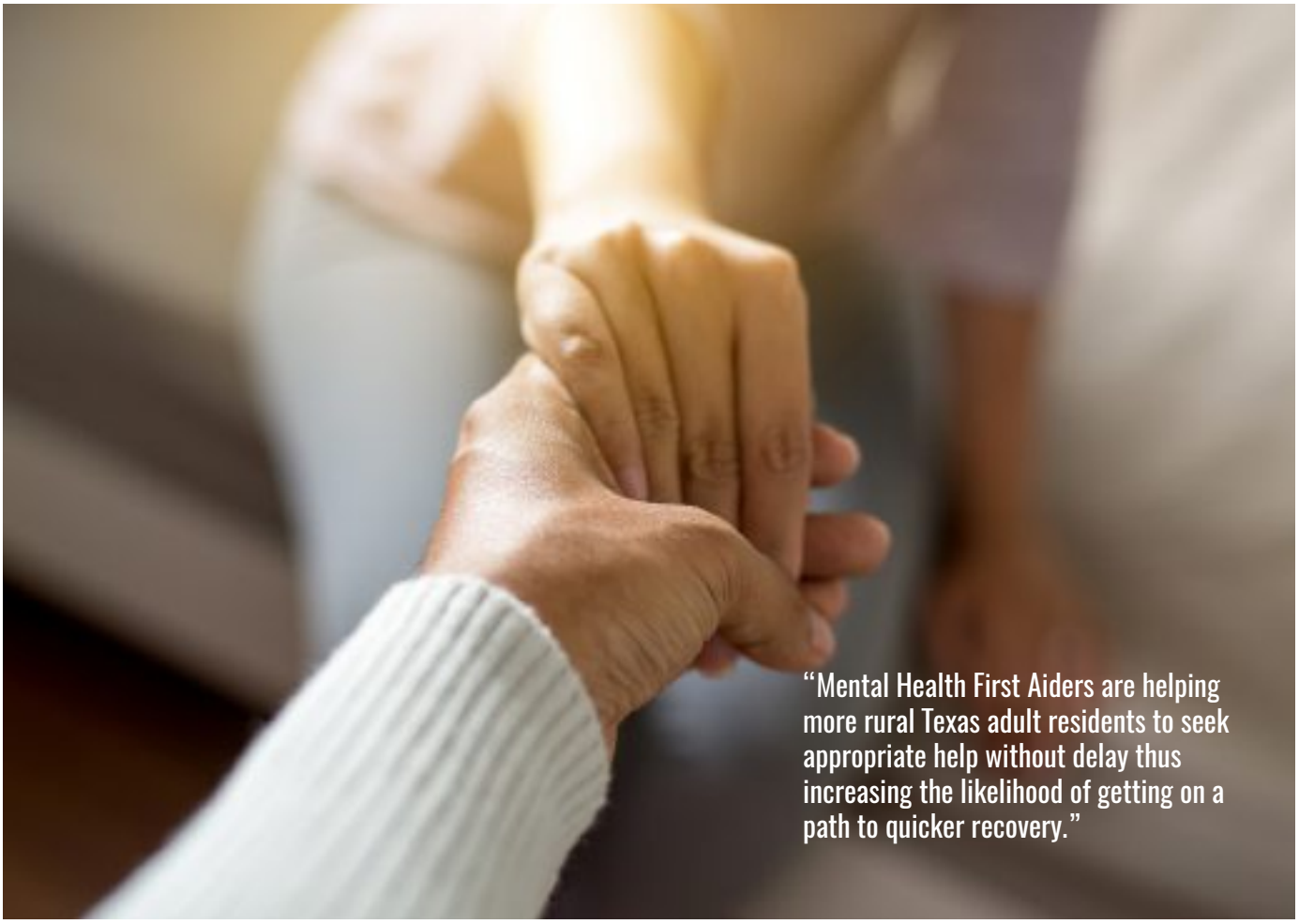
This is accomplished by training Mental Health First Aiders to apply a nonjudgmental approach throughout the duration of the MHFA interaction.

Mental Health First Aiders' nonjudgmental approach

1. Allowing individuals to say "I don't want to talk with you about this" or "I don't want to talk right now" or "Can I contact you later?" or "I would like to talk but not with you."
2. Refraining from advising individuals about undertaking a specific course of action.
3. Not making decisions or taking action that amount to seeking active treatment for the individuals unless it is a medical emergency.
4. Exercising patience with individuals who are indecisive, delay getting treatment or refuse to seek appropriate professional or self-care.
5. Knowing that the MHFA "ALGEE" framework is non-linear and will require starting over, repetition of steps, and consistent follow-up.
6. Giving individuals a variety of care options that they can choose to utilize in real time or in the future.
7. Encouraging individuals to choose the care options that are most appropriate.
8. Reminding individuals that they can choose to discontinue or choose alternate means of care as needed.
9. Using universal language that transcends cultural barriers such as "You are not alone..."; "I am concerned about you because I have noticed..." and, "It is natural to feel this way and I am here if you want to talk about it.".
10. Noticing signs and symptoms of substance use and non-suicidal self-injury and stating observations objectively without overreacting or heightened emotion.
11. Disclosing personal lived experiences emphasizing recovery, optimism and strategies that worked without making the conversation all about oneself.

As of 2022, MHFA_RTX grant has trained over 240 Texans to be Mental Health First Aiders. Of those trained, 90% indicated that their knowledge of mental health challenges, signs, and symptoms has improved. 85% of participants reported appreciation for the MHFA action plan and the potential for preventing, intervening and recovery for fellow rural citizens experiencing mental health challenges.

Additionally, 80% of participants



indicated that they were highly likely to have a supportive conversation with an adult experiencing signs and symptom(s) of a mental health or substance use challenge or crisis.

Participant testimonials

The most helpful part of the course was,

1. "Learning how to provide aid that will lead to encouraging a person to seek help".
2. "Approaching the awkward conversations for me would be difficult. The scenarios were very good demonstrating how to start the conversations in a variety of settings".
3. "Understanding how to approach a situation with purpose. Before, I had great advice, but failed to adequately listen in order to understand the actual struggles behind the situation".

Conclusion: The USDA-NIFA funded, "Reducing Opioid Use and Misuse through Mental Health First Aid in Rural Texas" grant is focused on and has been effectively working to offset barriers posed by ruralized culture, stigma and judgment to beginning difficult conversations about mental health.

Additionally, by encouraging independent decision making, and creating avenues for individuals to regain a sense of autonomy and control, Mental Health First Aiders are helping more rural Texas adult residents to seek appropriate help without delay thus increasing the likelihood of getting on a path to quicker recovery.

TEXAS A&M AGRILIFE EXTENSION

Lakshmi Mahadevan
Associate Professor and Extension Specialist – Special Populations
Texas A&M AgriLife extension Service
Tel: +1 979 321 5223
lmahadevan@ag.tamu.edu
https://twitter.com/ctespecialpops

Mental health and perinatal depression in the US

The National Institute of Mental Health (NIMH) is the lead U.S. federal agency for research on mental illnesses

The mission of NIMH is to transform the understanding and treatment of mental illnesses through basic and clinical research, paving the way for prevention, recovery and cure – including research into perinatal depression.

To carry out its mission, NIMH conducts and supports biomedical and behavioural research, health services research, research training and health information dissemination with respect to the causes, diagnosis, treatment, management and prevention of mental illnesses.

As mental health is an important part of overall health, NIMH invests in research on adaptive and maladaptive behaviours to better understand mental function and dysfunction.

The NIMH Strategic Plan sets four goals to form a broad roadmap for the institute's research priorities, spanning fundamental science to public health impact.

- **Goal 1:** Define the Brain Mechanisms Underlying Complex Behaviours.
- **Goal 2:** Examine Mental Illness Trajectories Across the Lifespan.
- **Goal 3:** Strive for Prevention and Cures.
- **Goal 4:** Strengthen the Public Health Impact of NIMH-Supported Research.

An introduction to perinatal depression

Perinatal depression is a mood disorder that can affect women during pregnancy and after childbirth. Perinatal depression includes depression that begins during pregnancy (called prenatal depression) and depression that begins after the baby is born (called postpartum depression). Mothers with perinatal depression experience feelings of extreme sadness, anxiety and fatigue that may make it difficult for them to carry out daily tasks, including caring for themselves or others.

Perinatal depression is a real medical illness and can affect any mother - regardless of age, race, income, culture or education. Women are not to blame or at fault for having perinatal depression: it is not brought on by anything a mother has or has not done. Perinatal depression does not have a single cause. Research suggests that perinatal depression is caused by a combination of genetic and environmental factors. Life stress (for example, demands at work or experiences of past trauma), the physical and emotional demands of childbearing and caring for a new baby, and changes in hormones that occur during and after pregnancy can contribute to the development of perinatal depression. In addition, women are at greater risk for developing perinatal depression if they have a personal or family history of depression or bipolar disorder or if they have experienced perinatal depression with a previous pregnancy.

Some women may experience a few symptoms of perinatal depression; others may experience several symptoms. Some of the more common symptoms of perinatal depression include:

- Persistent sad, anxious or "empty" mood.
- Irritability.
- Feelings of guilt, worthlessness, hopelessness or helplessness.
- Loss of interest or pleasure in hobbies and activities.
- Fatigue or abnormal decrease in energy.
- Feeling restless or having trouble sitting still.
- Difficulty concentrating, remembering or making decisions.
- Difficulty sleeping (even when the baby is sleeping), awakening early in the morning or oversleeping.
- Abnormal appetite, weight changes or both.
- Aches or pains, headaches, cramps or digestive problems that do not have a clear physical cause or do not ease even with treatment.
- Trouble bonding or forming an emotional attachment with the new baby.



- Persistent doubts about the ability to care for the new baby.
- Thoughts about death, suicide or harming oneself or the baby.

Only a healthcare provider can help a woman determine whether the symptoms she is feeling are due to perinatal depression or something else. It is important for women who experience any of these symptoms to see a healthcare provider.

Treatment for perinatal depression for both mothers and babies

Treatment for perinatal depression is important for the health of both the mother and the baby, as perinatal depression can have serious health effects on both. With proper treatment, most women feel better and their symptoms improve.

Psychotherapy

Several types of psychotherapy (sometimes called "talk therapy" or "counselling") can help women with perinatal depression. Two examples of evidence-based approaches that have been used to treat perinatal depression include cognitive behavioural therapy and interpersonal therapy.

Cognitive Behavioural Therapy (CBT)

CBT is a type of psychotherapy that can help people with depression and anxiety. It teaches people different ways of thinking, behaving, and reacting to situations. People learn to challenge and change unhelpful patterns of thinking and behavior as a way of improving their depressive and anxious feelings and emotions. CBT can be conducted individually or with a group of people who have similar concerns.

Interpersonal Therapy (IPT)

IPT is an evidence-based therapy that has been used to treat depression, including perinatal depression. It is based on the idea that interpersonal and life events impact mood and vice versa. The goal of IPT is to help people to improve their communication skills within relationships, to develop social support networks and to develop realistic expectations that allow them to deal with crises or other issues that may be contributing to their depression.

Medication

Women with perinatal depression are most commonly treated with antidepressants, which are medications used to treat depression. They may help improve the way the brain uses certain chemicals that control mood or stress.

Researchers at NIMH and around the country conduct many clinical research studies with patients and healthy volunteers to continue the development of treatments for perinatal depression.

Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
https://twitter.com/OpenAccessGov

Pregnancy-specific anxiety

Karen L. Weis, a professor at the University of Kansas School of Nursing, discusses pregnancy-specific anxiety

Introduction

Pregnancy-specific anxiety, is the strongest predictor of poor birth outcomes (Liou et al., 2016; Premji, 2014). O'Donnell et al. (2014) found that independent of a range of social determinants of health (age, education, crowding, socioeconomic status, discrimination), pregnancy anxiety predicted higher scores for measures of child emotional and behavioural problems (O'Donnell et al., 2014). In repeated studies, pregnancy anxiety for well-being of self and baby, fear of pain, helplessness and maternal identity were associated with both preterm birth and low birth weight infants after controlling for gestational age at birth, smoking history, and parity (Lederman & Weis, 2009; Weis et al., 2020).

Stress, anxiety, and depression have been studied in both animal and human pregnancy, and the evidence is convincing that a mother's psychological state has an impact on birth outcomes and the child's neurodevelopment outcomes (Ding et al., 2014; O'Donnell et al., 2014; Herba et al., 2016; Kinsella & Monk, 2009). Researchers have shown that high values for anxiety, (measured as perceived stress), increased the risk of small for gestational age infants (Khashan et al., 2014), and preterm birth (Liou et al., 2016).

What is pregnancy-specific anxiety?

Pregnancy-specific anxiety includes concerns related to discomforts, body changes, motivation and preparation for parenting, labour and the birth experience, and safety of oneself and the baby. Anxiety associated with a reduced sense of safety extends to fears regarding the birth experience. Fear of childbirth is a concern, as it correlates to longer durations of labour and an increased risk of delivery by caesarean section (Lederman & Weis, 2020; Matinnia et al., 2015; Waldenström et al., 2006).

"Stress, anxiety, and depression have been studied in both animal and human pregnancy, and the evidence is convincing that a mother's psychological state has an impact on birth outcomes and the child's neurodevelopment outcomes"

Fears of childbirth tend to be greater for first-time mothers (Weis et al., 2017; Nieminen et al., 2009), although multiparous mothers may have intense fear associated with memories of previous childbirth experiences (Lederman & Weis, 2020; Nieminen et al., 2009). Admittedly, the anxiety of those experiencing pregnancy for the first time differs from those with pregnancy and childbirth memories. However, while different, it is no less an issue. For those having experienced motherhood, there may be anxiety over expanding their identification with their role and anticipated life changes (Lederman & Weis, 2020). There is a greater tendency toward unwanted or unintended pregnancies in women with higher parity (Goiclea & San Sebastian, 2010; Takahashi et al., 2012; Postlethwaite et al., 2010), which increases the likelihood of anxiety and depression (Kharaghani et. al., 2018).

Pregnancy-specific anxiety is not static but fluid, as patterns of adaptation are complicated (Sameroff, 2002). Some investigators report higher pregnancy anxiety in the first and third trimesters (Da Costa et al., 2000; Figueiredo & Conde, 2011). Our research reflects growing anxiety throughout pregnancy for those fearful of birth, distrustful of healthcare professionals or having limited support (Lederman & Weis, 2020). For those struggling with role identification, the anxiety remains constant, with little variation, without intervention. Whereas anxiety related to pregnancy acceptance is generally the highest in the first trimester, ebbing as the pregnancy progresses unless the pregnancy is unwanted. Pregnancy-specific anxiety encompasses a broad range of constructs, of which some may overlap with state anxiety. It reinforces the need for appropriate assessment and ongoing awareness of enduring anxiety that could potentiate physiologic changes to both mother and infant.

Assessment and intervention of anxiety in patients

Discerning differences in the measurement of anxiety is particularly important for generalizing the findings, but it is also paramount to the development and assessment of effective interventions. Admittedly, measures



differ in their sensitivity to change, and the question should be asked as to whether the instrument can detect clinically meaningful change, or measure clinically relevant aspects of anxiety. Hence the importance of the science that delineates constructs of pregnancy-specific anxiety associated with poor maternal and infant outcomes. Moreover, as the science of precision health is advanced, it must include pregnancy. Pregnancy creates a transition within one's life regardless of whether it is a first pregnancy or one of many pregnancies and birth experiences. It inevitably produces anxiety, unique to pregnancy, which must be evaluated, and appropriate interventions applied accordingly.

To this end, interventions require theoretical frameworks aligned to the problem. Consideration must be given to the usefulness and applicability of the intervention as well as assessment tools. Patients and/or populations may differ in ways that demand modification of an intervention. Additionally, there is a need for time-sensitive interventions. Beginning in the first trimester, information is actively sought about the pregnancy experience (Deutsch et. al., 1988). Information-seeking, whether it occurs through interactions with family and friends or by reading books or online posts or watching videos, continues throughout pregnancy and into the postpartum period, with the occurrence peaking at the points of time in which the information is needed (Deutsch et al., 1988; Newhouse & Blandford, 2016).

This reinforces the need for well-designed, supportive interventions throughout pregnancy, particularly in an era in which a plethora of information exists related to pregnancy, birth, and infant care, but with little emphasis on quality control (Hughson et al., 2018). While there is an assumption that patients prefer the internet over the information provided by health professionals, evidence suggests that the majority prefer discussing issues with their healthcare provider (Grimes et al., 2014), and only turn to the internet when they feel the information provided is inadequate (Lagan et al., 2010). Certainly, poor quality, or mistimed information and support increases pregnancy anxiety.

Revaluation of how we approach pregnancy

Pregnancy-specific anxiety is complex and distinct from general anxiety, although both influence one another (Huizink et al., 2014). This complicates assessment and intervention, particularly when a 'one size fits all' approach is applied. Instead, individual variability must be considered. Additionally, how we approach pregnancy, both socially and medically requires an appraisal. Pregnancy is not an illness, but it certainly creates vulnerability. Identifying and providing support throughout pregnancy is critical. Pregnancy requires time to assess beliefs and expectations with support from family, friends, and healthcare professionals who assist in normalizing experiences and expectations (Staneva et al., 2016). This approach is key in helping the individual shift from a self-focused state which promotes increased apprehension regarding pregnancy and childbirth, to one recognizing that some anxiety in pregnancy is normal.

Click here for references

KU SCHOOL OF NURSING
The University of Kansas

Karen L. Weis
Professor, Christine A. Hartley Rural Nursing Professorship
University of Kansas School of Nursing
Tel: +1 785 822 0416
kweis2@kumc.edu
https://www.kumc.edu/kweis2.html
https://www.linkedin.com/in/karen-weis-3167593b/
https://www.kumc.edu/about/news/news-archive/karen-weis-phd-joins-son-salina-faculty.html

UK Cannabis Industry – the next Scottish Whisky

Nick Morland, Tenacious Labs CEO, All-Party Parliamentary Group for CBD Products Secretariat, Jersey Cannabis Services Advisory Board Chair, writes about the UK Cannabis Industry – could this be the next Scottish Whisky?

Now is a time-sensitive one-off opportunity for post-Brexit UK to dominate the premium segment of a valuable new worldwide industry if the right legislation can be agreed upon and implemented.

The Cannabis Industry

The Cannabis Sativa plant provides a range of products quite apart from recreational use – including high protein biomass for less flatulent cows and carbon credits, moisturiser for gardeners' stiff hands and arthritic dogs, natural alternatives for nausea, pain, sleep and anxiety and medical possibilities around MS and epilepsy.

Consumers have already recognised this and are buying a lot of Cannabis products, with the industry's worldwide turnover today circa £20 billion, expected to reach £69 billion in 2026 with long-term growth of more than 6% per annum from then.

Foundations to build on

The UK Cannabis Industry can look to two benchmarks – firstly the UK's world-leading Scottish Whisky, and secondly Colorado, the most advanced of the 33 U.S. states that are fully legalised.

Whisky's worldwide turnover is £69 billion as of 2021 and the UK's share of this is £5.5 billion. UK Whisky supports 42,000 permanent high-value jobs, the vast majority in rural areas and often employing people who prefer not to move away from hometowns or continue into higher education.

Colorado with a population of only 6 million has a Cannabis turnover of £2 billion with tax of £330 million per annum, and created more than 38,000 jobs (and this before inevitable U.S. Federal legalisation). A simple extrapolation to the UK's 67 million population suggests an annual turnover of £22 billion, with £3.7 billion of tax and 428,000 jobs. Before exports.

Work in progress

The UK Cannabis Industry is responding to this opportunity in part by engaging with government on an official and effective basis with the November 2021 formation of the highly active All-Party Parliamentary Group (APPG) for CBD Products. The CBD APPG is supported by the normal Secretariat, in turn, less conventionally informed by the Secretariat Advisory Board (SAB).

The SAB is key, directly representing more than 70% of all active UK businesses – including the Medical Cannabis Clinicians Society (MMCS), the Cannabis Industry Council (CIC), the Cannabis Trades Association (CTA), the European Industrial Hemp Association (EIHA), the Scottish Hemp Association (SHA), the British Hemp Alliance (BHA) and the Cannabis Services Advisory Board (Jersey), plus others totalling 701.

In one month alone, the Secretariat and SAB representatives have been in;

1. Scotland hosted by Food Standards Scotland – Scottish Whisky being the gold standard in premium F&B,

2. Wales hosted by Aberystwyth University – world-class agricultural development and seed bank,

3. Denver, Colorado – the most professionally established legalised State,



Nick Morland
Tenacious Labs CEO

4. Washington DC – for U.S. Federal thinking and emerging market inward investors, and

5. Jersey – still in the British Isles and has taken the early lead in both legislative and regulatory changes already made.

Crucially the APPG and SAB together represent the single legitimate functional successor to the single-issue groups that successfully completed the crucial first stage of raising awareness, and are now an important part of (but have no mandate to speak for) the UK Cannabis Industry as a whole.

Not squandering a natural lead

The UK is lucky to be in a peculiarly strong position to become the global powerhouse if the political will is there to provide the right framework to introduce clear, balanced, inclusive processes for legislation and regulation regarding updating POCA, consumer protection, quality standards, appropriate definitions and limits, research and development, banking, agriculture, insurance, London Stock Exchange listings and more.

In short, this is the time for government to actively drive a new cycle of growth, investment and jobs with some simple, immediate and informed decisions. Yet the route legislation is currently taking outlaws for all Cannabis production, except isolate.

Bluntly, this would be a short-sighted mistake that doesn't consider what is clearly the single most important economic opportunity available to post-Brexit UK, to legislate for and build a framework to enable a well-regulated home-grown Cannabis Industry.

Isolate and natural plants sources are both relevant and need to be included in the big tent, but by legislating for isolate only, or (as bad) moving too slowly, there's an immediate risk of squandering our advantage and ceding the initiative to other countries who will do more than import and package a lab-made commodity supplying an important sub-set of consumers but with limited agricultural, commercial and economic interest when compared with the full plant that can be grown across the UK.

Next steps

The APPG Co-chairs need to meet with Government ministers to organise a consultation process initially built around the CBD APPG including;

1. The production of an inclusive industry-informed report, via a public process, for the Cannabis Industry to complete by 21st July 2022,

2. Building on the existing Scottish Whisky industry experience,

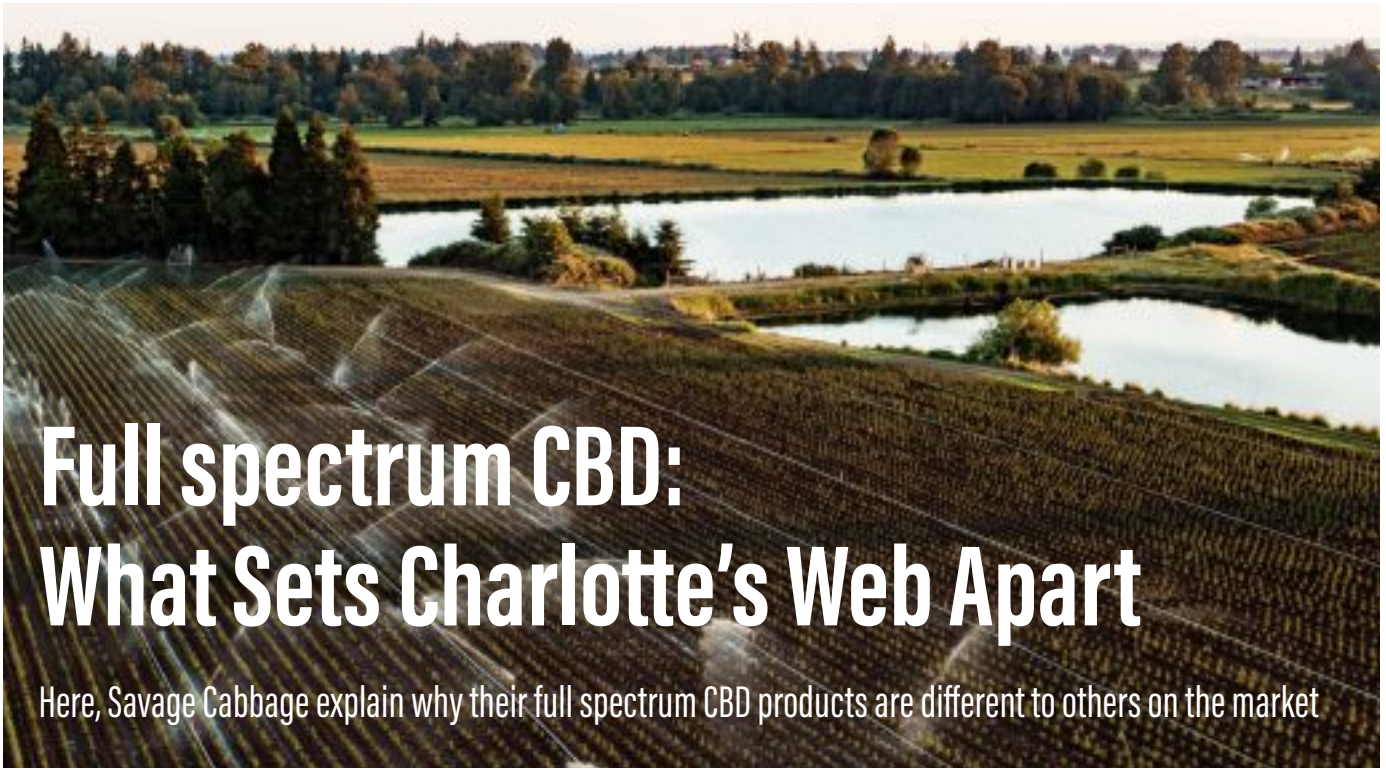
3. With clear economic benefits, choices and necessary consumer protection,

4. Including input from the big tent – across the industry (including isolate) as well as directly addressing all devolved governments and the various departments that will have responsibilities such as DEFRA, the Home Office, FSA, FCA, etc.

Finally

With a proper process established, post-Brexit UK has an excellent chance of becoming the leading force in the premium segment of the Cannabis Industry, generating massive economic benefits just like Scottish Whisky. Or it's too hard, we don't bother, and watch others doing it instead. It's as simple as that.

Nick Morland
Tenacious Labs CEO
All-Party Parliamentary Group for CBD Products Secretariat
Jersey Cannabis Services Advisory Board Chair
appg@tenacious-labs.com
www.appgcbd.org



Full spectrum CBD: What Sets Charlotte's Web Apart

Here, Savage Cabbage explain why their full spectrum CBD products are different to others on the market

One of the Charlotte's Web organic farms in the U.S.

Charlotte's Web is more than a name; it's a promise. They live and breathe quality to ensure their products are the best. This is their pledge to you — to customers, to the community and the world — to consistently produce the highest-quality hemp extract products on which people around the globe can trust and rely on. From cultivation to final product formulation, their passion for excellence translates into everything they do. And it's why they're **The World's Most Trusted Hemp Extract™**.

Charlotte's Web™ was created by the 7 Stanley brothers who believe in creating a world where good health through nature is accessible to all. At Savage Cabbage, we're proud to be official partners and exclusive distributor of Charlotte's Web CBD.

The State of the UK CBD Market

There are still thousands of CBD products on the UK market, even since the Novel Foods regulations. **But not all CBD products are made equal.** Low quality, isolate CBD products have flooded the UK market due to how cheap and abundant the raw material is. The price of CBD isolate has dropped by over 95% due to mass oversupply, with China being the largest supplier in the world.

By contrast, Charlotte's Web and Savage Cabbage focus on **full spectrum CBD products**. Each compound, vitamin and mineral that naturally occurs in the hemp plant plays a role in the effectiveness of a high-quality extract that provide natural benefits to human health and wellness. The variety of compounds found within the hemp plant work synergistically, called **the Entourage Effect.** We are strong advocates in full spectrum CBD products - and the results are there for all to see. Low grade CBD can be found all over the market, however none of these offer the proven benefits of full spectrum.

Charlotte's Web™ CBD and their rigorous commitment through the production process are what sets them apart. Organically growing and developing hemp the best way they know how: with quality and care at every step of the process, ensuring that every stage of production is monitored and of the highest quality to deliver superior results.

Quality full spectrum CBD starts from the ground up

The Charlotte's Web mission to help others motivates them to produce the best hemp products that people can trust. That's why **full production is managed in-house from seed to bottle,** beginning with superior raw materials. Their patent-protected genetics are grown and harvested intentionally to utilise all the flowering portions of the hemp plant. Only the highest quality materials are extracted, and the discarded scraps of other parts of the plant like the stem are excluded.



The World's Most Trusted Hemp Extract™

Forgive the pun, but let's get to the root of the issue: **healthy soil grows healthy plants.** The soils in which Charlotte's Web is grown are tested and cleared for all contaminants prior to planting. This is critical as the **hemp plant is highly absorptive and known to easily collect elements from the soil in which it is grown.** Hemp is so effective at cleaning up contaminated soil that it was planted at Chernobyl following the nuclear disaster to reduce soil toxicity.

All of the growing practices are natural, organic and sustainable – as beneficial to the earth and environment as they are for our plants and products. Charlotte's Web has achieved USDA Organic Certification, one of the only hemp companies globally to achieve this. Some methods adopted include:

- Encouraging natural predators of hemp pests to ensure biodiversity
- Using cover crops and tending to the plants by hand
- Zero use of anything toxic or harmful to the plants or environment

Consistency: from plant to plant, and bottle to bottle

The only way any CBD company can create consistent products is by using consistent plant genetics. The reality is most products on the market are only focused on ensuring a consistent level of CBD, and not the full product profile.

Charlotte's Web is committed to absolute consistency, so that every product gives the same benefit, time after time. How? Proprietary hemp genetics are expertly bred to optimise growth and cannabinoid profiles using scientifically determined inputs. The world-leading team of agronomists and chemists monitor plants in the field throughout the growing season to ensure the final product is of the highest quality.

Unadulterated Purity

Once Charlotte's Web have grown and harvested the plants, they trust in nature. You will never find any chemicals or additives in their bottles. Every Charlotte's Web product is gluten-free, vegan, non-GMO and have zero BPA in our containers (or products!). In fact, every product recently received the USDA Organic Certification (with the exception of The Original Formula, which uses a unique alcohol-based extraction that prevents it from achieving organic status).

Full Spectrum CBD Quality Procedures and Verifications

Charlotte's Web adheres to the gold standard of quality. Their facility is FDA-registered, follows Good Manufacturing Protocols (GMP) and have received one of the highest audit scores from a third party GMP auditor in the US at 98.9%.

Receiving a third-party certification for Good Manufacturing Practice (GMP) means the manufacturing process of Charlotte's Web has achieved numerous requirements needed to produce high quality, reproducible and most importantly safe products. With 20+ rounds of testing on every product, Charlotte's Web possess one of the most stringent testing protocols in place that monitor every product from start to finish.

Quality is pride of workmanship

Charlotte's Web is dedicated to achieving the highest standards due to the global community that relies on their products. As more and more people rely on high quality hemp extracts for their health and wellness, the onus is on companies to provide transparency into their processes behind their products.

But don't just take our word for it – try it and see how Charlotte's Web works for you. If you would like to join the family and explore the potential benefits of stocking the World's Most Trusted CBD brand in your store, find out more at: https://savagecabbage.co.uk/wholesale-enquiries/

savage cabbage
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Savage Cabbage Ltd
info@savagecabbage.co.uk
www.savagecabbage.co.uk



Image: © Andris Tkacenko | Dreamstime.com

Shifting sands in the UK CBD industry

Senior Associate David Hardstaff and Partner John Binns of BCL Solicitors explore shifting sands in the UK CBD industry

UK-based CBD companies may feel they have had a rough ride of late. From operating within a light-touch regulatory regime, founded on the belief that CBD products were no different to any other readily available food supplement, the closing drawbridge that is the Food Standards Agency's (FSA) novel food application process has been a shock to the industry's system. The process, which requires non-medicinal CBD products to be the subject of an application for authorisation has caused a stir within UK-CBD stocks and laid bare the industry's reliance on white-label goods. This has left many querying the real value behind some of the glitzy, celebrity-endorsed brands dominating the CBD landscape.

The longer-term consequences of the clampdown are difficult to predict. When announcing the publication of its list of products which have submitted a valid novel food application, the FSA confirmed the role of enforcement authorities and that it had recommended to local authorities that any products not on the list should be withdrawn from the market. Such products would be deemed "unsuitable for progressing to authorisation" or, in other words, dead in the water.

As one door closes, another opens

The UK CBD industry has, to date, catered to a wide variety of consumers. CBD can be found in a diverse range of products, from dog food to cosmetics. One of the largest and arguably sustainable customer bases, however, is consumers with some sort of health or therapeutic need for which they are unable to access medicinal cannabis. One potential consequence of the FSA's drive to rein in the UK's CBD industry is reduced access to the previously available wide range of products. By 2022, it is now difficult to find a high street


David Hardstaff, Senior Associate


John Binns, Partner

or retail centre between John o' Groats and Land's End without CBD products for sale. That position could dramatically change.

Medicinal cannabis products have been available since 2018

Cannabis-based products for medicinal use, or "CBPMs", have been available for prescription in the UK since 2018; however, access is strictly limited through existing and bespoke regulatory controls. In addition to the regulatory barriers to access, funding has long been cited as a problem, with limited patient access through the UK's National Health Service. In drilling down the issue, a lack of UK-based research as to the efficacy of CBPMs is the starting point.

Several laudable initiatives have sought to plug the research gap, including Project Twenty21, which is the UK's largest observational medicinal cannabis study. However, observational studies have their limitations, which is why most have recently welcomed with open arms the UK Health Research Authority approved trial, Canpain.

Canpain is planned to run for three years and aims to conduct clinical trials involving up to 5,000 patients suffering from chronic pain. The trial will be the first of its kind in the UK and could be significant in opening access to CBPMs for the UK's estimated 1.4 million patients currently accessing cannabis through the illicit market.

Reliable data on the number of CBD consumers with some sort of therapeutic need is patchy, but as access to CBD products becomes more limited through enforcement of the novel food regime, access to CBD-based medicines could provide an important lifeline. This could also present opportunities for the CBD industry, which until now has seen a benefit in its separation from the medicinal market. The industry must ask itself whether it is now time to explore the jump from consumer products to medicines.

Can a more agile CBD industry flourish and better serve patients?

No one would suggest that the development and marketing of a new medicinal product is a straightforward task. Although CBD is not a controlled drug in the UK, the position of the Home Office remains that it is difficult to produce CBD without any trace element of THC, which is controlled. Consequently, it is usually necessary to begin the process of developing a CBD-based medicine with an application to the Home Office for a Schedule 1 controlled drug licence for research purposes. Further licences are likely to be necessary throughout the development process, including a Schedule 2 controlled drug licence for operating with CBPMs, as well as Manufacturers (Specials) and Distributors licences from the Medicines & Healthcare products Regulatory Agency (MHRA).

The regulatory hurdles are many, but the potential UK market - thought to be the largest untapped market in Europe - is significant. Turning to the development of CBD-based medicines could represent a lucrative opportunity for some of the brands which have, until now, limited their reach to what might be described as the lifestyle market. That may not explain or justify the FSA's stance, and nor does it remove the urgent need to liberalise access to CBPMs. But for consumers with a therapeutic need, a more competitive UK CBD industry, agile in its ability to cross the barrier between the medicinal and non-medicinal worlds, can only be a good thing.

David Hardstaff, Senior Associate

John Binns, Partner

BCL Solicitors
Tel: +44 (0)20 7430 2277
law@bcl.com
www.bcl.com
https://twitter.com/bclsolicitors

The importance of personalised medicine & technology in the future of medical cannabis



Dr Stephen Barnhill M.D from Apollon Formularies Plc discusses the potential for technology to upgrade personalised medicine for cannabis treatments

With over 70% of new cancer drugs being derived from natural products, the future of medicine lies within nature. For centuries, the plant Cannabis sativa L. has been used across the world as a herbal remedy.

Modern research has shown its potential to treat various diseases such as cancer. Technology is taking treatment a step further with the potential to 3D print personalised cannabis-based medicines in local pharmacies.

Going back to nature

In the last century, there has been a trend within the pharmaceutical industry of new cancer drugs being derived from natural sources [1]. According to research by Newman & Cragg 2010, "in the area of cancer, over the time frame from around the 1940s to date, of the 175 small molecules, 131, or 74.8%, are other than "S" (synthetic), with 85, or 48.6%, actually being either natural products or directly derived therefrom".

The acceptance of plant-based medicines is also apparent in public attitudes towards medical cannabis. After its 50 year prohibition in the UK, medical cannabis was legalised in 2018 sparking renewed interest and research into the plant's properties.

Alongside its stand-alone properties, medical cannabis formulations can be used with other naturally-derived medicines to enhance efficacy. For example, independent testing showed that when medical cannabis and functional mushroom formulations were combined, nearly 100% of HER2+ breast cancer cells in 3D cell cultures were killed through the three different pathways [2]. These compelling results have warranted the initiation of human trials and mark a significant milestone in cannabis' potential role in oncology.

As cannabis-based medicines move away from the 'novel' and into the mainstream, we should continually be looking towards the future and how it

can fit into new approaches to drug design.

There's no 'one size fits all' for our health

Changes in drug development and manufacturing within the last century have led to a 'one size fits all' approach to our health [3]. Many mainstream medicines are mass produced based on broad population averages, meaning that the true efficacy for an individual could be significantly different depending on their genome [3].

Personalised medicine recognises that we are all genetically unique which has allowed gene-based biomarker therapeutic triage in certain individual cancer patients. Gene sequencing to identify new biomarkers for medical cannabis patients, like is currently used in some traditional cancer treatments, is currently underway.

With over 100 naturally occurring cannabinoids, there is no 'one size fits all' for medical cannabis in cancer treatment [4]. As discussed in the March 16 2022 article, AI is being used to carry out analysis of cannabis plant genetics and phenotypes, to determine the best combination of cannabinoids, terpenes and flavonoids to target and optimise the treatment of various cancers.

Modernising an ancient medicine

Personalised medicine raises the question of commerciality; how can pharmaceutical companies mass produce individual treatments?

One solution is three-dimension (3D) printing, which came into the mainstream during the 2000s [5] and 'involves the establishment of a three-dimensional object, in a layer upon layer manner using various computer software' [6]. Since the Food and Drug Administration in the United States approved the first 3D-printed drug in 2015, there has been growing interest in its application in the pharmaceutical sector [7].

> "Independent testing showed that when medical cannabis and functional mushroom formulations were combined, nearly 100% of HER2+ breast cancer cells in 3D cell cultures were killed...."

Advances in technology mean that 3D printing has a range of printing methods which are compatible with printing drug products [7]. This allows the creation of 3D-printed medicines with dosage forms varying in drug combination, release profile and shape to meet individual needs [6].

As 3D printing moves towards the mainstream, companies such as Apollon Formularies are researching its application with cannabis-based medicines. The confluence of this powerful technology and the huge potential of medical cannabis in the treatment of a number of diseases makes for a compelling future of personalised healthcare.

The ambition is to have 3D printing available in local pharmacies, where pharmaceutical companies would be able to send the printer the combination of compounds for on-demand printing of personalised medication. This would also allow for medicines with short-shelf lives to be produced in a timelier manner. Whilst we are still years away from making this aspiration a reality, the fundamental technology is firmly rooted.

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Dr Stephen Barnhill M.D
CEO
Apollon Formularies Plc
Tel: +1 (912) 713 4007
barnhillmd@sprynet.com
info@apollon.org.uk
www.apollon.org.uk
https://twitter.com/apollon_uk

Healthcare in Canada: Milestones & opportunities

Cecilia Van Cauwenberghe from Frost & Sullivan's TechCasting Group, turns the spotlight on healthcare in Canada, focussing on milestones & opportunities triggered by pandemics. The discussion begins with an exemplary model worldwide, Canada Medicare

Canada is one of the most evolved federations worldwide and one of the Organisation for Economic Co-operation and Development (OECD) members. With a strong political power and policy responsibility to govern ten provinces and three territories, including the province of Quebec, with a unique French-speaking linguistic and cultural context. Healthcare in Canada has a system known as Medicare, which is decentralised. Indeed, it comprises a collection of provincial and territorial, taxation-based, publicly funded, universal health insurance plans subject to national standards.

A team of researchers from six different universities in Canada - University of Toronto, Dalhousie University, McGill University, University of British Columbia, Université de Montréal, and University of Regina - have published a paper series on Canada's health system and global health leadership (Martin et al., 2018; Marchildon et al., 2020; Marchildon and Tuohy, 2021). The researchers have analysed the singular trajectory of this country in providing a high-quality, accessible, affordable, and inclusive healthcare system and the key factors impacting policymakers while advising on its potential to become a world-in-class model.

According to the researchers, Canadian Medicare is based on need instead of the ability to pay. Therefore, it constitutes more than a set of public insurance plans. More than 90% of Canadians agree on the healthcare system as an essential source of collective pride, an implicit social contract between governments, healthcare providers, and the public. The Canadian Institute for Health Information (2021) further states that health expenditures as a percentage of GDP were at 11.5% in 2020 (Ufodike et al., 2021).

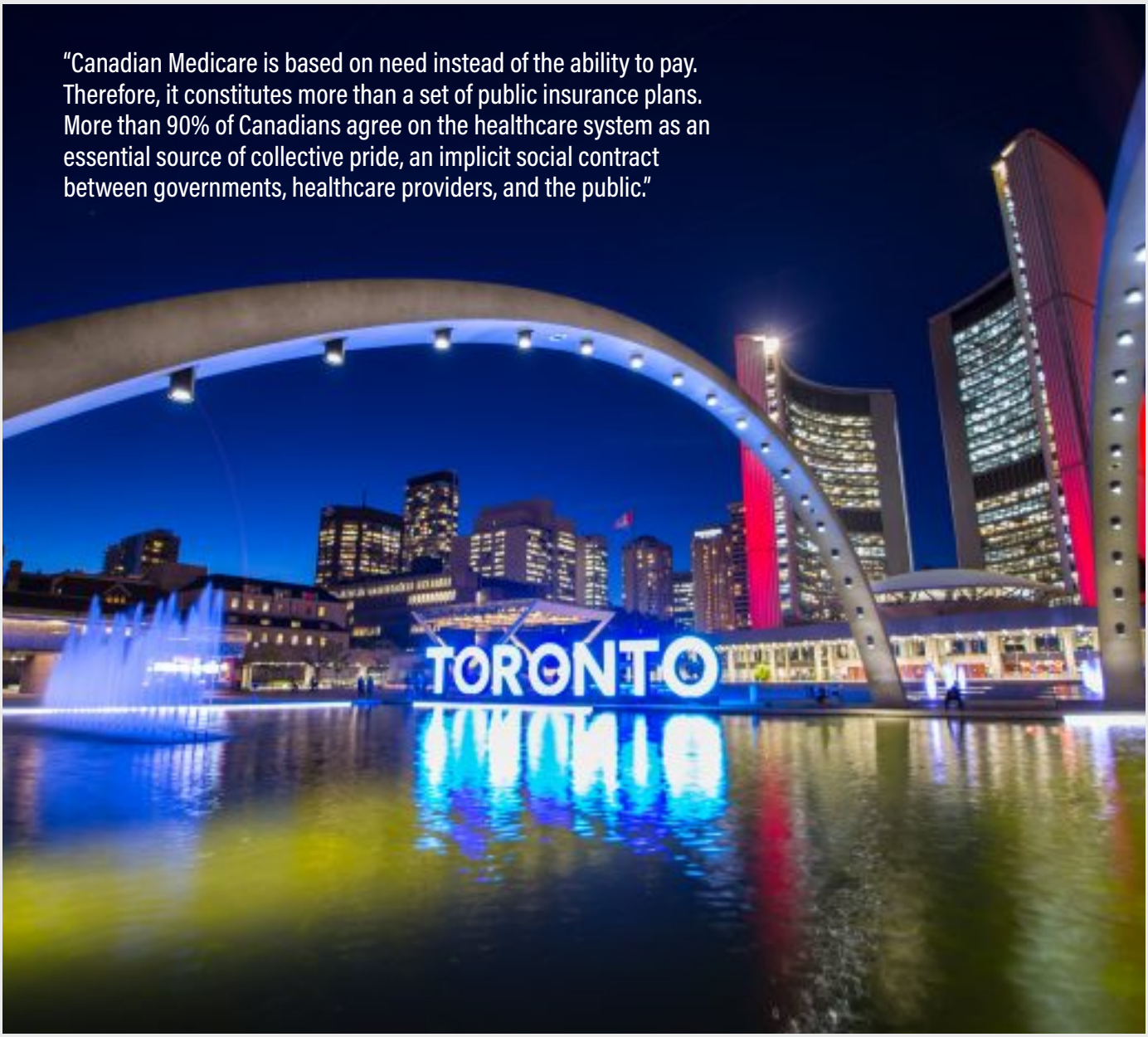
On the other hand, Canada faces an ageing population and fiscal constraints in its publicly funded programmes that deserve attention. Its vast geography, high migration rates, and ethnocultural diversity are also factors of note in delivering health and wellness options. Decentralisation comes with some level of fragmentation, inherent to the fact that hospitals and authorities have their own independent boards and separate budgets.

Canada Pharmacare & long-term care: Paradigm shift after COVID-19

Some researchers remark on some inherent issues in the country's health system (Martin et al., 2018). Whereas Canadians have a life expectancy at birth of 82.14 years - above OECD, U.S., UK and Denmark measures - the average masks variations in vulnerable groups. Socioeconomic inequalities in health are significant, and the large and persistent gaps in health outcomes between Indigenous peoples and the rest of Canadians represent a major challenge facing the health system and society more generally (Marchildon et al., 2020).

Healthcare in Canada, conversely, to the major nations, is often slow and incremental in terms of change and flexibility to new times. Furthermore, although urgent medical and surgical care is prompt and of high quality, the timeliness of elective care, such as programmed surgeries, non-urgent advanced imaging and outpatient specialty visits, is problematic.

Finally, Canada is the only developed country with universal health coverage that does not include prescription medications. It is important to highlight, however, that there have been some initiatives



towards introducing a national programme of prescription drug coverage, called Pharmacare, though the COVID-19 pandemic that started in 2020 may constitute an inflection point in addressing this issue (Marchildon et al., 2020). According to the researchers, this fact could represent a paradigm shift from whether to add outpatient pharmaceuticals to universal health coverage toward federal standards in long-term care (LTC) and its possible inclusion in universal health coverage (Marchildon and Tuohy, 2021). In their opinion, the best option would be a LTC insurance programme directly linked to Canada' public pension arrangements.

Researchers working at the McMaster University, have tracked the experience of the physicians' assistants (PA) introduced by the Ministry of Health and Long-Term Care (MOHLTC) into the Ontario healthcare system a decade ago, with present post-pandemic concerns with the goal of helping to increase accessibility, promptness, care continuity, and work interaction (Burrows et al., 2020).

Final remarks

The COVID-19 pandemic has opened a window of opportunity for policy reform in areas previously neglected. In Canada, the first result has been related

Honourable Jean-Yves Duclos, Minister of Health

In Canada, Honourable Jean-Yves Duclos, Minister of Health is in charge of improving and maintaining the health of all Canadian people. This role is supported by the Health Portfolio, which is made up of Health Canada, the Public Health Agency of Canada, the Patented Medicine Prices Review Board, the Canadian Food Inspection Agency and the Canadian Institutes of Health Research. (1)

Minister Jean-Yves Duclos recently completed a trip to Europe to attend the G7 Health Ministers' Meeting and the 75th World Health Assembly (WHA). It is in this spirit that Canada is committed to collaborating with its international partners to combat global public health threats during a time of multiple crises and collaborate on shared health priorities. The Minister emphasised bilateral cooperation on global health issues like disease surveillance, mental health, sexual reproductive health and rights plus building vaccine confidence.

Finally, let's see what Minister Jean-Yves Duclos had to say about this very important in-person meeting: "After the hiatus imposed by COVID, attending these international events in person was even more important. Thanks to the support of the Canadian delegation, we were able to reiterate Canada's commitment to multilateral engagement as a way to protect the health and safety of Canadian and global citizens everywhere. We must seize the opportunity to learn from COVID-19 and strengthen our global health systems and response for the future." (2)

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to an increase in the federal government's presence beyond Medicare conventional coverage. The current debate is more focused on LTC, leaving Pharmacare deferred once again for further discussions.

Acknowledgements

I want to thank all contributors from the industry involved with developing and delivering this article from Frost & Sullivan.

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Cecilia E. Van Cauwenberghe, PhD, MSc, BS Eng, BA, MBA
Principal Consultant
Senior SciTech Advisor & Associate Fellow
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
www.frost.com
www.twitter.com/Frost_Sullivan



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A fascinating look at optimal leisure lifestyle

Robert Stebbins, Professor Emeritus at the University of Calgary in Alberta, Canada, takes a fascinating look at what we need to know about optimal leisure lifestyle

An optimal leisure lifestyle (OLL) consists of deeply fulfilling participation during free time in one or more substantial, absorbing activities known as serious leisure. They are complemented by judicious amounts of casual leisure or project-based leisure or both. People find an OLL by doing leisure activities that individually and in combination help them realise their human potential (their talents and tastes), leading thereby to an enhanced quality of life and well-being. Nevertheless, the OLL is basically a leisure conception, though one that always has work and non-work obligations in the background as a comparative backdrop.

In addition, the OLL is a contextual phenomenon, where a person's diverse work, leisure, and obligatory non-work activities are coordinated along, among others, the dimensions of time, money, and available resources. Though it is individual people who experience this lifestyle, it is inevitably embedded in several wider contexts influenced as it is by certain organisations, groups, networks, social arrangements and cultural patterns. Some of the latter may also have deep roots in history. Moreover, such structural and cultural phenomena can, depending on circumstances, constrain or facilitate the pursuit of these activities. A key issue for many people is finding an agreeable lifestyle, a highly personal goal to be sure. Nevertheless, the quest for this state entails in the most general sense finding the most acceptable balance possible among the component activities that comprise an OLL. Yet, for all this talk about large-scale context, the effort and perseverance needed to find it stand out as critical micro-processes here. The idea of the OLL really does span all contextual levels.

"The OLL is a contextual phenomenon, where a person's diverse work, leisure, and obligatory non-work activities are coordinated along, among others, the dimensions of time, money, and available resources."

Finding lifestyle balance

What does lifestyle balance mean, when applied to everyday living? In common sense it seems to refer to "spending more time with family," or more broadly, having more leisure time as in "getting a life," gaining some measure of freedom from unpleasant obligations expressed as escaping the "rat race," and other adaptive strategies. In the leisure sciences, however, the answer to this question is much subtler: people typically find balance in the domains of work, leisure, and non-work obligation by crafting a lifestyle that encompasses these three and is thereby endowed with a substantial appeal of its own. Everyone who is working has some kind of lifestyle bridging these domains. But it is also true that many people have activities in their lifestyles they would sooner be free of. How, then, to generate an appealing, balanced lifestyle spanning the three domains? Achieving this leads to Aristotle's idea of the "good life," often reached when people abandon certain irritations in their present lifestyle.

In broadest terms, finding an appealing leisure lifestyle hinges on discretionary time commitment. More particularly, it hinges, in part, on committing more hours to the activities one likes most, while subtracting hours from those one likes less or flatly dislikes. Understandably, this kind of balancing is easiest to accomplish in the domain of leisure, where by definition people stay away from unappealing activities. Even here, however, some activities are more difficult than others to abandon on a whim. So the young male can, at the last moment, tell his friends that the weekend "pub crawl" no longer excites him and that, from thereon, they may continue their escapades without him. But the actress, having grown tired of community theatre as performed in her city, can only comfortably announce that next season, she will be unavailable for



roles. She cannot, without great social cost, quit midway through preparation for an upcoming play because of her role in it, for to do so would leave many associates in a lurch and spoil immensely their serious leisure. In these examples, such meso-level ties to other sets of people act to constrain the individual's behaviour.

Closing remarks on finding the optimal leisure lifestyle

So, an appealing, balanced lifestyle may be reached, in part, by tinkering with one's pattern of leisure activities, spending more time in some while cutting back time spent in others. But, if someone caught in a poorly balanced lifestyle has little free time, then a solution to this problem must be found by redeploying commitments in the other two domains. In one sense, anyway, decisions about which activities to commit less time to in these areas of life are more subtle and difficult than in the domain of leisure. The first two domains are loaded with obligations that may, at least at first glance, appear absolutely fixed – the constraints of the meso and macro contexts loom large at this point.

> "In broadest terms, finding an appealing leisure lifestyle hinges on discretionary time commitment. More particularly, it hinges, in part, on committing more hours to the activities one likes most, while subtracting hours from those one likes less or flatly dislikes."

Thus, people enjoying an optimal leisure lifestyle are usually conscious of other appealing casual, serious, and project-based leisure activities, but nonetheless sufficiently satisfied with their present set to resist abandoning them or adding others. Still, this might well change in the future, as an activity loses its appeal, Homo Otiosus (leisure man) loses his ability to engage in it, or new activities gain priority. From what I have observed in my own research, people with OLLs seem to sense that, at a given point in time, if they try to do too much, they will force a hectic routine on themselves, risk diluting their leisure, and thereby become unable to participate as fully as they would like in what they are passionate about.

Leisure education plays an outsized role here. Lacking instruction or reading on the nature and types of serious, casual, and project-based leisure, most people are unlikely to find the information they need to choose the activities that could make up their OLL. Fortunately, formal instruction in this area is increasingly common, much of it being offered these days through lifestyle courses in continuing education programmes or private counselling agencies, while various books now cover in detail this route to the world of leisure. As Henry David Thoreau put it: "The laboring man has not leisure for a true integrity day by day."

UNIVERSITY OF CALGARY

Professor Emeritus
University of Calgary
Tel: +1 403 239 2138 (landline home phone)
stebbins@ucalgary.ca
www.seriousleisure.net



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The rudiments of asbestos removal

Michael Edwards, Occupational Safety and Health Content Developer from The Institution of Occupational Safety and Health, walks us through the fundamentals of asbestos removal

A recent report called for a 40-year deadline to be set for the removal of all asbestos from public and commercial buildings in the UK.

While a lot of planning will be needed before such a task is undertaken, there is good reason for recommendation. It may be banned in dozens of countries including in Britain since 1999, but it is still all around us and presents a significant hazard to anyone who may be exposed to it.

What is asbestos?

Asbestos is the name used for a group of naturally occurring minerals that are used in many products. It is used to strengthen building materials and provide fire and chemical resistance. In the production process, asbestos has usually been mixed with other substances to create different asbestos-containing materials (ACMs), but it has also been used on its own.

There are several types of asbestos. The most commonly used types have been chrysotile (white asbestos), amosite (brown asbestos) and crocidolite (blue asbestos). Less commonly used have been anthophyllite, actinolite and tremolite.

Asbestos fibres are microscopic: a thousandth of the diameter of human hair. In fact, it is impossible to see an individual asbestos fibre without a microscope, but you can see dust that contains fibres when ACMs are damaged.

Asbestos fibres are easily inhaled and carried into the lower regions of the lung where they can cause fibrotic lung disease (asbestosis) and changes in the lining of the chest cavity (pleura). These diseases can lead to reduced respiratory function and death. Long-term inhalation of asbestos fibres also increases the risk of lung cancer and mesothelioma.

Enlargement of the heart can also occur as an indirect effect from the increased resistance of blood flow through the lungs.

The World Health Organization estimates that approximately 125 million people in the world are

exposed to asbestos in the workplace. Latest figures suggest that work-related asbestos exposures claim at least 233,000 lives every year.

Research has shown an association between asbestos exposure and lung cancer and bile duct cancer. The latter is a relatively rare form of cancer affecting the liver, but is now being increasingly reported in greater numbers worldwide. The research suggests that after inhalation or ingestion, asbestos fibres may reach the circulatory system, and are then delivered to all organs, including the liver. It is hypothesised that asbestos fibres are likely to be trapped in smaller bile ducts, leading to tumour formation.

Many countries have banned the importation and use of asbestos. For example, the United Kingdom banned the importation and use of amosite and crocidolite in 1985 (although voluntary industry bans had existed – for example, for crocidolite from 1970), actinolite, anthophyllite and tremolite in 1992 and chrysotile in 1999.

However, many workers can still potentially be exposed by working with older buildings in construction and demolition, shipbuilding trades and other equipment that used asbestos in their construction.

There are also many countries that still use asbestos in their industries and/or export it. This includes asbestos mining and milling, manufacturing of asbestos textiles and other asbestos products, as well as insulation work in the construction and building trades.

Preventative measures and asbestos removal

Our survey of tradespeople in 2018, conducted as we launched the asbestos phase of our No Time to Lose occupational cancer campaign, suggests much work is still needed.

Around a third of respondents (32%) said they had never checked an asbestos register before starting work on a new site, with 15% of these not knowing about the requirements for a register. Meanwhile, 18% said that if they found asbestos, they would either be unsure or have no idea what to do.

What can organisations do to eliminate or reduce their workers' or supply chain's exposure?

Firstly, develop a policy and strategy for asbestos and asbestos removal. This includes a commitment to manage the risk of working with existing asbestos and eliminate its use in their activities. Organisations can take further steps by interacting their supply chain and influencing them to follow their commitment as well.

Secondly, identify where asbestos might be found in the organisation and what type it is. This might include surveys by a competent person. It is important to record the findings of this identification.

Thirdly, assess the risk of asbestos exposure for the organisation's activities. How are workers interacting with it? What tasks are they doing?

Fourthly, create a management plan for asbestos found in the workplace.

Lastly, identify and action controls to eliminate or manage worker exposure. This can include avoiding disturbing encapsulated asbestos material, use of specialist equipment to reduce exposure, to training of workers interacting with asbestos and reporting asbestos-relating incidents.

Further information on management of asbestos can be found on IOSH's No Time to Lose website at www.notimetolose.org.uk

Michael Edwards
Occupational Safety and Health Content Developer
The Institution of Occupational Safety and Health
Tel: +44 (0)116 350 0800
media@iosh.com
https://iosh.com/
https://twitter.com/IOSH_tweets

Is drinking water safe? A neglected source of asbestos fibres

Prof. Giovanni Brandi and Dr. Simona Tavolari investigate the prevalence of asbestos fibres in drinking water around the world

For decades the health risks of asbestos have been discussed among academics, companies and countries, but nowadays its harmfulness is recognised worldwide. Still in 1997, when asbestos use was banned in French, Canada (the main producer of chrysotile) sustained its innocuity; 3 years later, the carcinogenicity of chrysotile was set off by the World Trade Organization.

While sophisticated estimates have evaluated the link between the number of inhaled fibres and the risk of asbestos-related diseases, a hidden source of asbestos exposure still remains almost ignored: the water. This potential source represents a challenge in Western societies, as it poses strong social and political questions. Indeed, unlike airborne asbestos dusts, that one cannot avoid inhaling and whose source is often unknown, the source of fibres in water is frequently known, and drinking polluted or safe water is a matter of choice. After some studies in USA fifty years ago evaluating the presence of asbestos fibres in drinking water, a scientific silence has fallen on the possible health risks of asbestos in the water. In the Western coast of USA, the primary (and no modifiable) source of polluted water are asbestos rocks. A different scenario occurs in Europe, where the main source of polluted water are pipes built in asbestos-cement; in Italy, over 125,000 km of asbestos-cement water pipes have been estimated and in UK over 257,000 km. The only conclusion coming from the American agency US-EPA has been the introduction of 7 million fibres (>10µm) as the threshold value associated with an increased risk of developing intestinal polyps; however, this threshold value has been defined only on rodent models.

What lesson can we borrow from the mesothelioma experience?

An accurate analysis from the Italian National Mesothelioma Register revealed that only 80% of mesotheliomas show a previous asbestos-exposure; in the remaining cases, the source of exposure is unknown, suggesting hidden environmental sources. The risk of mesothelioma follows a stochastic model. Some authors suggested that a threshold value of "fibre saturation" of the pleural spaces exists (beyond which the risk shouldn't increase), whereas the Italian Consensus Conference on Mesothelioma certified a strong correlation between exposure and risk-level (doubling the incidence, or shortening the time of disease development, at higher levels compared to lower levels of exposure).

Despite these conclusions are considered valid for mesothelioma only (where asbestos represents the almost unique risk factor), it is conceivable that they can be applied also for other asbestos-related cancers (although this hypothesis is more difficult to demonstrate, due to the number of confounding risk factors in these diseases). As asbestos carcinogenesis is driven by both genotoxic (direct DNA damage) and non-genotoxic (oxidative stress increase, epigenetic and others) mechanisms, its role is poorly explainable by toxicology, which postulates a threshold effect below which there is no estimable risk.

If for pleural mesothelioma there is agreement that fibre uptake occurs almost exclusively by inhalation (with the preliminary mandatory passage across the pulmonary alveoli), for gastrointestinal (GI) cancers it can occur by inhalation (for clearance of airborne asbestos and subsequent swallowing) and ingestion (water and diet). The relative risk (RR) of developing asbestos-related cancer is variable among various cancer types: 5-50 times for mesothelioma (case-control studies); 2-5 times for lung (case-control studies); 1.16 times for stomach and colon (meta-analysis) (IARC monograph 100, 2012). A more accurate re-analysis, correlating colon cancer risk to the level of asbestos exposure, showed an increased risk up to 1.38 times for high levels of exposure. This trend is similar to that observed for mesothelioma: more exposure, more risk in a less time. Furthermore, an Australian cohort

INGESTION OF ASBESTOS FIBERS AND ELIMINATION IN URINE

(extrapolated from Cook PM, Olson GF. Science 1979;204:195-8)

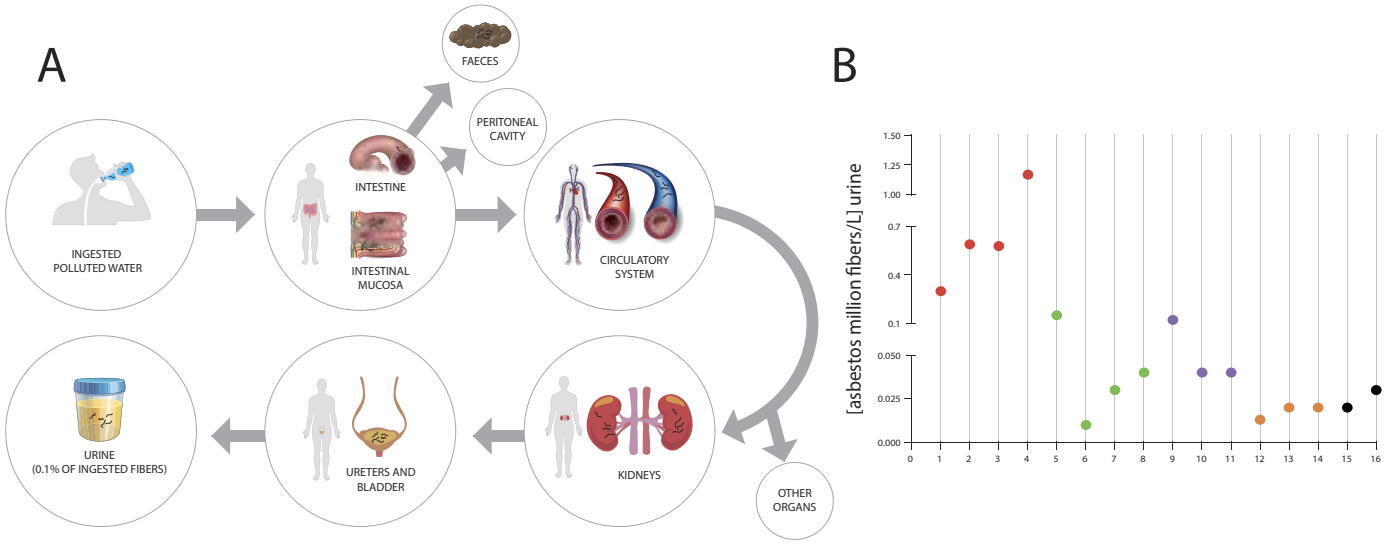


Figure 1: Ingested asbestos fibres are eliminated by urine. A) After ingestion of polluted water, thinner asbestos fibres migrate along the GI tract reaching the intestine. Then, they across intestinal mucosa and are in part eliminated by faeces and in part enter peritoneal cavity and the circulatory system. Once entered in circulatory system they are delivered to different organs in the body, including kidneys. In kidneys, they are not re-absorbed by proximal tubules as occurs for most proteins, but they pass through ureters and reach the bladder, being finally eliminated with urine; B) Detection of asbestos fibres in the urine of healthy volunteers drinking water from the Superior lake in Minnesota.

study on about 1 million people living in asbestos-exposed homes showed a colorectal cancer RR of 1.7 in women. Since it is intuitive that asbestos fibres reaching the GI tract can cause damage primarily to these organs, the first obvious question is: is there any evidence that ingested fibres may be absorbed by the GI mucosa? An important, but often ignored, study published in Science in 1979, definitively clarified this point. In healthy volunteers drinking water from the Superior lake in Minnesota (widely contaminated with asbestos), fibres were detected in urine, and their presence was observed for at least 2 months after the last intake. The concentration of asbestos fibres in urine was about 0,1% of those ingested, suggesting that they can be absorbed by the GI mucosa and in particular the colon (Figure 1). In another study, up to 36 million/100gr of asbestos fibres were found in fish reared in an artificial pond near Milan (Italy), built with cement-asbestos material. These animal studies have undoubtedly shown that fibres can penetrate the intestinal mucosa and migrate to peritoneal sierosa, causing peritoneal mesothelioma. This is of particular interest as a meta-analysis of 20 years ago reported that a variable proportion of mesotheliomas had peritoneal origin, and that while for pleural mesothelioma asbestos exposure induces a linear risk increase, for peritoneal mesothelioma the increase is quadratic.

How do ingested asbestos fibres represent a significant clinical risk?

In the 1980s, some ecological studies in North America correlated the incidence/mortality from GI cancer with asbestos exposure of residing populations (Table 1). However, these studies have intrinsic biases due to misclassification of exposure that: a) is not usually assessed by geographical studies using residence as a surrogate for exposure; b) is of short duration compared to the long latency time for cancer development; c) requires extremely large samples to detect rare diseases (as cancer) linked to low level of exposure; d) confounding factors (as occur in GI cancer genesis) are not considered. Some of these studies resulted negative for an association, but the largest cohort study in San Francisco Bay showed a significant increase in stomach, oesophageal and colon cancers, that was directly correlated to the number of ingested fibres with water. In another Canadian cohort study, subjects exposed to large amounts of fibres (1.2 x 10^9/L) also showed an increased mortality rate from stomach and pancreatic cancer compared to the cohort with fewer fibres in water. A further small cohort study, with very high levels of exposure (> 1.8 x 10^9/L) and a long follow-up, showed an increased incidence of gastric and pancreatic cancer in lighthouse keepers.

Case-control studies are usually more

ASBESTOS AND GASTROINTESTINAL TRACT CANCERS

Reference	Area (milions fibers/liter)	Type of study (N° subjects)	Type of asbestos/ Time of exposure	Period	Cancer site	HR (M/F)
Howe HL. et al. [1989]	Woodstock (NY) 3.2-304.5	Cohort (2936)	Crysotile [13-23 years]	1973-83	Prostate	1.7
					Stomach	0
					Colon	0.1
					Rectus	0.8
Polissar L. et al. [1982]	Western Washington State ~200	Case-control Population-based (382 cases vs 462 ctr)	Crysotile >50 years	1974-77	Esophagus	0.6/1.5
					Stomach	1.15/0.6
					Small intestine	1.3/1.5
					Colon-rectus	1.08/1.05
Polissar L. et al. [1984]				1977-80	Stomach	2.4/0.85
					Colon	0.7/1.1
					Rectus	0.9/0.8
Wingle DT. [1977]	Quebec 1-1300	Cohort (420000)	Crysotile >50 years	1966-72	Stomach	1.4/1.2
					Pancreas	1.0/1.7
					Lungs	1.7/1.3
Kanarek MS et al. [1980]	San Francisco Bay 0.025-36	Cohort (3000000)	Crysotile >50 years	1969-71	Stomach	1.17
					Esophagus	1.43
Conforti PM, et al. [1981]					Small intestine	0.9
					Colon	1.1
Levy BS et al. [1976]	Duluth, Minnesota 1-65	Cohort (100000)	Anfiboles <20 years	1969-71	Stomach	1.89
					Pancreas	1.47
Kjaerheim K. et al. [2005]	Norway 1760-71350	Cohort (726)	Crysotile >20 years	1960-02	Stomach	1.7
					Colon-rectus	1.6

appropriate than cohort studies to capture associations between low exposures and rare events; however, the only study on this issue resulted negative. This can be due at least to two biases: the small number of cases and controls (<400) and the census section deficit which resulted in the same asbestos exposure between cases and controls. In 2006, a review of 42 cohort studies conducted by IOM of the National Academy of Science certified that the level of evidence was inadequate to infer either the presence or the absence of a causal relationship between asbestos and GI tract cancers. More recently, a close correlation has been demonstrated between the intake of filtered beer (with filters containing asbestos) and oesophageal adenocarcinoma, a tumour with the same epidemiological trend and similar molecular characteristics of mesothelioma.

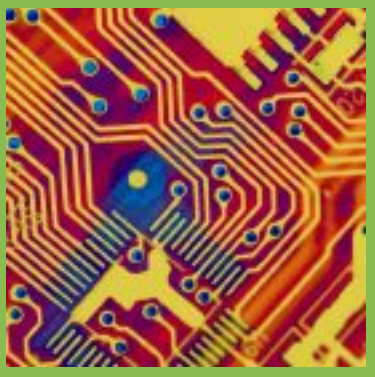
In Netherlands up to 33 million fibres/L have been detected in drinking-water supplies, and in Yunnan region (China) up to 42 million fibres/L. In Italy, a progressive increase of fibres has been registered in the last 20 years in drinking water, with peaks over 100,000 fibres /L in Modena city. All these observations strongly suggest that the issue of asbestos in the water still remains open and that it has been closed too quickly, not applying (imprudently) a precautionary principle. The resolution of the European Parliament of 14th March 2013, which urges the EU to monitor asbestos in drinking water and the potential risks for health, has however shown that politics (at least for once) has proven more sensitive than academics in protecting public health.

Giovanni Brandi
Associate Professor of Medical Oncology
University of Bologna
Tel: +39 0512 143 838
giovanni.brandi@unibo.it
https://www.unibo.it/sitoweb/giovanni.brandi/cv-en

Simona Tavolari
Adjunct Professor for the School of Specialization in Medical Oncology
University of Bologna
Tel: +390512144536
simona.tavolari@unibo.it
https://www.unibo.it/sitoweb/simona.tavolari/ricerca











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Improving the lives of people with brain disorders

European Brain Council outlines the priorities for the future when it comes to improving the lives of people with brain disorders

More than half of the European population currently are people with brain disorders, which translates into an increasingly worrying burden on society. In 2019, neurological and mental disorders together accounted for more than 16 million disability-adjusted life years (DALYs). Stroke accounts for more than one million deaths while dementia (most commonly Alzheimer's disease) and Parkinson's disease complete the top three causes of death due to neurological disorders in Europe.

In addition, one out of 10 Europeans live with an anxiety or depressive disorder and almost 85,000 Europeans die annually due to substance abuse. Such a high disease burden showcases the immensity of the problem, and it makes clear that brain health and brain research need to be promoted and recognised as a priority by European society.

A future of excellence in European brain research

The European Union (EU) has already undertaken some important steps to boost brain research initiatives with partners around the world, including the EU-funded project "the European Brain Research Area (EBRA)" (2018-2022), led by the European Brain Council and in partnership with the EU Joint Programme on Neurodegenerative Diseases (JPND), the Network of European Funding for Neuroscience Research (ERA-NET NEURON) and the Human Brain Project (HBP). One of the priorities of the EBRA project is to provide recommendations on future areas for excellent, innovative, and translational research in the brain space. To identify the gaps in currently existing brain research and set the priorities for the future, EBRA, working with experts in the brain space (neuroscientists, neurologists, psychiatrists, and persons with brain disorders) has developed the Shared European Brain Research Agenda (SEBRA).

Consensus was reached that only by advancing the understanding of the healthy and the diseased brain – as well as the interaction between the brain and its environment – we will provide proper improvement in the lives of those living with brain disorders and prevent others from being similarly affected in the future. Brain research nowadays must touch upon fields beyond its own biological background and beyond fundamental and translational brain research. Connections should be established with experimental, computational/artificial intelligence and theoretical approaches, as well as with disciplines like psychology, sociology, education, and philosophy. This interdisciplinary approach allows neuroscience to be linked to empirical and phenomenological sciences, ultimately transforming brain research towards a more holistic approach.

Translating research into reality

To understand and cure the diseased brain, we need to improve the capacity to translate ground-breaking discoveries in basic neuroscience to clinical settings. Furthermore, a better and complete understanding of disease mechanisms is crucial. The creation of translational awareness should be encouraged: basic and clinical researchers need to work and interact together to bring about results in potential clinical applications. We need to gain better insight into the development, and progression of brain diseases, improve the prediction of brain disorders, identify appropriate treatments, understand the impact of neurorehabilitation, and uncover protective and preventive factors (including genetic, epigenetic, environmental, and social factors for brain disorders),


Professor Monica Di Luca

as well as compensation mechanisms. To address these disease priorities, investments are particularly fundamental in the field of personalised and precision medicine, particularly in the brain space.

To ensure that these priorities can be addressed, the conditions for carrying out brain research need to improve. Smart data sharing should be encouraged – there is a wealth of existing data in brain research. This huge amount of data should be exploited to ensure relevant use, intelligent interpretation and smart application. The sharing of existing datasets and new pre-clinical and clinical data must be prioritised and accessible in open access mode. Within this perspective, common data rules need to be created for the use of complex human and patient data across the Member States in Europe, as well as for data sharing with industry, small and medium enterprises (SMEs) and between different EU and non-EU countries.

Improving lives through collaboration in research

Tackling the challenge posed by the complexity of brain physiology and brain disorders is possible only through close collaboration and cooperation within the community and related actors. The involvement of all relevant stakeholders in the brain area is required, including basic, translational, and clinical scientists, neurologists, neurosurgeons, psychiatrists, industry, regulators, funders, and policymakers. The role of people with brain disorders, their families and citizens cannot be underestimated here and is of utter importance. Their experiences, needs, views and quality of life should be considered during all steps of a brain research project. Building networks and matchmaking with key experts in the field (e.g., the Brain Innovation Days, organised by the European Brain Council) should be a priority for all the stakeholders, including policymakers. This will reduce fragmentation in the brain space, contribute to a better understanding of the brain, and encourage the development of a clear scientific discovery-to-market pathway which will eventually improve the lives of persons with brain disorders, their families and society as a whole.

Prioritising the brain in Europe

The brain research community demonstrates a clear need: the European Commission must come forward with a clear plan to tackle brain health in a collaborative, integrated and forward-looking manner in Europe and further support the Member States and associated countries in their efforts to combat the impact of brain disorders. Additionally, the Member States and associated countries would benefit from the implementation and creation of brain research programmes addressing brain health systematically and comprehensively.

Professor Monica Di Luca
Project Coordinator, European Brain Research Area
Immediate Past President, European Brain Council

Dr Kristien Aarts
Project Manager, European Brain Council

Dr Elke De Witte
Head of Project Development, European Brain Council

Frédéric Destrebecq
Executive Director, European Brain Council

ebra@braincouncil.eu
www.ebra.eu
www.braincouncil.eu

JPND: Towards a stronger brain health partnership

One of JPND's key objectives is to fortify its work in brain health partnerships in Europe to better combat the challenges of neurodegenerative disease (ND)

Neurodegenerative disease (ND) in Europe is synonymous to the next health challenge with huge and mounting social and economic costs. As a joint-programme ND research initiative, JPND has been set up to tackle this challenge by strengthening brain health partnerships in Europe. OAG talks to JPND's Chair, Philippe Amouyel (PA), to find out how.

Please share with us the landscape of brain health in Europe

PA: In Europe alone, there are 380 million patients suffering from brain diseases. An average of 800 billion euros is spent in Europe annually to treat these diseases and the last COVID19 pandemic has added to that burden in terms of brain diseases. The economic and social burden in facing them will only continue to grow; therefore, it is crucial that there is alignment in ND research and partnerships towards brain health that will help address and alleviate the increasing societal and economic burdens of brain disorders.

How can Europe address the challenges of brain health?

PA: Europe can address the challenges of brain health by capitalising on existing international initiatives, facilitating access to infrastructure and resources, structuring brain research area, reinforcing patient and public involvement and accelerating research transfer and innovation.

Please describe some of the current collaborative brain health initiatives in Europe

PA: Amongst European brain health collaboratives, there is a need to strengthen collaborations between each one and to work towards establishing a common brain health agenda. In the last ten years, both the European Commission (EC) and its Member States (MS) have established and led initiatives in Europe to face these challenges collectively. To date, there is JPND, the Joint Programming initiative on ND research, the largest global collaboration in this field/domain; NEURON – an EC ERANET partnership that supports basic, clinical and translational research in the fields of brain diseases and the Human Brain Project – an EC's Future and Emerging Technologies Flagship funded by the seventh framework programme that aims to put in place a unique Information and Communications Technology-based infrastructure for brain research. In 2019, together with the European Brain Council, the three initiatives began discussions in the context of an EU-funded European Brain Research Area (EBRA) EC Coordination and Support Action, to discover operational synergies, identify strengths and gaps and foster alignment across European and global brain initiatives.

European Brain Research Area

In February 2022, EBRA released its long-awaited European Research Inventory and Mapping Report, providing insight into the brain research activities that are funded at the European level within the EU framework programmes FP7 and Horizon 2020 (the Framework Programme for Research and Innovation (2014-2020) under the ERA-Net Cofund programme), as well as the funding initiatives of JPND, ERA-NET NEURON and the Human Brain Project. The mapping report gives an overview of the current state of brain research in Europe and the areas of brain research (if any) that are being focussed in Europe. The report shows that, in spite of increased support in brain research, funding is still lacking in all areas of brain research in the EU. For instance, more focus is needed on public and patient engagement and on enabling data sharing.

From 2007 to 2019, the EC and leading European brain research initiatives allocated €6 billion to about 4,000 brain research projects, an average of €500 million per year. From 2008 to 2012, an average of 400 million was invested per year, increasing between 2014 to 2018 to 550 million, marking a steady growth. ***"The EBRA inventory and mapping report demonstrates that annual fundings can reach significant levels to support highly competitive research projects especially through sustainable, transnational initiatives as JPND."*** – Philippe Amouyel

However, continued funding of research



Philippe Amouyel

consortia across countries is key for a lasting impact on collaboration and innovation in the European and global brain research area. ***"It is now time to accelerate this momentum through an ambitious partnership on brain health in Horizon Europe under a coordinated approach."*** – Philippe Amouyel

JPND and Patient and Public Involvement

Another crucial component in JPND's move towards stronger brain health partnerships is to foster greater public and patient involvement (PPI) in brain health research. JPND has been calling for heightened awareness in the need to incorporate PPI in ND and brain health research. There is an overt call for the strategic implementation of PPI in JPND's annual calls, the encouragement of active PPI participation in all of JPND-supported projects, the training of public, patients and patient advocates, the running of workshops emphasising PPI, the acculturation of scientists and physicians to PPI and a dedicated PPI page on JPND's website to increase awareness of the important role PPI plays in brain health research.

JPND's goal towards a stronger brain health partnership

PA: Creating a critical mass of researchers and increased funding are two of the conditions of success in our work against brain diseases. As one of EBRA's partners, we are committed to a future partnership on brain health in the 2nd strategic programme of Horizon Europe 2025. Only by working together collectively: bringing together all brain research initiatives under one umbrella; coordinating brain research activities under a common brain research agenda, will we be able to make progress in the face of tackling the challenges posed by ND and brain diseases.

Karin YEO
Communications Manager
JPND (EU Joint Programme – Neurodegenerative Disease Research)
Tel: +33 1 44 23 64 78
karin.yeo@jpnd.eu
https://www.neurodegenerationresearch.eu/
https://twitter.com/jpndeurope



Huntington's Disease: The Importance of Brain Banking

Dr. James E Goldman and Dr. Osama Al-Dalahmah from the Department of Pathology and Cell Biology at Columbia University, discuss the importance of brain banking from individuals with Huntington's disease

In an article in Open Access Government in 2021, we described a new experimental strategy to study the brain tissues that have graciously been donated for research by Huntington's disease (HD) patients and their families. We discussed a technique called single nuclei RNA sequencing (snRNASeq), in which we isolate the nuclei from thousands of cells from a piece of frozen brain tissue and extract the RNA from these nuclei to determine what genes are being expressed in individual cells of the tissue.

By comparing our results from HD brains to those of individuals without neurologic or psychiatric disorders (control donors) we have found many differences in gene expression due to the presence of the mutant protein causing HD. We have found changes in all of the different cell types that make up the human brain, neurons (of different types), astrocytes (cells that control the levels of ions and neurotransmitters and that help neurons to survive), oligodendrocytes (the cells that make myelin, the insulating substance of axons), and microglia (the immune cells of the brain).

Understanding the cellular and molecular mechanisms of neurological disorders requires access to human brain tissues

Some of these changes in gene expression are positive, reacting to the alterations caused by the toxic mutant protein and helping cells to survive these alterations. Some of the changes are deleterious, provoking reactions that further damage the tissue and prevent normal functioning.

> "We must rely on brains that had been harvested as soon as possible after death, then carefully dissected in the fresh state to generate blocks from specific areas."

To accomplish this research, we must have access to brains from well-characterized donors with or without Huntington's disease, which were obtained at autopsies and have been processed meticulously for basic investigations. We cannot isolate nuclei from tissues that have been preserved in a fixative. Thus, we must rely on brains that had been harvested as soon as possible after death, then carefully dissected in the fresh state to generate blocks from specific areas. These blocks are immediately frozen and kept at a very low temperature to prevent degradation.

The importance of brain banks and availability for research

We have been extremely fortunate to work with the New York Brain Bank (NYBB) at the Columbia Irving Medical Center, where we conduct our studies. The NYBB was established in our Neuropathology Division and with its support in 2001 under the guidance of Dr. Jean Paul Vonsattel, whose focus of interest is HD and other neurodegenerative disorders. The new Director of the NYBB is Dr. Andrew Teich.

When a fresh or an unfixed brain is made available for research, we divide the brain in half, down the middle. From one half we dissect 50 or more precisely selected blocks, each about one square inch, and each including specific areas of interest. The blocks are placed between Teflon-coated plates), frozen in liquid nitrogen vapor

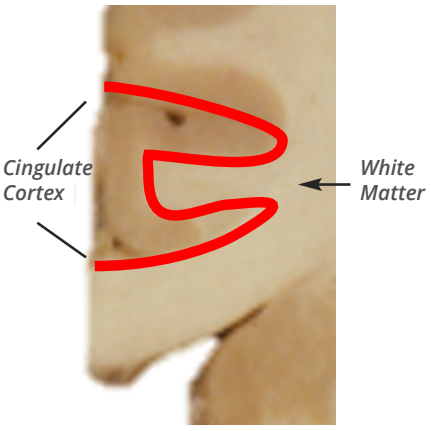
and then stored in a freezer at -80° C. In addition, we collect many other pieces that are crushed in liquid nitrogen, and stored in 2 ml vials; these samples are suitable for research that do not require integrity of the cellular morphology.

Each fresh frozen block and each crushed frozen parenchyma containing vial receives a barcode, unique to that individual brain. Relevant information is entered into a computer database, including the barcode, and the freezers, shelves and boxes where the samples are stored. This allows us to access critical information easily. The other half of the brain is immersed in a formalin solution, which is a standard fixative. A subset of the same areas as those obtained from the unfixed half of the brain are collected from the fixed half brain and placed in cassettes for embedding in wax.

We then cut and stain thin sections from the fixed pieces and examine them under the microscope to render a detailed neuropathological diagnosis. The New York Brain Bank provides optimally prepared and diagnostically categorized human brain samples to neuroscientists worldwide. The Bank mails many hundreds of samples each year.

RNA sequencing and single cell nuclei

For Dr. Dalahmah's and my work, we require several qualities from the banked tissues. First, for RNA sequencing, the RNA of the tissue must be well preserved. RNA will break down after a patient's death, after which RNA sequencing will not be possible. The frozen specimens in the Bank contain very well-preserved RNA.



Second, we are interested in examining single cell nuclei in specific regions of the brain. In the case of Huntington's Disease we have isolated nuclei from the cingulate cortex, the caudate nucleus, and the nucleus accumbens, and are planning to examine further regions. To do this we must first isolate the specific area we wish to analyze. The brain is a complex structure and each of the specimens may contain more than the specific region from which we want to isolate nuclei. For example, the specimen of the cingulate cortex contains both cortex and the subcortical white matter (the area under the cortex that contains the axons of cortical neurons). The anatomy of the pieces is clear in the frozen specimens, so that we are able to dissect out only those regions we want to analyze (Figure).

Third, we must be able to cut very thin slices from the frozen tissues to perform a variety of special stains. It is important in these sections to be able to see the microscopic anatomy and the individual cells clearly and without any distortion. The method the Bank uses to freeze the tissues preserves the structure of the tissue very well.

We have been fortunate to have access to brains stored at the NYBB. Indeed, neuropathologists from other medical centers have visited our Brain Bank to learn the protocols to help them establish their own repositories or upgrade current ones. We would strongly urge governments and institutions that want to study neurological diseases using these sophisticated molecular techniques to establish high quality brain banks or to support those that are already in place.

The Figure shows a piece of brain tissue that includes the cingulate cortex and underlying white matter. We can dissect out the cortex free of other areas along the red line so that the sample of cortex is not contaminated by white matter.

Columbia University
Department of Pathology and Cell Biology

Columbia
Taub Institute for Research on Alzheimer's Disease and the Aging Brain

NewYork-Presbyterian

Hereditary Disease Foundation

Huntington's Disease Society of America

Dr. James E. Goldman
Professor of Pathology and Cell Biology
Columbia University
jeg5@cumc.columbia.edu
www.pathology.columbia.edu

Using AI to support decision making & transform outcomes for stroke patients

Adam Nickerson, Head of Category, Digital and IT procurement frameworks at NHS Shared Business Services (NHS SBS), explains how artificial intelligence software (AI) is used to support decision making & transform outcomes for stroke patients

Artificial intelligence software (AI) is a prime example of how new technologies have the potential to transform NHS patient outcomes, speeding up diagnosis and treatment times by ensuring expert clinical resource is targeted where it has the greatest impact for patient care.

The NHS Long Term Plan has set objectives to improve services and outcomes for stroke patients. These include attaining a ten-fold increase in the proportion of patients who receive a thrombectomy after a stroke by 2022 so that each year, 1,600 more people can live independently after their stroke. It also aims to have the best performance in Europe for delivering thrombolysis to all suitable patients by 2025.

Life-changing treatments for stroke patients

The milestones for stroke care also contain the scaling of technology to drive the expansion of life-changing treatments, including the use of AI interpretation of CT and MRI scans to support clinical decisions regarding suitability for thrombolysis and thrombectomy.

Every year, over 100,000 people in the UK are affected by stroke (source: The Stroke Association). Speed and accuracy in the interpretation of brain scans are critical to diagnosis and treatment. Interventions are time-dependent, with significant harm and long-term disability caused if left untreated.

Ischaemic stroke is the most common stroke. It happens when a blood clot, or other blockage, cuts off the blood supply to the brain. Those diagnosed as being eligible can be treated with a clot-busting drug i.e. thrombolysis. It needs to be administered within four and a half hours of stroke symptoms starting. The more time that passes, the less effective thrombolysis will be. Thrombectomy physically removes a clot from the brain. Like thrombolysis, it has to be carried out within hours of a stroke starting.



Adam Nickerson
Head of Category, Digital and IT
NHS Shared Business Services

AI can speed up the diagnostic process & reduce decision-making time

The use of AI can speed up the diagnostic process, crucial to facilitating timely interventions in stroke. This software uses AI algorithms to support the clinical decision-making process, providing real-time interpretation of imaging to augment the review, diagnosis and delivery of treatments.

AI can reduce the decision-making time for both thrombolysis and thrombectomy, increasing the numbers of patients eligible for both interventions and improving the likely benefit of treatment. The Diagnostics: Recovery and Renewal Report finds it can provide interpretation of imaging within seconds, as opposed to up to 30 minutes when manual review of the images is undertaken remotely by a reporting doctor.

The use of AI software is also an integral part of the National Optimal Stroke Imaging Pathway (NOSIP). Designed to guide the efficient use of radiology resources and reduce duplication, the NOSIP puts a patient's rapid need of appropriate brain and vessel imaging acquisition and interpretation front and centre of the initial assessment when a stroke is suspected. AI features prominently for use as decision support, rather than as a substitute for expert radiological interpretation.

"Rapid brain imaging is one of the most important steps in stroke patient care"

According to Dr David Hargroves, Getting It Right First Time (GIRFT) Clinical Lead for Stroke and National Specialty Advisor for Stroke Medicine, NHS England and NHS Improvement (NHSEI), "rapid brain imaging and its interpretation is arguably one of the most important steps in the care of patients with stroke-like symptoms. Adherence to the NOSIP, incorporating AI decision support software, is likely to improve access to disability-saving interventions to thousands of patients".

Novel procurement framework for ischaemic or haemorrhagic stroke images

As a mechanism to support providers of hyperacute stroke care in the purchase of AI software, and NHS trusts and networks to deliver the optimal pathway for patients suspected of suffering a stroke, NHS SBS has developed a novel procurement framework, the only one of its kind in the UK, specifically for the analysis of images for the detection of ischaemic or haemorrhagic strokes.

Developed with expert contributions from NHSEI, clinical leads from the 20 Integrated Stroke Delivery Networks across England, the Academic Health Science Network – and with further input from NHSX and the Care Quality Commission – The Provision of AI Software in Neuroscience for Stroke Decision Making Support framework agreement enables NHS organisations to source and acquire this innovative medical technology, and use evidence-based, cost-effective technology to provide rapid treatment where required.

Suppliers to the framework are working right at the cutting edge of healthcare. In an emerging marketplace, contracting with the most innovative technology start-ups can come with challenges. This route helps remove barriers and de-risks procurements, thereby providing a viable commercial solution offering assurance to public sector buyers.

Future progress in outcomes for stroke patients

Darrien Bold, NHSEI National Digital and AI Lead for Stroke, observes that over the past 18 months, the health and care system has been compelled to look to new technologies to continue providing frontline care, with the stroke community embracing new ways of working in times of unprecedented pressure and realising the benefits.

"We are already seeing the impact AI decision-support software is having on stroke pathways across the country. The introduction of this framework will drive forward further progress in delivering best-practice care where rapid assessment and treatment are of the essence."

Adam Nickerson
Head of Category, Digital and IT
NHS Shared Business Services
Tel: +44 (0)303 123 1144
www.sbs.nhs.uk
https://twitter.com/NHS_SBS

What should hospitals consider when using Artificial Intelligence in the ER?



Mary Hardcastle at RapidAI looks at the advancements in health tech, explaining what hospitals need to do to implement Artificial Intelligence in the ER

Despite incredible advancements in health technology over the last decade, many hospitals had remained hesitant to make meaningful changes to the way their emergency departments operated — until COVID-19 shed new light on the inefficiencies and pain points that have long plagued the process and exposed the inability of legacy systems to deal with major operational challenges at a time when the stakes for triaging emergency departments for patients with emergency conditions became even higher.

In a recent survey of senior healthcare executives, 98% say their organization has or is planning to implement an AI strategy. As hospitals around the world emerge from the pandemic and reconsider new solutions to solve age-old problems with workflow, here are five considerations for vetting and implementing new technology to achieve the full clinical, operational, and financial benefits AI can deliver.

Technology doesn't need to be complex to be valuable

In many cases intuitiveness and usability is directly correlated to a technology's value. Evaluate technology for both promise, but also sensibility. New tools should unquestionably alleviate physician burnout, rather than contribute to it. For example, the RapidAI advanced imaging and workflow technology allows physicians to view CT images anywhere at any time from their mobile devices, giving them greater flexibility and improving the speed of patient care.

Keep interoperability & transparency top of mind

Interoperability is closely connected to value, by saving time, reducing redundancies, and supporting more actionable data. However, it's not only crucial for solutions to integrate with your current technologies and processes, but also those you may consider for the future. Ultimately the more integrated and interoperable a solution, the more scalable it is.

Transparency is another major factor to consider when reviewing new technologies. Increasingly we are seeing more attention paid to the data and algorithms driving our healthcare systems, as it relates to privacy, biases, accuracy, and more. By doing your due-diligence and digging deeper during the vetting process, you will be better positioned to ultimately deliver the most equitable and ethical patient care.

Data is a critical component for measuring impact

Choose tools that give you strong and plentiful data on usage, efficiency, and outcomes to ensure you know how it's working, yielding ROI, and identifying where your team and technology can improve. Valuable analytics solutions

such as RapidAI Insights provides automated reports and data to help hospitals and multi-site systems standardize patient care processes and protocols, make better financial decisions, and achieve operational excellence.

The key to unlocking technology's maximum potential? Effective training & support

A big part of maximizing the full potential of clinical technology is having effective training for those using it day-in and day-out. Look for companies that provide comprehensive training opportunities, and end-to-end support in order to implement, adopt, learn and use the platform with confidence and ease.

Look beyond the surface to clinical validation

The best technologies will likely attract the best minds, so consider the medical experts involved in the product's development, look to key opinion leaders you trust, and expect clinical validation throughout the process. As you consider new technologies, bring key stakeholders into the process, including the physicians, nurses, and support staff, to determine whether the new technology is the right fit or not.

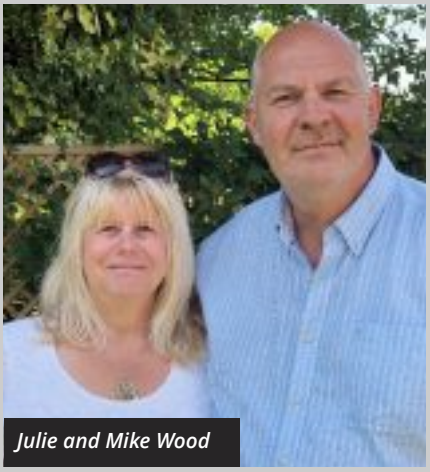
RAPIDAI

Mary Hardcastle
Vice President of Sales, EMEA
RapidAI
Tel: + 44 7741 243590
hardcastle@rapidai.com
https://www.rapidai.com/
https://twitter.com/rapidai

An example of AI in Action

Leeds Teaching Hospital Puts Stroke AI Into Action

It was a Sunday evening, and Dr. Tony Goddard was getting ready to leave Leeds General Infirmary. The interventional neuroradiologist had just completed a stroke case at the hospital, part of Leeds Teaching Hospitals NHS Trust, when he was alerted that another patient was coming in.



Julie and Mike Wood

That patient, Mike Wood, 57, suffered a stroke in his kitchen and was on his way to the hospital via ambulance, having been discovered by his wife, Julie. When he arrived, Mr. Wood was met and assessed by a Brain Attack Team (BAT) nurse. His symptoms at this time included right-sided weakness, eye deviation, confusion, and the inability to speak. His National Institutes of Health Stroke Scale (NIHSS) score was 18, indicating a potentially severe stroke. A non-contrast CT scan was quickly ordered, followed by CTA and CT perfusion scans.

Leeds Teaching Hospitals, equipped with RapidAI advanced imaging technology, which uses artificial intelligence to quickly analyze a patient's brain scans and deliver results to doctors within minutes – allowed Dr. Goddard and the Brain Attack Team fast access to real-time views of Mr. Wood's brain. They were able to quickly see that a blood vessel was blocked, how much blood was flowing through, how much of his brain had likely "died" and how much could potentially be saved.

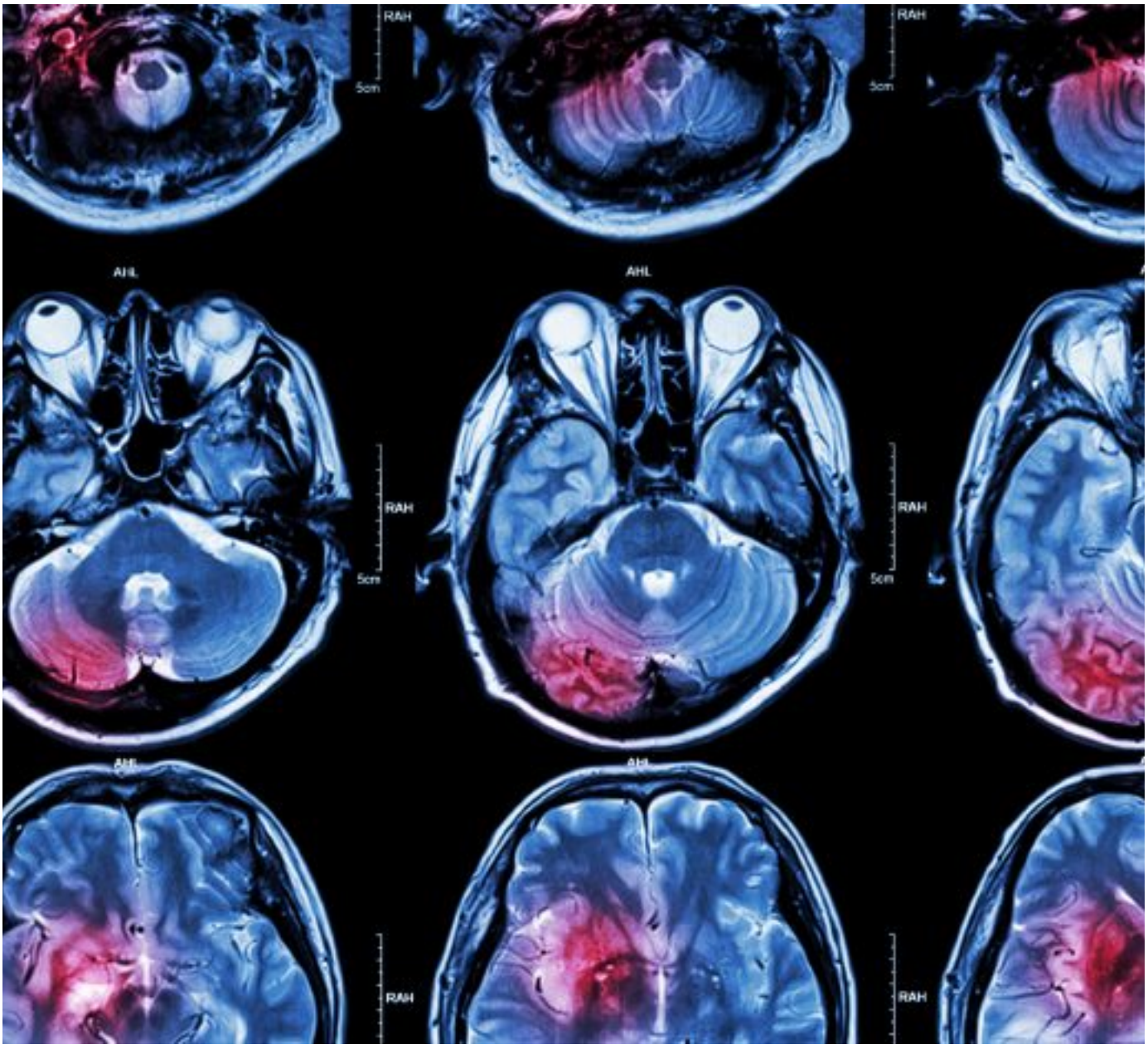
This information helped Dr. Goddard make the call to perform a mechanical thrombectomy, the procedure that would remove the clot and restore blood flow to Mr. Wood's brain. He said the Rapid CTP results were especially useful in determining the amount of tissue at risk of becoming infarcted if the procedure was not done immediately. "The CT perfusion results were very helpful and allowed us to make a very quick decision," Dr. Goddard said. "Just looking at the results, you could see the patient had a huge amount of salvageable tissue."

Back in the angio suite for the second time that day, Dr. Goddard used a stent retriever to successfully remove the stroke-causing blood clot through the left carotid artery. Within 24 hours, Mr. Wood's NIHSS score dropped to 7, and he was well enough to be discharged from the hospital six days after the procedure.

Dr. Goddard credits a number of lucky factors that led to the success of the procedure. "It's one of those situations where everything lines up. There was no traffic for the ambulance crew, so the transfer time was quite good. He collapsed in the kitchen, so he was found immediately. We were already at the hospital (having just completed another procedure), and we had the information available to us with Rapid, which really helped to remove time from the equation."

The UK's largest regional stroke thrombectomy network is powered by e-Stroke

Jeff Wyrtzen, Chief Marketing & Business Development Officer at Brainomix explores the impact of the e-Stroke thrombectomy platform and its implementation across the supraregional network



The Royal London Hospital is a leading, internationally renowned teaching hospital in east London, part of Barts Health NHS Trust. Home to London's Air Ambulance service and one of the capital's leading trauma and emergency care centres, it also serves as a comprehensive stroke centre that delivers a 24/7 mechanical thrombectomy service to patients with acute ischemic stroke in London and across much of Southeast England. In fact, the Royal London Hospital, Essex, East of England & Kent Stroke Network serves a population of over 9 million, making it one of the largest stroke networks in Europe.

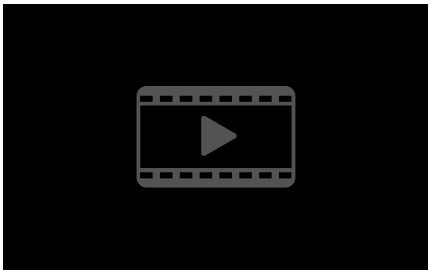
A revolutionary way to manage patients

Brainomix's e-Stroke platform has been widely implemented across the supraregional network, linking the Royal London Hospital with referring sites such as Colchester Hospital, Darent Valley Hospital, Maidstone Hospital, Kent & Canterbury Hospital, Ipswich Hospital, and Peterborough Hospital. "We now have the largest AI-enabled stroke network in the country, enabling us to quickly review images and make decisions across this large patch," noted Dr Oliver Spooner, Consultant Stroke Physician, Barts Trust NHS Health.

Dr Paul Bhogal, Consultant Interventional Neuroradiologist at the Royal London Hospital, also commented: "Brainomix has revolutionized the way that we are managing these patients, enabling us to quickly, effectively and accurately analyse images that have been conducted at other hospitals, speeding up our decision-making process around diagnosis, transfer and treatment."

The impact of e-Stroke

To assess the impact of e-Stroke on the network, the Barts team performed a retrospective analysis of patients that underwent thrombectomy at the Royal London Hospital between July and mid-December of 2021. This included patients referred from external sites that used e-Stroke, as well sites that did not use e-Stroke. A total of 112 patients were referred for thrombectomy during this period, with 26 presenting locally and 86 from external sites. One-third of the referring sites were actively using e-Stroke software as part of their patient referral process.



The results showed that the door-in-door-out (DIDO) times were significantly faster at sites using e-Stroke, dropping from an average of 183 minutes down to 125 minutes, a savings of nearly 1 hour. Sites with e-Stroke also demonstrated shorter time of arrival to ambulance request, and shorter time of arrival to initial referral. This speed of treatment is essential, as each minute represents a loss of nearly 2 million neurons.

Dr Spooner spoke further about the impact that e-Stroke has had on their regional stroke service: "Before e-Stroke was implemented, the network delivered 96 thrombectomies. In the first year of using e-Stroke, thrombectomy increased to 256 thrombectomies. More importantly, from a patient outcomes standpoint, the implementation of e-Stroke was associated with a significant improvement in functional independence rates (defined as mRS@90 days 0-2), going from 33-41.4% to 55.8%."

Dr Bhogal commented on the ongoing collaboration and partnership between Brainomix and his colleagues at The Royal London Hospital: "For us, Brainomix offers the right balance of scientific evidence, ease of use, and as with our own department, a track record of delivering steady and consistent improvements in their AI stroke solutions. One of the main reasons we chose Brainomix was their commitment to really listen to us, and their enthusiasm to form a truly collaborative partnership. As we are a team of consultants closely involved in research and development of stroke care, this partnership approach is critical. As a UK-based, Oxford spin-out with frontline NHS clinicians on their team, Brainomix understand the challenges faced by NHS trusts better than companies based elsewhere."

BRAINOMIX

Jeff Wyrtzen
Chief Marketing & Business Development Officer
Brainomix
Tel: +44 (0)1865 582 730
jwyrtzen@brainomix.com
www.brainomix.com
https://twitter.com/Brainomix

What we need to make breakthroughs in dementia research

David Thomas, Head of Policy (Access and Innovation) at Alzheimer's Research UK, looks at what we need to make breakthroughs in dementia research

In 2019, COVID-19 plunged the world into uncertainty. Back then, we didn't even have a name for the virus, and many certainly didn't foresee the impact it would have on people's lives.

As I write this, we now know that people with dementia have been some of the hardest hit by the pandemic. One in four people who died from COVID-19 in England and Wales also had dementia.

At the moment in the UK, we're mostly free of COVID-19 restrictions. This is in large part due to the medical successes we've had, including the delivery of effective vaccines.

"It's been twenty years since the last treatment for Alzheimer's disease, the leading cause of dementia, was developed."

At Alzheimer's Research UK, we're calling for the same approach that delivered the lifesaving vaccines to be applied to bring about the first life-changing medicines for dementia.

Why do we need a dementia treatment?

Of the UK's leading causes of death, dementia is the fastest growing health condition. Almost one million people across the UK are living with it and this number is set to rise to 1.6 million by 2050.

Dementia is progressive and it can have a devastating impact on individuals and families. The diseases that cause dementia strike at humans' most valuable resource, the cells of the brain. It takes away people's memories, the ability to communicate and can leave people feeling disconnected from themselves and the world. Not only this, but the condition costs the UK economy £25 billion a year.

It's been twenty years since the last treatment for Alzheimer's disease, the leading cause of dementia, was developed.

And to this day, there are no treatments in the UK to stop or slow the diseases underlying the condition. With the damage that Alzheimer's and similar diseases inflict, how can this be possible?

A new strategy needs to be implemented for breakthroughs in dementia research

To turn the tide, we need to see the prioritisation and urgent action taken to develop COVID-19 vaccines applied to dementia.

Research investment is a vital part of the solution, but we also need to see greater priority given to developing new treatments and better partnerships across the research community to enable this. As a UK dementia research charity, we're calling on this government to convene a Dementia Medicines Taskforce.

The idea is that this taskforce would deliver and build on existing UK initiatives and act as a catalyst for radical action to accelerate the development of new dementia treatments.

This requires coordinated, bold action from government to bring together industry, the NHS, charities like ourselves, and researchers to ensure treatments reach people with dementia.

But what could a Dementia Medicines Taskforce look like?

Chaired by a senior figure and reporting directly to government, it could bring together representatives from industry, the NHS, charity, and also researchers,



with a single focus on fast-tracking the development and delivery of new medicines for diseases like Alzheimer's.

Its scope would be to look across the whole research pathway, but it would focus in particular on how we expedite the set-up of new dementia medicine trials and quickly recruit participants.

Boosting the number of volunteers in clinical trials is important and the taskforce would aim to increase the number of volunteers taking part in larger, late-stage dementia trials to pre-pandemic levels.

One of the difficulties in dementia research has been getting the right volunteers for the right trial. Current medicine trials are focused on finding people in the early stages of disease like Alzheimer's at the point when treatment will be best able to modify the disease. However, often people with dementia are not diagnosed until later in the progress of their disease and are, therefore, not eligible for involvement in a clinical trial. We want to change this, and the Dementia Medicines Taskforce would help roll out cutting-edge diagnostics in the NHS to provide more accurate, early diagnosis. It would also develop a dementia health and care data registry to ensure people with a diagnosis are matched to the right studies, appropriate to their type of dementia and stage of disease.

One of the major accelerators for COVID-19 vaccines was the fast-tracking of regulatory procedures. And to help the most promising new treatments to make progress along the clinical trials pipeline, we need to see the same for dementia and help successful medicines to be rapidly assessed by regulators.

Supporting the NHS to deliver benefits to patients

A new treatment will have a large impact on the health system because of the sheer number of people living with dementia.

And the scale of the resources required in the NHS to deliver future treatments needs to be considered now.

The Dementia Medicines Taskforce would help ensure the NHS has the right clinical pathways and support for healthcare professionals to enable new medicines to be given as soon as they become available.

A look at Alzheimer's disease

According to the National Institute on Aging, Alzheimer's disease is the most popular cause of dementia among older people. The loss of cognitive functioning and the ability to remember, think and learn are the main symptoms. Alzheimer's can affect not only the life of the patient but also their families. [1].

Alzheimer's disease was first mentioned by Alois Alzheimer in 1906, we read on the Alzheimer Europe website. Alzheimer's dementia-like any other type of dementia are progressing with symptoms worsening over the years. The disease is associated with the build-up of harmful proteins in and around brain cells.

These proteins (called amyloid and tau) create plaques and tangles that can harm sometimes the connections between brain cells. The production of important brain chemicals, such as the neuro-transmitter acetylcholine, is decreased. These changes lead to a loss of brain function and cell death, initially in areas that are responsible for memory, and later in areas that control language, reasoning, and social behaviour. Eventually, the entire brain is affected [2].

Symptoms of Alzheimer's dementia

Among the first signs of Alzheimer's dementia are, short-term memory loss, disorientation, and misplacing. At first, people with Alzheimer's dementia can find it difficult to complete tasks or to organise and express their thoughts [2].

Many changes occur in the brain of someone with Alzheimer's disease, long before any symptoms appear. Neuropathology research has been critical in identifying biomarkers that can help diagnose and treat diseases. This information has revolutionised the methods scientists and doctors use to diagnose and fight these diseases. Over the years, researchers have developed and tried ways to find evidence of protein fragments associated with Alzheimer's. Being able to diagnose Alzheimer's earlier, helps researchers test new treatments that may slow or stop the progression of the disease [3].

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It would help fund those parts of the NHS that are already innovating and work with the NHS to implement this best practice more widely.

Onboard with our vision

The development of COVID-19 vaccines showed the power of science, the talent of our scientists and institutions, and what can be achieved with the right leadership from the government.

We need to see the same leadership now for those with dementia today and people who will go on to develop the condition in the future.

With your support, we can make sure people living with dementia and research into the condition remains a political priority. For more information, visit https://www.alzheimersresearchuk.org/how-you-can-help/campaign/



David Thomas

David Thomas
Head of Policy (Access and Innovation)
Alzheimer's Research UK
Tel: +44 (0)300 111 5666
infoline@alzheimersresearchuk.org
www.alzheimersresearchuk.org
https://twitter.com/AlzResearchUK
https://twitter.com/david_rt84



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Searching for a novel marker of preclinical Alzheimer's disease

Research suggests that multisensory integration could be used as a novel marker for preclinical Alzheimer's disease given reported associations between magnitude of visual-somatosensory integration and important cognitive and motor outcomes

"If we can detect modifiable multisensory impairments, then we can develop novel strategies to strengthen these processes, in an effort to slow the progression of Alzheimer's disease and prevent serious mobility problems such as falls."

Jeannette R. Mahoney, PhD



Jeannette R. Mahoney, PhD, Associate Professor of Neurology, Albert Einstein College of Medicine

Alzheimer's disease

Alzheimer's disease affects nearly 6 million Americans and is the most common cause of dementia.[1] The notion that Alzheimer's alters sensory processing is in its early stages.[2] This premise is supported by growing evidence that amyloid-beta (Aβ) protein accumulates in sensory-association areas of the brain well before higher-order cognitive areas like the prefrontal cortex (PFC).[3] The National Institute on Aging (NIA) has recognised that functional changes in sensory and motor systems modulate the progression of Alzheimer's disease, and have requested discovery of novel, non-cognitive and non-invasive predictors. Our research reveals that worse visual-somatosensory integration is associated with worse motor – specifically worse balance, slower gait, and increased falls – and worse cognitive functioning. Thus, further investigation of whether multisensory integration could be developed not only as a novel behavioural marker of Alzheimer's disease, but also as a novel marker of falls, is warranted.

Multisensory Integration (MSI)

When sensory inputs (e.g., visual and somatosensory) are presented concurrently, they combine in the brain by a non-linear process to yield faster responses than their unisensory constituents. Researchers claim that our brains are designed to simultaneously process multiple sensory inputs so as to produce the most appropriate response to environmental cues.[4] Research on animals (cats and primates) and humans (young adults) reveals that intact multisensory integration is critical for functional independence in the real world, including successful completion of daily activities.[4-6] Further, studies reveal that flexible multisensory integration is regulated by PFC, including dorsomedial and ventrolateral subregions.[7, 8]

Much of the research conducted over the past several decades has investigated multisensory integration effects (namely auditory-visual, auditory-somatosensory and visual-somatosensory combinations) in young adults, using diverse psychophysical, electrophysiological, and neuroimaging techniques.[4] Findings typically reveal a speeding up in response time [also known as reaction time (RT) facilitation] for the multisensory as compared

to the unisensory events. Considerable strides have been made in defining the underlying properties, neural substrates, and timing of multisensory integration effects in healthy young adults.[4] However, influential editorials highlight limited multisensory aging research, as well as the lack of clinical multisensory applications as major gaps in the field.[5, 6, 24]

MSI & Aging

Further understanding of multisensory integration in aging could prove valuable, given that increased sensory deficits are associated with aging. Age-related visual and somatosensory impairments have been linked to slower gait,[9] functional decline,[10] increased risks of falls,[11-14] and poorer quality of life.[15] In a study contrasting multisensory integration in old and young adults across auditory-visual, auditory-somatosensory, and visual-somatosensory combinations, we reported that older adults exhibit the greatest (i.e., best) multisensory integration effects when presented with visual-somatosensory stimulation.[16] We generated evidence for robust, but differential visual-somatosensory integration (VSI) effects in healthy older adults [17-19] and discovered its significant link with clinically-meaningful outcomes like falls, balance, gait speed, and cognition.[17-22]

Specifically, we found that older adults with intact levels of VSI (area-under-the-curve values > 0 over fastest 10 percent of RTs) demonstrate better balance, faster gait velocity and lower incidence of falls, compared to those with VSI deficits (area-under-the-curve values < 0 over fastest 10 percent of RTs). VSI deficits associated with worse unipedal stance and worse spatial gait performance inevitably contribute to worse quality of life and increased risk for falls. Additionally, we reported that older adults with mild cognitive impairments and dementia demonstrated significantly reduced magnitude of VSI compared to older adults without cognitive impairments.

Clear clinical-translational value

Relatively few aging studies to date have investigated the clinical utility of multisensory tools. Our method for quantifying multisensory integrative effects demonstrates clear clinical-translational value with regards to predicting declines in mobility, including but not limited to falls. Using our research as a solid foundation and our patent-pending system and methods for testing multisensory integration effects (U.S. Provisional Application No: 62/908,180; U.S. Non-Provisional Application No: 17/038,974), we have developed an innovative and quantitative visual-somatosensory iPhone-based reaction time assessment called CatchU™ [see 23].

The main objectives of the CatchU™ simple reaction time test and corresponding personalised physician report is to facilitate the identification of patients who are at increased risk of falls and promote physician-initiated falls counselling or other therapeutic services. We believe that optimising integration of visual-somatosensory inputs may ultimately provide the necessary framework for development of future personalised multisensory interventions aimed at reducing falls and improving mobility, while alleviating disability, that will in turn help our seniors maintain functional independence.

Recent Funded Projects

The functional neural substrates of VSI have not been identified in either healthy or cognitively impaired adults. In our most recent project funded by the NIA (1R01AG075679), we aim to establish VSI as a novel marker of preclinical Alzheimer's disease since growing evidence suggests that Alzheimer's pathology manifests in sensory association areas well before appearing in neural regions involved in memory function. Specifically, we plan to examine integrative neural activation using state-of-the-art multi-modal MRI & fMRI procedures in older adults with and without preclinical Alzheimer's disease, while linking these specific neural networks to clinically meaningful outcomes like falls. This project specifically challenges existing multisensory and aging research paradigms by assessing the time course and interplay between cognitive, motor, and sensory processing in healthy and pathological aging. Identifying associated functional neural networks involved in multisensory integration processes will allow us to conduct future randomized clinical trials to determine whether novel multisensory-based interventions can alleviate disability in people with cognitive impairments.

References

Disclosures:

JRM has a financial interest in JET Worldwide Enterprises Inc., a digital health startup spun out of research conducted at Albert Einstein College of Medicine.

Jeannette R. Mahoney, PhD
Associate Professor of Neurology
Albert Einstein College of Medicine
Tel: +1718 430 3809
jeannette.mahoney@einsteinmed.edu
https://einsteinmed.edu/faculty/11512/jeannette-mahoney/
https://einsteinmed.edu/news/4768/new-$42-million-nih-grant-to-discover-novel-markers-of-early-alzheimers-disease/
twitter: @JetMahoney206
twitter: @CatchU_b4_UFall
linkedin: /jeannette-r-mahoney-1b72a459
Instagram: @jetski206
Facebook: @Jeannette Piesco Mahoney



ArrestAD: Exploiting the bittersweet side of Alzheimer's disease

The Alzheimer's disease puzzle is being completed.
This is where the ArrestAD programme comes in, to exploit the bittersweet side of AD

The puzzle is being completed

Alzheimer's disease (AD), the more common cause of dementia in the world, has concentrated the attention of thousands of specialists in most domains of the health sciences. However, despite immense efforts in the development of therapeutic approaches based on classic disease cascades, the disease progression has not been halted, indicating that hidden pieces central to the disease puzzle mechanism are missing.

Too evident to be considered

Since the early 1990s, complex sugars called heparan sulfates (HS) were seen inside the damaged neurones that accumulate in the AD brain. These molecules generated much research interest at the time concerning their first observation because of their roles in ensuring the maintenance of all the body's tissues. However, the importance of their neural accumulation in the AD brain, although evident, was disregarded for years.

> "By affording the missing piece of the puzzle, our approach fits together all known neurodegeneration cascades and concepts."

It is at this point that a primordial discovery was made at Gly-CRRET, a laboratory of UPEC (France), working to understand the central roles of HS in the puzzles of biological systems.

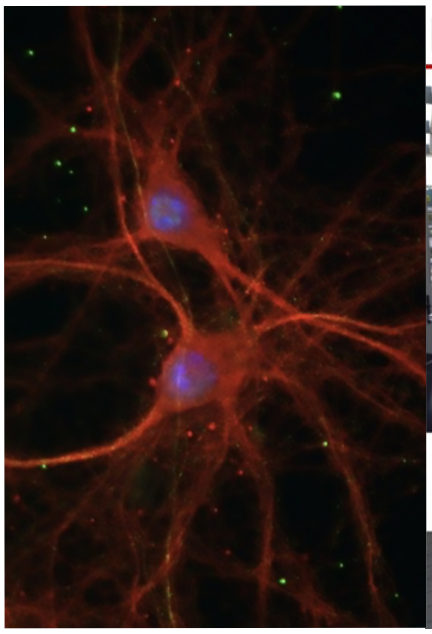
Brain sugars were the missing piece in the AD mechanistic puzzle

Accumulation of HS in vulnerable neurons was at the bases of the protein aggregation that evolves from the synapse until the cell dies. Based on this central discovery, a completely new approach to arrest AD emerged, opening up innovative drug candidates able to stop the development or even the initiation of the disease. Moreover, HS changes observed in the AD brain could be mirrored in blood cells and then used as a diagnosis tool. A completely new mechanism-based hope for preventing and arresting AD was born.

The FET OPEN ArrestAD consortium

The stage was set for the **ArrestAD** programme, funded by the European Commission *(FET-OPEN H2020 737390)*, based on this new Alzheimer's Disease concept. Diagnosis through measuring the accumulation of neural-related HS (nHS) in blood cells of patients and therapy by means of finding chemicals that block the enzymes producing nHS.

ArrestAD is a complete programme that has two parallel arms and a central body. The central body furnishes the scientific bases of the approach. The diagnostic arm aims to establish in patients the extent to which the mirror of brain nHS observed in blood might provide a means to screen





ArrestAD consortium

populations who are at risk of developing AD. The therapeutic arm aims to establish that specific chemical compounds that can inhibit the neural enzyme producing nHS in brain regions vulnerable to developing AD. By bringing the two arms together, we have a screening programme allied to a treatment.

The research planned in **ArrestAD** afforded many innovations and the invention of new methods and tools to implement new approaches and technologies able to fulfil the requirement of this new vision of AD. To meet the challenge, a strong multidisciplinary team was built, comprising six teams of researchers in five countries, two with local collaborating clinical units. The expertise ranged from sugar chemistry, through to high-powered analytical tools and clinical units with cohorts of Alzheimer's patients at different stages of disease progression. Led by Professor Dulce Papy-Garcia in Paris (UPEC), the teams of Professor Lydia Giménez Llort in Barcelona (UAB), Professor Javier De Las Rivas in Salamanca (CSIC/USAL, FICUS), Professor Urszula Wojda with clinical colleagues of the Central Clinical Hospital in Warsaw (NENCKI), Professor Toin van Kuppevelt in Nijmegen (SRUMC), Professor Dave Fernig in Liverpool (UoL), and Professor Bruno Dubois in Paris (AP-HP), got down to work.

What was surprising to the team members drawn from beyond the confines of sugar research and the underlying concept of ArrestAD was holding, and so real progress was made. The outcomes beat our greatest expectations, and **ArrestAD** has delivered:

1. Corroboration of nHS biosynthetic enzymes as completely new drug targets for prevention and arresting AD and the tools to discover safe innovative drugs for patients.
2. Several unrevealed steps in the mechanism by which nHS trigger protein aggregation at the synapse and in the whole cell.
3. A raft of new diagnostic tools, from the direct measurement of nHS in blood cells to molecular changes in these cells (miRNA).

Is there hope for efficiently treating the disease?

Yes, by affording the missing piece of the puzzle, our approach fits together all known neurodegeneration cascades and concepts. With the right puzzle piece in hand, we advance the way patients go, thanks to the company Glycanix, that will bring the ArrestAD concept into patients. On the diagnostic/prognostic side, one of the challenges will be the establishment of procedures to identify people very early, before disease onset. The use of single cell analysis and mathematical conveyance of data will support the success of this new concept in AD.

"The ArrestAD has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 737390.

Dulce Papy-Garcia
Professor and director of Gly-CRRET research Unit at UPEC
University Paris-Est Créteil (UPEC)
Tel: +33 1 45 17 70 80 (or 70 81)
papy@u-pec.fr
https://arrestad.wordpress.com/
https://twitter.com/ArrestAD1



Latinx with dementia: Getting the help you need

The Tension Between Cultural Values and Getting the Help You Need

Latinos, on average, experience greater longevity than do non-Latino Whites and African Americans. This longer life expectancy is a mixed blessing, as it comes with an increased risk for dementia. As previously noted in April 2022 edition, Latinx with dementia exhibit a higher number of behavioural symptoms, notably depression and anxiety. These symptoms, in addition to others complicate dementia care and present major challenges for caregivers, especially family caregivers.

Latino caregivers and asking for help

Familismo/familism, simpatia, and respeto continue to be the traditional Latinx cultural values among ageing Latinx, a concept that involves broad networks of support including aunts, uncles, grandparents, godparents, and other close family members. Dementia is truly a family affair, emphasising affiliation, obligation and cooperation. Given the strong sense of obligation, loyalty, and responsibility that familism engenders, Latinxs are more likely to be cared for by family members when faced with chronic and terminal conditions. Although frequently reluctant to go outside the family, caregivers need help and relief.

In their chapter on "Latino Families Living with Dementia: Behavioral Issues and Placement Considerations," Janette Rodriguez and Viviana Padilla- Martínez (Chapter 8 from Caring for Latinx with Dementia in a Globalized World, 2020, editors Hector Y. Adames, Yvette N.) discusses different dementia service models, internal, external and hybrid. In the Latino culture, given cultural values, several Latino caregivers are reluctant to ask for assistance or avail themselves of resources meaning that a hybrid model will likely work best. This model includes significant support and collaboration from both within the family and outside professionals/ experts.

As one caregiver expressed, "Si tú estás más enfermo que ella, ¿cómo tú la vas a cuidar? *[If you're sicker than she is, how are you going to care for her?*]". She noted self-management approaches that might relieve stress including yoga, art, prayer, exercise, singing and dancing, spending time with loved ones, and getting caregiving help.

Underusing help available

In general Latino families underutilise formal dementia caregiving options. Barriers to accepting help outside the family include distrust of outsiders, acceptance of stress as a part of the familial caregiving role, and resistance to sharing familial problems with out- siders or admitting that care is too demanding. Many Latino families may find that expressing or acknowledging distress or difficulties is unacceptable, as caring for elders with grace is culturally expected. Some of these issues can be addressed by educating the family and caregivers so that they will accept some outside help.

Family members can provide specific help and be proactive. This help includes setting up a schedule to relieve the main caregiver so that she/he can socialise with friends for example or engage in other enjoyable activities. In addition, the extended family can help by completing several tasks that can alleviate the main care- giver such as grocery shopping, laundry, travel to doctor's appoint- ments and other specific needs. Visiting is wonderful; however, specific assistance can make the difference between eeling overburdened, ready to quit, not knowing how to go on and the ability to manage. This help can decrease the sense of being alone in the process, provide support and decrease negative experiences.

Experts can provide culturally appropriate resources for Latinx with dementia

"Experts" can be proactive and engage in preventative efforts, communication and problem solving with families so that they can begin to address issues such as grieving and the experience of caregiving. Some examples that may help with communication and with helping the family to accept outside help include the use of infographics, telenovelas, attending specifically culturally sensitive interventions (groups) and educational offerings.

The following are examples of some of the help that experts can offer:

The use of ***Infographics***. To "get the picture", using infographics, a means of communicating effectively with caregivers regarding their health and dementia. For example, to understand that their level of depression symptoms may need treatment. This technique can also be used to communicate about the symptoms of depression and anxiety exhibited by the person with dementia and poten- tial ways of handling these symptoms.

Fotonovelas, culturally congruent stories conveyed through photographs and text, are used to increase awareness about BSDs, symptom management, and to teach Latinx caregivers how to understand and manage stress and depression. These are extremely helpful when health literacy may be an issue.

Circulo de Cuidado, is a culturally-sensitive, cognitive behavioural therapy (CBT) group intervention, supporting Latino families to deal with BSD and improve caregiver well-being. Groups are small, informal, and highly interactive, involving a great deal of chatting. Each group choses the type of preferred refreshments and suggests the use of a particular bodega. Each week the group leader arrives early and stays late to provide ample time and space for mutual exchange.

REACH-OUT is another program offered, led by social workers and nurses to provide support and assistance to Latino families. Spousal and older caregivers benefitted most from this program.

PACE (Program of All Inclusive Care for the Elderly) Programs are offered in several states in the United States. They are especially designed for those with fewer financial resources and provide comprehensive care including but not limited to medical, nursing, social work, nutrition, and social activities

The development of culturally tailored engagement efforts and educational resources to promote dementia health literacy, early detection, and caregiver training among individuals, families, and community stakeholders is essential.



Dr Diana Lynn Woods, PhD, APRN-BC, FGSA, FAAN
Professor
Azusa Pacific University
School of Nursing
Department of Doctoral Programs
Tel: +1 (626) 815 6310
dwoods@apu.edu
https://www.apu.edu/nursing/faculty/dwoods/

A Bluetooth tracking device to aid the search for older people with dementia who get lost



Getting lost can affect caregivers and families of older people with dementia – now, a Bluetooth tracking device can assist the search for their loved ones

Getting lost affects the quality of life of community-dwelling older people with dementia and their caregivers.

A phone survey on 251 family caregivers of people with dementia[1] found that the prevalence of getting lost among community-dwelling people with dementia was 28%, the getting lost episodes usually happened during 2pm to 6pm (39%) and 6am to 12noon (28%).

Places prevalent for older people with dementia getting lost were street (24%) and their own homes (18%). 61% of respondents would search for the care recipients in neighbourhood, 12% would seek help from friends and neighbours. It was also found that 46% of care recipients were found within one hour of missing and 96% were found within 24 hours.

People who get lost generally go to places where other people are

From these data we learn that when a person with dementia get lost, they are more likely to be in the streets during the day with people around. Neighbourhood may therefore be a good source of help, given that nearly half of missing care recipients could be found within one hour i.e. not far from the places they get lost.

In this regard, education to the general public would have its significance that the community would be educated to be aware of this issue and empowered to offer help in case they meet older people with dementia getting lost.

> "When a person with dementia is getting lost, his or her caregivers could activate the missing alert on the app installed on the caregiver's mobile phones."

The afore-mentioned survey indicated that nearly half (45%) of caregivers would get worried about future getting lost episode and 30% of caregivers would forbid care recipients from going out again in order to prevent potential getting lost.

However, such restriction would cast adverse influence to the mobility and psychological well-being of care recipients, while, there are various adaptive measures to help prevent walking and getting lost other than restriction of care recipients going out.[2]

"iBeacon" for a fast and helpful response

Thanks to the donation from The Hong Kong Jockey Club Charities Trust, Jockey Club Centre for Positing Ageing collaborated with The Hong Kong University of Science and Technology and St James Settlement to develop a tracking device using blue tooth and crowdsourcing machine learning technology in the "Caring communities for dementia campaign".

The tracking device "iBeacon" we developed has fast response (beacon interval being 1s) and up to 50m tracking distance. It is battery-saving (battery life being 1 year) and is designed in different forms so that it can be put into a wallet or attached onto a walking stick to lower the resistance of people with dementia to carry the device.

When a person with dementia is getting lost, his or her caregivers could activate the missing alert on the app installed on the caregiver's mobile phones. And then the "dementia angels" who have installed the tracking app on their mobile phones will be notified to turn on their Bluetooth for iBeacon searching and GPS for location sharing.

When the dementia angels' mobile phones detect the iBeacon, their location would be anonymously sent to our cloud server and our localization engine would calculate the location of





the iBeacon which would then be sent to the caregivers to help their searching. Such technology not only facilitates family caregivers' search for the lost relatives with dementia but also promotes dementia friendliness community by mobilising the public to help older people with dementia who get lost.

75% thought that the designated mobile app was easy to use

Over 2,300 people have obtained our iBeacons in this project and over 23,400 dementia angels have downloaded our app to help the searching. In 45 out of 131 lost episodes recorded, the caregivers used our technology to help search their relatives with dementia.

The caregivers participating in our project welcomed the technology and the tracking device. 87% caregivers thought that the iBeacon was easy for the people with dementia to carry, 82% observed that their relatives with dementia were willing to carry the iBeacon during the intervention period.

79% caregivers were satisfied with the durability of the iBeacon, and 75% thought that the designated mobile app was easy to use. In addition, 74% caregivers trusted the data security. The overall programme satisfaction rate was 85%, revealing that they held positive stance towards using this technology in their daily lives to prevent getting lost.

We also offered a series of public education talks about prevention of people with dementia getting lost. Over 95% of the 6,000 participants had enhanced knowledge about dementia and the prevention of getting lost in people with dementia.

They also expressed a more positive attitude towards dementia and willingness to help people with dementia who get lost. Overall, this programme has promoted dementia friendliness in Hong Kong.

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賽馬會友里蹤跡社區計劃
JOCKEY CLUB CARING COMMUNITIES FOR DEMENTIA CAMPAIGN

Ms Bel Wong, Research Manager
bel.wong@jccpa.org.hk

Ms Florence Ho, General Manager
florence@jccpa.org.hk

Prof Timothy Kwok, Director
tkwok@cuhk.edu.hk

Jockey Club Centre for Positive Ageing
Tel: +852 2636 6323
https://www.jccpa.org.hk/en/

Digital biomarker predicts mild cognitive impairment conversion to Alzheimer's

Digital biomarker can identify which cases of mild cognitive impairment will develop into Alzheimer's so that early interventions can be put in place to prevent the onset of the disease

Mild cognitive impairment is a multi-faceted ailment that has long bedeviled researchers due to the unpredictable nature of its progression. Some individuals with mild cognitive impairment (MCI) later develop Alzheimer's disease syndrome (ADS), while others remain at their same level of MCI or develop other forms of dementia. Finding a way to identify those whose MCI will convert to Alzheimer's before they become symptomatic is key to developing early interventions that can lessen the disease's severity or stop its progression entirely.

Linking eye movement patterns and cognition

The digital health and artificial intelligence company ViewMind has employed a novel cognitive digital biomarker – tracking eye movement and pupil response – to help predict the conversion of mild cognitive impairment (MCI) to Alzheimer's disease. As they found in a recent longitudinal study, this diagnostic technique holds great promise as an affordable and accessible early intervention for Alzheimer's.

Certain well-defined eye movement patterns have been shown to indicate healthy visual short-term memory, a reflection of a strong connection between eye movement and cognition. As ViewMind has discovered, recognising deviations from such patterns is a key way to locate signs of Alzheimer's as much as 20 years before symptoms begin to present. Not only can these differences indicate that dementia is present; they can also differentiate Alzheimer's dementia from other types such as Parkinson's Disease or fronto-temporal dementia.

"Finding a way to identify those whose MCI will convert to Alzheimer's before they become symptomatic is key to developing early interventions that can lessen the disease's severity or stop its progression entirely."

ViewMind built on previous studies, which showed that viewing fixation duration can be affected by memory and processing load, as well a previous study from ViewMind and partner institutions[1] which reported that oculomotor behavior related to cognitive tasks could serve as a biomarker for Alzheimer's.

ViewMind then created a visual exploration exercise to measure impaired cognitive processes among its participants with MCI by tracking their eye movements.

ViewMind's longitudinal study

In their three-year longitudinal study (2017–2020), forthcoming Journal publication, researchers at ViewMind compared the eye movement of patients with no cognitive impairment to that of those with mild cognitive impairment as the participants performed a visual short-term memory binding (VSTMB) task. The team found that specific patterns in eye movement and pupil response among participants with MCI positively corresponded with their likelihood of later converting into ADS.

The study, which assessed 105 participants (63 with MCI and 42 controls), employed ViewMind's proprietary digital biomarker, an AI application that detects patterns in eye movement associated with various forms of cognitive decline. Participants completed neurocognitive and oculomotor (VSTMB) assessments at baseline followed by annual clinical evaluations to monitor the progression of cognitive decline throughout the three years of the study. The VSTMB task required participants to view bicolored objects and recall their colours either as individual features or as appearing within a unified representation.

Based on the participants' ability to

recall the colors in a unified representation, ViewMind's sensitive AI technology was able to conclusively predict which participants demonstrated processing difficulties consistent with cognitive decline due to Alzheimer's. These results correlated strongly with those from traditional cognitive screening tools such as the Minimental State Examination (MMSE), the INECO Frontal Screening (IFS), and the Addenbrook's Cognitive Examination Revised (ACE-R).

Of the 63 participants with mild cognitive impairment, researchers predicted that 36 would later develop ADS based on their initial assessments, with the remaining 27 remaining in their current state of MCI or progressing to other forms of dementia (fronto-temporal or Parkinson's Disease). The results of the study showed a 94% accuracy in predictions of conversion to Alzheimer's syndrome based on analysis of the digital biomarker and 100% accuracy of predicting non-converters.

Early detection of mild cognitive impairment is challenging, but critical

One of the most significant challenges in fighting Alzheimer's disease is finding a way to diagnose the disease before symptoms develop. Even when symptoms begin to present, they are often indistinguishable from common signs of normal aging, such as forgetfulness and occasional disorientation.

By the time a person is showing enough possible signs of Alzheimer's to warrant a diagnostic procedure, the disease is typically already at a very advanced stage. Beta-amyloid and Taub protein formations – two of the key indicators of Alzheimer's disease – can be present in brain cells for



years and even decades before symptoms become detectable. ViewMind recognised that so much more could be done for people with Alzheimer's if the signs could be detected far sooner.

Using the digital biomarker to assess conversion of MCI to Alzheimer's also presents a possibility for normalizing regular cognitive assessments as a preventive rather than retroactive measure. ViewMind's eye-tracking technology can be used widely and at a comparatively low cost, meaning that it could eventually become part of a regular cognitive check-up for everyone, not just individuals experiencing cognitive difficulties.

Future steps

Current diagnostic tools for Alzheimer's disease are costly and sometimes risky. Even more problematic, they are currently only utilised once the disease has advanced significantly and cognitive damage is likely irreversible. ViewMind's highly sensitive diagnostic technology makes it possible to detect the first signs of Alzheimer's early in the disease's development, long before a patient becomes symptomatic. With rates of Alzheimer's cases expected to triple by 2050, the promise of a safe, affordable, and accessible diagnostic option that could help normalise routine cognitive check-ups is a welcome development indeed.

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VIEWMIND

Mark Edwards
CEO
ViewMind Inc
info@viewmind.com
https://www.viewmind.com
https://twitter.com/ViewMind_

Multiple sclerosis facts & trends

Cecilia Van Cauwenberghe from Frost & Sullivan's TechCasting Group, walks us through multiple sclerosis facts & trends

Multiple sclerosis (MS) is one of the most prevalent central nervous system (CNS) disorders which rapidly progresses with age. MS is an autoimmune condition where the myelin sheath of neuronal, spinal, and optic nerves is damaged, resulting in several disabilities such as fatigue and reduced eyesight. Multiple sclerosis facts & trends demonstrate how MS reduces the brain and cognitive reserve delays the appearance of age-related neurodegenerative disorders in later life (Sengupta, 2017).

According to the Multiple Sclerosis International Federation (MSIF), the most common type of MS is relapsing-remitting MS (RRMS). Around 85% of MS patients are diagnosed with RRMS. The MSIF reports that MS affects over 2.8 million people worldwide. Near 25% of them residing in low- and middle-income countries. Women are twice as likely to have MS than men; although, in certain countries, the female to male MS ratio can be 3:1.

Disease-modifying therapies (DMTs) for people with MS are partially or wholly government-funded in high-income economies, whereas there is no such federal support in low-income countries. Disparities per country and region in the availability of treatment for MS are notable. In Africa, for instance, 60% of countries have no licenced DMTs, and this number is even higher, 70% when analysing low-income countries around the world (Piggot et al., 2021).

The researchers emphasise the need for guidance for off-label treatments as a critical matter. Off-label DMTs are sometimes more available or affordable (Laurson-Doube et al., 2021). The Atlas of MS highlights that at least 89 countries use one off-label DMT to treat MS (Walton et al., 2020).

Main therapies and trends

The treatment of MS comprises disease-modifying therapies (DMTs) that are highly MS-specific and symptomatic therapies (STs) that are more generic and usually used in different disease areas to treat common symptoms resulting from neurological dysfunction (Dobson and Giovannini, 2019).

As the number and efficacy of DMTs increase, the main focus is on early diagnostics of MS to prevent long-term disability, a focus that has grown. Early treatment of those at risk of long-term disability is needed to minimise the physical morbidity associated with MS. Treatments consist of immunosuppressants (e.g., fingolimod, natalizumab, ocrelizumab), or immuno-modulatory agents (e.g., interferon beta, glatiramer acetate, teriflunomide).

There are several new treatments in the pipeline for MS. However, current disease-modifying treatments are only available to people with clinically relapsing forms of the disease and a minority of those with progressive disease (Dobson and Giovannini, 2019).

The role of digital healthcare

Researchers working at the Multiple Sclerosis Center Dresden, Dresden University of Technology, have reviewed the last innovations in digital solutions for people living with MS (Ziemssen and Haase, 2021). According to the researchers, facing a disease onset in their early adulthood is often seen as the ideal target group for new trends in digital healthcare because of their demand for a more personalised and tailor-made disease management. This fact is particularly relevant due to the complexity and heterogeneity of MS.

The development of digital applications and remote communication technologies for people with MS has increased notably. Indeed, eHealth apps have improved outcomes and facilitated access to care, disease information, and support. From the perspective of healthcare professionals treating patients with MS, such eHealth technologies facilitate clinical disability assessment.



Even other clinical practices, including laboratory analysis, imaging technologies and remote monitoring, have been enhanced thanks to digital healthcare applications. The patient's symptoms, adverse events, and outcomes can be tracked more precisely, hence allowing optimising time and intervention quality.

Acknowledgements

I want to thank all contributors from the industry involved with developing and delivering this article from Frost & Sullivan.

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A U.S. perspective on multiple sclerosis

The disease, multiple sclerosis (MS) concerns the central nervous system "that disrupts the flow of information within the brain, and between the brain and body", according to the National Multiple Sclerosis Society in the U.S. "The exact cause of MS is unknown, but we do know that something triggers the immune system to attack the brain and spinal cord," they add. (1) There is currently there is no cure for MS and symptoms vary and can include cognitive changes, mobility challenges and disabling fatigue. (2)

Earlier this year, the National Multiple Sclerosis Society commissioned a study which showed that the average total cost of living with MS is $88,487 per year, for the nearly 1 million people in U.S. with the condition. The conclusion is that MS is a very expensive disease. Cyndi Zagieboylo, President and CEO of the National Multiple Sclerosis Society explains more.

"While we've long known MS is a highly expensive disease, this study confirms the real impact these costs have on people with MS, their families and carepartners—as well as the U.S. economy. Urgent and immediate action is needed to ensure the cost of care is affordable and treatment for MS is accessible." (3)

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Cecilia E. Van Cauwenberghe, PhD, MSc, BS Eng, BA, MBA
Principal Consultant
Senior SciTech Advisor & Associate Fellow
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
www.frost.com
www.twitter.com/Frost_Sullivan

Regenerative therapies for multiple sclerosis: Clues from studying normal brain development

Tara M. DeSilva from the Department of Neurosciences, Cleveland Clinic, walks us through regenerative therapies for multiple sclerosis, including comment on clues from studying normal brain development

What is multiple sclerosis?

Approximately 3 million people worldwide are living with multiple sclerosis (MS), a leading cause of neurological disability in young adults. [1] MS is a neuroinflammatory demyelinating disease characterised by lesions in the brain, spinal cord and optic nerve (i.e., central nervous system, CNS) that are detected using magnetic resonance imaging. Lesions in MS are multifarious, giving rise to heterogeneous symptoms depending on their location.

In MS, the immune system becomes abnormally activated, entering the CNS, and facilitating damage to myelin, the insulating sheath around nerve fibres (axons) causing demyelination (Figure 1). Axons are responsible for conducting action potentials essential for transmitting information to other neurons throughout the CNS. The myelin sheath regulates the speed of nerve conduction and maintains the health of the axon. Thus, damaged myelin, not only slows the propagation of nerve impulses giving rise to disability in MS, but chronic demyelination perpetuates axonal loss, which is a key component of disease progression and permanent neurological disability.

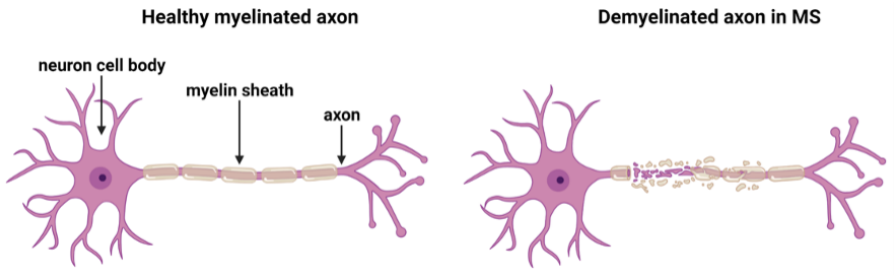


Figure 1: The myelin sheath ensures proper conduction of electrical impulses along the nerve fiber (i.e. axon). Damaged myelin not only slows propagation of nerve impulses giving rise to disability in MS, but chronic demyelination perpetuates axonal loss, which is a key component of disease progression and permanent neurological disability. Image created in BioRender.com

Why are regenerative therapies important for multiple sclerosis?

Current therapies for MS target immune cells by limiting their numbers or inhibiting their entry into the CNS. Although these immunomodulatory strategies decrease relapses and improve quality of life early in the disease course, ultimately disease progression ensues. Regenerative strategies are essential to overcome this barrier, with early intervention being critical to rescue axonal integrity and overall neuronal function. One such strategy involves remyelination, or the formation of new myelin sheaths from cells that produce it, called oligodendrocytes. In demyelinating lesions in MS, early-stage myelin-producing cells called oligodendrocyte progenitor cells (OPCs) proliferate as a prerequisite for remyelination but fail to rebuild the insulation around axons. This is in contrast to normal development when OPCs become mature oligodendrocytes and successfully form myelin sheaths around axons. Mechanisms that drive OPC maturation to form myelin are, therefore, a major focus for remyelinating therapies in MS.

How can a developmental process advance therapeutic strategies for multiple sclerosis?

The DeSilva laboratory's recently published study [2] uncovered an important mechanism of developmental myelination: regulation of OPC number. Cutting-edge neuroimaging

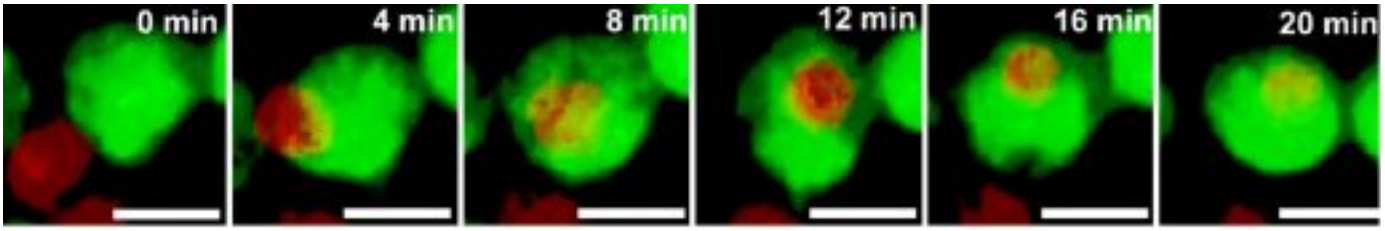


***Figure 2:** Microglia (green) engulf OPCs (red) during a restricted window of development to regulate developmental myelination. Reprinted from Nemes-Baran et.al., 2020. Cell Reports.*

and genetic labelling techniques were utilised to track and visualise cellular interactions using in vivo models of development. Microglia (Figure 2, green) were found engulfing OPCs (Figure 2, red) through a phagocytic process during a restricted developmental window before the onset of myelination. Microglia are a specialised population of cells in the CNS that respond to inflammatory processes in the brain. They have mainly been studied in the context of contributing to inflammation and cellular damage as well as clearing cellular debris in disease states.

More recent studies have demonstrated their role in engulfing neurons during development as well as structures that form connections between neurons, called synapses. This is the first study, however, documenting their role in phagocytosing OPCs to regulate myelination. More than 30% of OPCs were engulfed by microglia, indicating the substantial nature of this developmental process. It was also found that the population of microglia engulfing OPCs was amoeboid in shape (activated state), but as OPCs matured to form myelin and ensheath axons later in development, the microglia transitioned to a ramified or resting state.

To further explore the mechanisms regulating the cue for engulfment, time-lapse imaging was performed to document live cellular interactions between microglia and OPCs. Engulfment for the purpose of cell degradation is usually triggered by the expression of "eat me" signals in cells that are stressed or dying. Interestingly, the majority of OPCs being engulfed by microglia did not express markers of cellular stress. Thus, microglia engulf OPCs during their pre-myelinating state when they are viable and healthy, suggesting that this process is necessary to reduce OPC number and ensure proper myelination. To understand the impact of OPC removal by microglia on myelination, the ability of microglia to engulf OPCs was blocked by deleting a key signaling factor from microglia called the fractalkine receptor. This did not change the morphology or number of microglia but did reduce their ability to phagocytose OPCs resulting in an increased number of oligodendrocytes. Deleting the fractalkine receptor also resulted in the formation of thinner myelin sheaths, suggesting that an overcrowding of oligodendrocytes impaired the efficiency of the myelination process. These results indicate that microglia perform a critical role in regulating the number of OPCs to facilitate proper myelination with potential ramifications for remyelinating therapies in MS. Studies in human post-mortem brains from individuals with MS show that OPCs are present in chronic lesions, but do not properly reform myelin. [3] The presence of newly generated OPCs in the adult MS brain represents a developmental process that requires refinement by microglia to initiate proper myelin formation. These data suggest that reprogramming of microglia to a developmental state to regulate OPC number may provide a therapeutic strategy for remyelinating therapies.

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Cleveland Clinic

Tara M. DeSilva
Associate Professor and Vice Chair,
Department of Neurosciences
Cleveland Clinic
Tel: +1 216 217 6107
desilvt@ccf.org
www.lerner.ccf.org/neurosci/desilva/
https://twitter.com/DeSilvaTara

Can predictive genomics make our healthcare systems more sustainable?

Dr Zisis Kozlakidis with Francesco Florindi, discuss predictive genomics and ask if it can help make our healthcare systems more sustainable

Many healthcare systems across the world are perilously approaching the no-return in terms of sustainability. Ageing, resulting in increasing patient numbers with multiple conditions, sedentary lifestyles and changing nutritional profiles are driving the rising prevalence of non-communicable diseases (NCDs) such as cancer, cardiovascular diseases and diabetes.

At the same time, the young healthy and productive population (which should shoulder the socio-economic burden of older generations) is anticipated to continue shouldering the increased healthcare costs. The result is a potentially catastrophic sustainability pressure for healthcare systems' functioning, which can further expand inequalities, especially in Low- and Middle-Income (LMIC) settings, where there is high competition for resource access and prioritisation.

Thus, healthcare systems and policy-makers have a responsibility to comprehensively evaluate new ways to predict and prevent NCDs, providing citizens with the tools to change their lifestyles and, at the same time, supporting public health professionals with the most innovative tools available to allocate dwindling resources effectively. Here we will focus on predictive genomics and how such methods might influence sustainability.

Harnessing genetic information

The genetic material, organised into genes, provides the operating template for all our biological processes, and in some cases, sequence variations in the genetic material have been linked to conferring genetic disadvantages, for example, higher risks of developing certain types of cancer. [1]

Predictive genomics is the capacity to harness the power of this genetic information and interpret it in a clinically actionable manner to help in preventing disease and/or managing a healthy lifestyle. For most common diseases, such as coronary artery disease and type 2 diabetes, polygenic inheritance, involving many common genetic variants of small effect, plays a greater role than much rarer mutations in single genes.

In cancer for example, while rare mutations in genes such as BRCA1 and BRCA2 confer high risks of developing breast cancer, these account for only a small proportion of breast cancer cases in the general population. On the other hand, a more common situation includes variants that confer a small risk individually, but their combined effect, when summarised as a polygenic risk score, can be substantial. This polygenic inheritance might also be distinct between different individuals as well as different population groups.

As such, the capacity to understand the risk of developing disease(s) might constitute a critical component in future healthcare provision. Predictive genomics has the potential to transition healthcare systems from an emergency-based response, taking care of those who get sick, to helping everyone stay as healthy as possible for as long as possible.

This could be achieved at the individual level by promoting lifestyle choices and/or providing the more effective medication based on each personal genome; and at the public level by increasing the accuracy of targeted public health screening programs and treatments. Thus, using tools such as genomics, a more preventative outlook for the healthcare systems is anticipated to eventually emerge and widen the time window at which lifestyle changes or interventions can be recommended to avert the development of preventable disease.

Opportunities and barriers

Governments have demonstrated their interest in the potential of genomics in making healthcare systems more sustainable. For example, all large European economies have launched genomic initiatives in the last five years (UK, France, Germany, Italy, Spain and others), however these are mainly focused on

diagnostics (with a shorter market implementation horizon) rather than a longer-term prevention. Furthermore, the emergence of pan-European initiatives, such as the 1+ Million Genomes [2], Beyond 1+ Million Genomes and the Million Veteran Program in the USA – to name but a few - demonstrate the governments' collective appetite for genomics.

However, only a few countries (Finland, UK, Estonia) have specifically invested in predictive genomics. One of the reasons for doing so, is that predictive genomics can raise practical, ethical and legal considerations. For example, predictive genomics are data-intensive approaches to improve diagnosis and develop new treatments for major diseases, however this increased sharing of personal information raises concerns about data privacy, commercialisation, and public trust.

Thus, the time is ripe for the following three conversations to happen on the role(s) predictive genomics can play in creating sustainable healthcare systems. Firstly, a discussion on the allocation of clinical attention and resources across individuals with different levels of genetic risk and the ways in which the integration of predictive genomics will be implemented into routine healthcare practice.[3] Secondly, a health economic conversation to evaluate more precisely the financial impact of predictive genomics as part of such routine healthcare planning and provision. Thirdly, a wider public and political conversation to strike a new balance between the benefits of predictive genomics, the potential ethical/legal risks, and how to mitigate them.

Importantly, new technologies such as predictive genomics should be viewed and leveraged as opportunities for LMICs to leapfrog into a more sustainable healthcare provision model for NCD patient populations within their regions. However, achieving this would require new technologies to become LMIC-friendly by design, allowing for their successful implementation and long-term routine operation in the field. If for example the reliance of high-cost digital equipment and skilled technical expertise remains an inflexible requirement for predictive genomics, then the risk emerges of the latter becoming an improvement applicable to a small number of resource abundant settings only.

Opportunity to improve healthcare

Predictive genomics are fast emerging as a promising opportunity for healthcare systems to improve disease prevention and survival, through targeted screening, preventative strategies or other interventions addressed to those individuals most likely to benefit. However, risk communication will require serious consideration. For example, while predictive genomics might allow for relative risks to be calculated at birth for all common diseases, the usefulness of the knowledge and the potential harms to the individual may vary with the disease and stage of life. Thus, while research progresses at rapid pace, it will be important to consider how predictive genomics will be integrated into the core of healthcare services and how to communicate any identified risks to best serve each patient. The considerable investments by many countries in the field of predictive genomics, by helping to promote the future integration of genetic testing in healthcare delivery and clinical decision making, is anticipated to advance precision medicine and improve the healthcare of the general population.

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Dr Zisis Kozlakidis
International Agency for Research on Cancer World Health Organization Lyon, France
www.iarc.fr
www.twitter.com/iarcwho

Francesco Florindi
Strategic Partnerships Manager – Predictive Genomics
Thermo Fisher Scientific
Brussels, Belgium
https://www.thermofisher.com/uk/en/home.html
https://twitter.com/thermofisher



Individualised Multimodal Immunotherapy beyond personalised medicine for brain cancer

Stefaan Van Gool, MD, PhD brings to light the important role of **I**ndividualised **M**ultimodal **I**mmunotherapy in improving the survival of brain cancer

Despite the intensive research on personalised medicine to treat patients with glioblastoma multiforme (GBM), no real progress has been made in the last decade to improve the prognosis of these patients.

Individualised **M**ultimodal **I**mmunotherapy, having its focus not only on the unique tumour in each patient but also on the tumour microenvironment and the patient's unique immune system, is a new major step forward to improving long-term overall survival.

Glioblastoma multiforme

Brain cancer remains a rare disease when compared to other cancer types. The term includes more than one hundred different types of tumour entities, categorised in the WHO classification, and regularly updated based on scientific progression. They are distinct from brain metastases. The most frequent malignant primary brain cancer in adults is the GBM. It is an orphan disease, with a yearly incidence of four to six adults per 100,000.

Still, the years of loss of life due to cancer is highest for GBM, compared to other cancer types. GBM can present already at a younger age, and most if not all patients die. The last major and significant step towards standards of care was realised around 2005-2010. Since then, the standard of care has not changed and consists of adjuvant radiochemotherapy and maintenance chemotherapy (Temozolomide) after neurosurgery.

Personalised medicine for glioblastoma multiforme

A clinical risk profile, expressed as the recursive partitioning analysis (RPA one to six), distinct groups of patients depending on grade III/IV malignant glioma; younger/older than 50y patients; below/above 70 Karnofsky performance index; below/above 27 Mini-Mental status; complete/non-complete resection; optimal/suboptimal radiotherapy. Besides, the MGMT promoter methylation status plays an especially important role in chemo/radio-sensitivity and is a dominating prognostic factor.

The diversity of patients became even more obvious based on epigenetic profiling of GBM pointing to at least six different entities. Finally, the expression of membrane molecules and receptors, and the existence of different intracellular pathways opened the possibility for targeted therapies. The latter is the key for personalised medicine approaches. The penetration through the blood-brain barrier within the tumour reduces the spectrum of available drugs. One challenge to prove the efficacy of novel targeted therapies within controlled trials is the diversity of the patient population making the design of an appropriate control population almost impossible. This challenge and the need for rapid testing of new compounds have been partially solved with the development of novel clinical trial designs with adaptive randomisation arms and/or external control arms. However, another not yet solved but more important major challenge is the heterogeneity within the tumour and the rapidly changing unpredictable predominance of different tumour subclones over time.

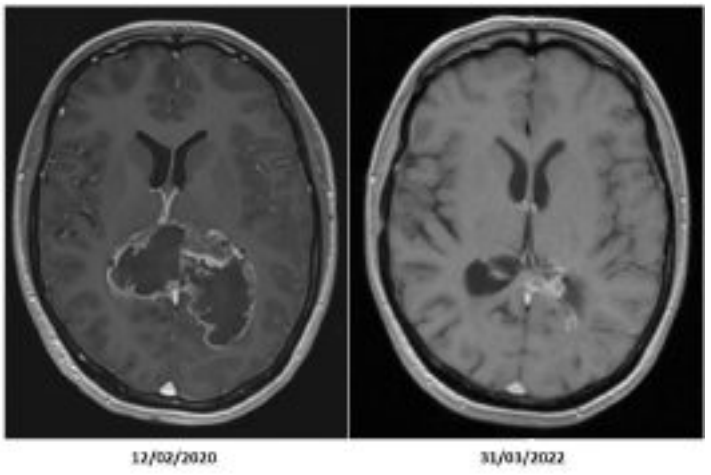
Keeping a fixed treatment protocol, personalised or not, to treat a patient with a permanently changing tumour biology has no rationale. Both challenges explain in part why clinical research has made no progression during the last decennium.

Glioblastoma multiforme within an immune (micro) environment

The particular tumour micro-environment and tumour-host interaction come on top of these challenges. The connection of the immune system within the brain exists, but has special characteristics. The tumour microenvironment is strongly immune-suppressive, and most GBMs are evaluated as "cold", without immune cell infiltration. Furthermore, there is a predominance of myeloid cells, partially infiltrated, partially being microglia from the brain itself. A GBM has even a suppressive influence on systemic immune functioning. Treatments like radiotherapy, chemotherapy and steroids also have negative influences on the systemic immune responses. Again, these negative influences are diverse for each patient. This all means that clinicians have to develop new treatment strategies individualised for each patient at the side of the GBM, at the side of the immune system and at the side of the tumour-host interaction. Treatments should allow adaptations over time, following the individual characteristics of each tumour and patient.

Individualised Multimodal Immunotherapy for glioblastoma multiforme

Neurosurgery and radiochemotherapy are primarily aimed to reduce the tumour volume. Maintenance chemotherapy is aimed to keep control over residual tumour cells. We combined immunogenic cell death therapy



(oncolytic virus therapy and modulated electrohyperthermia) during maintenance chemotherapy, and continued with active specific immunotherapy using dendritic cell vaccines and maintenance immunogenic cell death therapy, in combination with modulatory immunotherapy, to improve the overall survival of GBM patients. To our surprise, a strong synergy became visible between the chemotherapy and the **I**ndividualised **M**ultimodal **I**mmunotherapy for the improvement of the overall survival for IDH1 wild-type MGMT promoter-unmethylated patients. Whereas both treatment modalities alone did hardly improve the median overall survival beyond 12 months as obtained with radiotherapy alone, the median overall survival with combination treatment raised to 22 months with a two-year overall survival of 36%. The combination treatment resulted in a median overall survival of 33 months for IDH1 wild-type MGMT promoter-methylated patients with a two-year overall survival of 82%.

To conclude, the role of the **I**ndividualised **M**ultimodal **I**mmunotherapy integrated within and after the standard of care to improve long-term overall survival with good quality of life of GBM patients becomes obvious. Immunogenic cell death therapy changes the tumour-host interaction by releasing danger signals within the tumour microenvironment and thereby starting an immunisation process. The dendritic cell vaccines are loaded with antigenic extracellular microvesicles and apoptotic bodies induced by immunogenic cell death therapy, and yielded out of the serum. In this way, the vaccine is loaded with actualised tumour antigens out of residual tumour cells that escaped the radio-chemotherapy and the maintenance chemotherapy. The maintenance immunogenic cell death therapy remains killing potentially appearing new tumour sub-clones thereby including potential novel tumour antigens under the dendritic cell vaccine-induced global anti-GBM immune protection. This treatment strategy is adapted for each patient and each phase of the disease, taking into account dynamic changes in the tumour, in the immune system, and in the tumour-host interaction.

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Stefaan Van Gool, MD, PhD
Medical Director
Praxis für Immunonkologie & Translationale Medizin
Tel: +49 221 420 39925
vangool@iozk.de
www.iozk.de
https://www.linkedin.com/in/stefaan-van-gool-1b7652b5/

Genomic instability and nuclear architecture in cancer

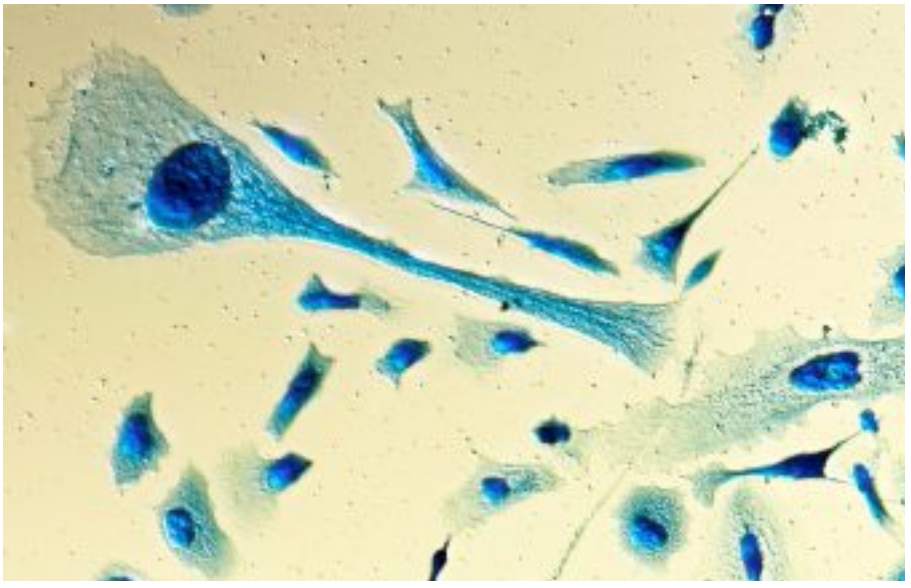
Sabine Mai and Aline Rangel-Pozzo, at the CancerCare Manitoba Research Institute and The University of Manitoba, Winnipeg, Canada, discuss genomic instability in relation to 3D spatial organization of telomeres

Genomic instability and cancer

Genomic instability is a hallmark of cancer. It drives the evolution of cancer cells having a genome that differs from that of normal cells. It enables the development of cell clones and cell-to-cell heterogeneity within the tumour and between the tumour and its metastatic site(s).

The presence of genomic instability in cancer was first reported by David von Hanseman (1858-1920). His work as a pathologist in Virchow's group in Berlin concluded that cells exhibiting genomic instability were not found in normal tissue but only in tumour tissues. His illustrations showed chromosomal instability, which included aberrant chromosome numbers (aneuploidy: gain or loss of chromosomes); and chromosomal mis-segregation between daughter cells.

The first mechanistic studies into genomic instability were performed by Theodor Boveri (1862-1915), whose work proposed that genomic instability led to the development of cancer and was not compatible with normal cell life. While he did not use the term 'genomic instability', his data clearly implicated it in this malignant process.



PC-3 human prostate cancer cells, stained with Coomassie blue, under differential interference contrast microscope.

Genomic instability is a dynamic process and continues to evolve with every cell division. Therefore, if samples are taken at an early time point of tumour development and at later stages, genetic changes will have occurred.

The three-dimensional (3D) space of the nucleus: spatial genome disorder in cancer

The nucleus harbours the genetic information. This information is not simply organized in a random manner but has a clear organization. In normal cells, chromosomes assume specific places within the 3D space of the nucleus. The spaces occupied by the chromosomes are called 'chromosome territories'. They have been conserved during evolution, and they are cell-type and differentiation-specific. This organization has functional importance; for example, animals with night vision have a chromosome organization in their rod cells that is distinct from the one found in animals with diurnal vision. Similarly, hepatocytes have a different arrangement of chromosome territories and chromosome neighbourhoods than lymphocytes.

The organization of chromosomes and of the genes they harbour is key to transcriptional regulation. Genes located near the periphery of the 3D nucleus are commonly repressed, while genes found in the centre of the nucleus are expressed.

Cancer cells have re-ordered the genetic information within the nuclear space and often change the position and orientation of chromosomes, which enables new transcription patterns. Cancer cells also change the way their DNA is packaged and increase the presence of interchromatin space. Moreover, when using telomeres, the ends of chromosomes, as structural markers for genome (in)stability, cancer cells, compared to normal cells, show very significant changes in their 3D organization.

3D telomere profiling in cancer

3D imaging of telomeres, developed and carried out at the Genomic Centre for Cancer Research and Diagnosis (GCCRD) at the University of Manitoba and CancerCare Manitoba (Winnipeg, Canada) enabled the fine-mapping of nuclear organization of the cancer cell genome. At nanoscale resolution, Dr. Mai's team and collaborators visualized and measured the structural organization of the cancer genome; telomeres were used as surrogate markers of genome organization and proved to play a role as structural biomarkers of genomic instability.

Multiple cancers were examined. 3D telomere profiling allowed the team to quantify the level of genomic instability, the risk to progression and/or the response to treatment. Examples include lymphoid (such as, Hodgkin's Lymphoma, Multiple myeloma, Chronic Myeloid Leukemia, Myelodysplastic Syndromes and Acute Myeloid Leukemia) and solid tumors (such as neuroblastoma, glioblastoma, thyroid cancer, and prostate cancer). The software developed by the team (TeloView® - currently proprietary to Telo Genomics Corp. Toronto, Canada) allowed for single cell profiling and informed about each patient's cancer.

As a result of these initial clinical studies, a biotech company, Telo Genomics Corp., was founded. Telo Genomics Corp. is located at the MaRS Discovery District in Toronto, ON, Canada (telodx.com). The company is dedicated to personalized medicine solutions in cancer, with a current focus on multiple myeloma.

An example of nuclear remodeling: nuclear remodelling and risk assessment in prostate cancer

Prostate cancer is the 2nd most common cancer in men globally, with 1.4 million new cases in 2020. Intermediate risk prostate cancer in men is often stable, but sometimes aggressive. No clear test predicts which patient is with either type of prostate cancer. Research done by the Mai team, in collaboration with the urologists Drs. Drachenberg and Saranchuk at CancerCare Manitoba (Winnipeg, Canada) has focused on circulating tumor cells (CTCs) isolated from the blood of the prostate cancer patients. Such isolates are called 'liquid biopsies', and these blood samples contain (CTCs) that originate from the tumor. Our analyses of 3D telomere profiling indicate that the genomic profile of CTCs in intermediate risk prostate cancer predicts stability or aggressiveness of disease better than the commonly used prostate specific antigen (PSA) or the Gleason score (Drachenberg et al., Cancers, 2019, Jun 20;11(6):855. doi: 10.3390/cancers11060855.PMID: 31226731). This study was funded by the Prostate Cancer Fight Foundation/Manitoba Ride for Dad.

Summary

The assessment of nuclear architecture enables the analysis of genomic instability in cancer. Structural biomarkers, such as the spatial arrangement of cancer genomes, are poised to become future tools in personal patient risk assessment.



Sabine Mai
Professor
University of Manitoba
Tel: +1 204 787 2135
sabine.mai@umanitoba.ca
https://www.chairs-chaires.gc.ca/chairholders-titulaires/profile-eng.aspx?profileId=4532



Understanding cancer research in the U.S.

Open Access Government lifts the lid on the priorities of the National Cancer Institute, when it comes to cancer research in the U.S

The National Cancer Institute (NCI), part of the National Institutes of Health (NIH), is a government agency concerned principally with cancer research in the U.S. NCI is one of 11 agencies from the Department of Health and Human Services (HHS). With a team of around 3,500, NCI describes how they show a deep commitment to their central values of: "equity, diversity, and inclusion that allow all staff to reach their potential and fully contribute to the Institute's cancer mission."

The NCI's mission is essentially to support, lead and conduct cancer research in the U.S. to not only progress scientific knowledge, but also to help individuals live healthy and long lives. [1] The National Clinical Trials Network (NCTN) and Cancer Grand Challenges are examples of how this bold mission is being achieved. Also, we find out about the aim of the Biden-Harris Administration to end cancer as we know it today.

NCTN: NCI's National Clinical Trials Network

NCI's NCTN consists of clinicians and organisations that support and coordinate cancer clinical trials at no less than 2,200 sites across North America and beyond. In essence, NCTN facilitates the infrastructure for NCI-funded treatment and primary advanced imaging trials that seek to better the lives of those with cancer. For example, the Imaging and Radiation Oncology Core Group (IROC) assist in ensuring and monitoring quality in trials to do with radiation therapy and/or new imaging modalities. [2] NCTN set up an Imaging and Radiation Oncology Core (IROC) Group that assist all NCTN groups that make use of these modalities in trials. [3]

Funding for cancer research in the U.S.

In recent news, we learn that the Cancer Grand Challenges program will fund $100 million to four interdisciplinary teams globally to solve some of the hardest cancer research challenges. Here, NCI is partnering with Cancer Research UK and as such, each team will get $25 million over a five-year period. In the words of the press release, "Cancer Grand Challenges aims to provide multiple rounds of funding for multidisciplinary research teams from around the world whose novel ideas have the greatest potential to advance cancer research and improve outcomes for people affected by cancer," sums up the high level of ambition demonstrated here.

The four selected teams are researching:
1) A muscle-wasting condition in patients with cancer (called cachexia).
2) Biology concerning extrachromosomal DNA in cancer.
3) New therapies for children with solid tumours.
4) Triggers for normal cells causing cancer-causing mutations to become tumour cells. (4)

"The partnership with Cancer Research UK (5) to develop the projects funded for the Cancer Grand Challenges program will enable a global collaboration on a disease that has touched everyone around the world," Douglas R. Lowy, M.D., Acting Director at the NCI comments. "We're confident these multidisciplinary teams of scientists – with the flexibility and scale to innovate and carry out cutting-edge research – will be able to address several critical cancer research problems that can advance the understanding of cancer and benefit patients," he adds.

Cancer: Looking ahead

We hope that the above examples and many more from the NCI will help toward the U.S. President's ambition to end cancer as we know it today. "We have an audacious but achievable goal to reduce the cancer death rate by at least half in 25 years and to improve the experience of all whose lives are impacted by cancer – working across government to develop and deploy additional ways to prevent, detect and treat cancer," says Danielle Carnival, PhD, White House Cancer Moonshot Coordinator.

Norman Sharpless recently stepped down as Director of the National Cancer Institute and knows that the passion and talent in NCI will continue across the cancer research community and, of course, the Biden-Harris Administration. This approach "will continue to fuel tremendous progress for people with cancer in the years ahead," Dr Sharpless explains.

"During my time in the federal government, I have been inspired by the ways that researchers, caregivers, advocates, and survivors have broken down silos to collaborate and embrace new ways of working together to solve some of the toughest problems in cancer. President Biden's continued commitment to the Cancer Moonshot℠ will foster even greater progress. The community stands ready to meet the President's call to end cancer as we know it," Dr Sharpless adds. (6)

To find out the latest news from the NCI, it's well worth a look through their comprehensive resource here about cancer research, such as the launch of a programme to offer molecular characterization of childhood cancers (7) or a study that advances personalised immunotherapy for metastatic breast cancer. (8)

Source

National Cancer Institute at the National Institutes of Health (NIH).

References

The links below were originally published by the National Cancer Institute, except (3) and (5).

(1) National Cancer Institute Overview and Mission (https://www.cancer.gov/about-nci/overview)
(2) NCTN: NCI's National Clinical Trials Network (https://www.cancer.gov/research/infrastructure/clinical-trials/nctn)
(3) IROC (https://www.irocqa.org/)
(4) Four multinational, interdisciplinary teams selected to address major challenges in cancer (https://www.cancer.gov/news-events/press-releases/2022/cancer-grand-challenges-funded-team)
(5) Inside Cancer Grand Challenges Part 1: what makes a grand challenge? (https://news.cancerresearchuk.org/2022/06/16/inside-cancer-grand-challenges-part-1-what-makes-a-grand-challenge/)
(6) Norman Sharpless steps down as director of the National Cancer Institute (https://www.cancer.gov/news-events/press-releases/2022/nci-director-norman-sharpless-steps-down)
(7) NCI launches program to offer molecular characterization of childhood cancers (https://www.cancer.gov/news-events/press-releases/2022/childhood-cancer-molecular-characterization-initiative)
(8) NCI study advances personalized immunotherapy for metastatic breast cancer (https://www.cancer.gov/news-events/press-releases/2022/personalized-immunotherapy-metastatic-breast-cancer)

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Imaging & radiation oncology core: Improving radiotherapy quality & care

The Imaging and Radiation Oncology Core is part of the U.S. National Cancer Institute's clinical trial program and provides quality assurance for trials with radiation oncology and/or imaging

Unfortunately, medical errors are known to be one of the leading causes of death. Sometimes these errors are glaring mistakes with dramatic and immediate consequences. These provide a clear link between an error and the consequence, and while difficult, this at least allows for the opportunity to understand the error and learn from it, helping prevent similar errors from happening in the future. However, not all situations have such a clear link, and not all situations that can harm the patient are strictly errors. There is a continuum between erroneous care and optimal care, and within this continuum is a large area of suboptimal care; where practice isn't where it should be, or at least could be. This suboptimal care may cause problems that manifest later and are less dramatic, making the link between the event and the consequences harder to identify. Nevertheless, such deficiencies may be very serious because they can affect large numbers of patients without being detected.

While the issue of medical quality has received increased attention in recent years, this topic remains understudied and under-resolved. This is in no small part because of the difficulties inherent to studying this topic. The ethical challenges inherent to studying low medical quality are front and centre – how does one allow a patient to receive suboptimal care? But other issues also complicate this question: if the effect of lower quality is a 5% reduction in survival, a large number of patients would be needed in a controlled setting to see this effect. And the quality deficiency would need to be known - if the quality of care is systematically inferior (e.g., a miscalibrated piece of equipment), there may be no readily available baseline to indicate what optimal outcomes should look like. Despite these complications, the issue of quality of care may be at the heart of why outcomes are better or worse at different facilities.



Exploring issues in medical quality

The field of radiation oncology provides an outstanding opportunity to explore the question of medical quality, and through that understanding, improve it and the underlying issues that more broadly affect medical quality. Radiation oncology outcomes are dependent on getting the right dose to the right place. And like any other branch of medicine, it is essential that the correct dose be given to get the desired effect. When patient outcomes have been reviewed in the clinical trial setting, it has been repeatedly shown that patients who received optimal

radiotherapy care have much better survival outcomes than those whose treatments have deficiencies. These data show that the risk of suboptimal quality is clearly affecting patients.

> "While the issue of medical quality has received increased attention in recent years, this topic remains understudied and under-resolved. This is in no small part because of the difficulties inherent to studying this topic. "

Radiation oncology is a uniquely quantitative branch of medicine. When trying to cure disease, it is generally held that the dose must be accurate within 5% to have the desired outcome. Through high precision measurements, it is possible to measure the radiation dose delivered (in a patient surrogate if not in the actual patient) as accurately as within 2%. Given that radiation doses can be measured within 2%, it would be expected that all treatments should fall within the desired 5% accuracy. However, this does not seem to be the case.

The Imaging and Radiation Oncology Core (IROC) is the largest radiotherapy and imaging quality assurance centre in the world and supports clinical trials from the US's National Cancer Institute. One tool used by IROC to evaluate the performance capability of institutions wishing to participate in clinical trials is to provide them with a plastic dummy-patient loaded with radiation detectors. This pseudo-patient is mailed to an institution who treats it like a real patient, developing and delivering a treatment. The plastic patient is returned to the Imaging and Radiation Oncology Core and the delivered dose is compared to the intended dose. IROC performs approximately 700 of these plastic patient tests every year at institutions all over the world and has tested several thousand radiotherapy clinics. Unfortunately, while all institutions should be able to deliver the dose within 5%, the result is that more than 30% of institutions fail to do so. In fact, 10-20% of institutions fail to deliver the dose even within 7%.

Large and frequent deficiencies

It is worth noting that the institutions internally evaluate these radiotherapy treatments before delivery. That is, each radiotherapy treatment has been tested and the institution believed they were delivering a highly accurate dose of radiation. It was only upon independent review of their delivery that the deficiency was identified. The fact that such large and frequent deficiencies are observed is not only concerning for the patient but highlights broad problems in radiotherapy dose delivery evaluation.

There are a host of reasons why these errors may be manifesting in current radiotherapy practice. One factor is that technology changes rapidly in radiation oncology to allow for the most conformal radiation dose to be delivered to the tumour. However, this means that new techniques and technology are constantly implemented, introducing an opportunity for suboptimal implementation. Also, while radiation doses can be measured within 2%, many measurement techniques do not achieve this accuracy, highlighting a disconnect between what is expected and what is achieved. This highlights a major and systemic deficiency in the quality of radiotherapy delivery. It is known that lower quality radiotherapy leads to poorer patient outcomes, and a shockingly large percent (up to 30%) of institutions are delivering lower quality than expected and desired. This poses a critical risk to radiotherapy patients that requires more attention to better understand and address.

Reducing medical errors across branches of medicine

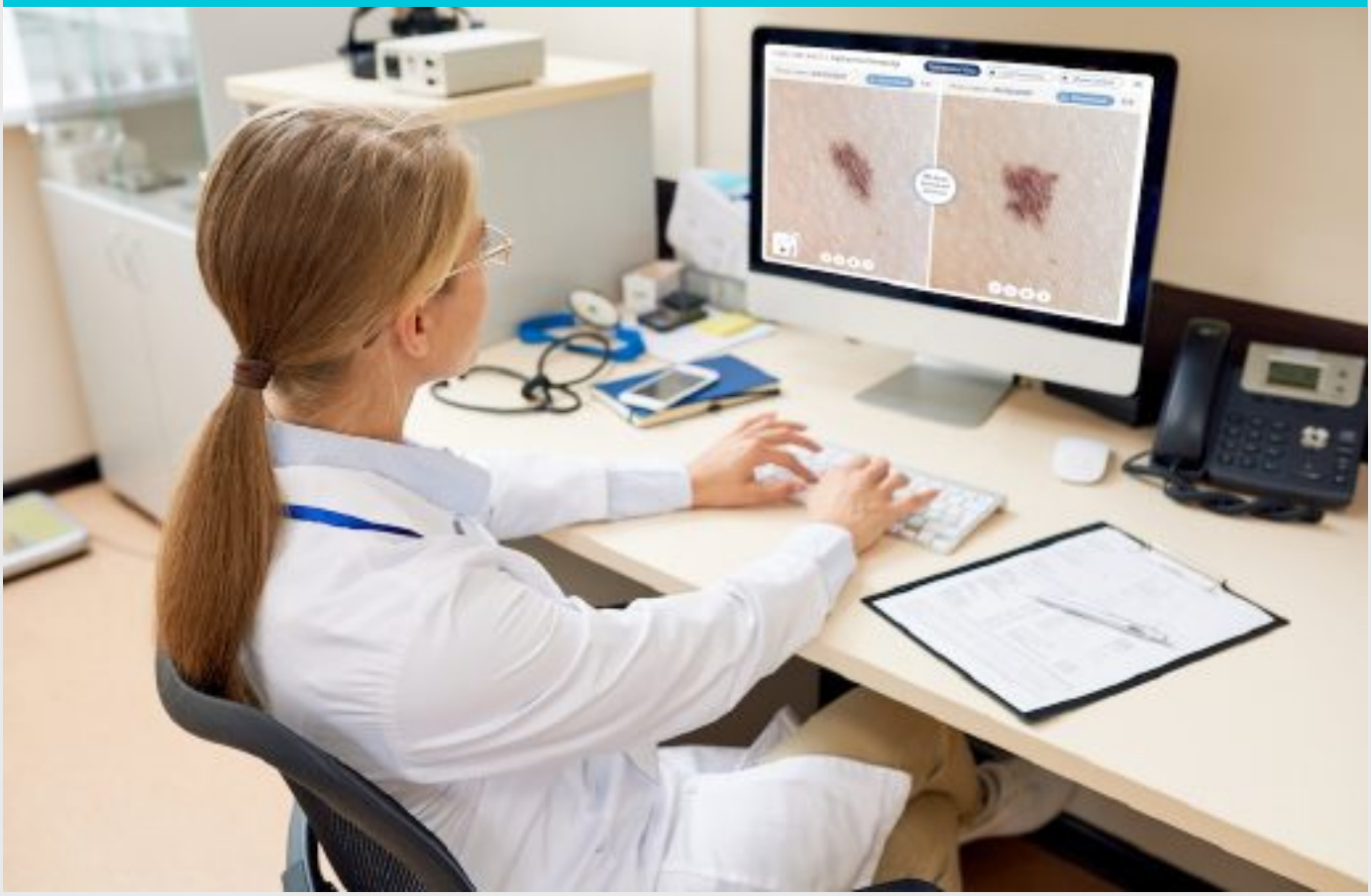
More broadly, while there are unique aspects to radiation oncology, it is hard to imagine that these deficiencies don't also exist in other branches of medicine. The example of radiation oncology should serve as a call to arms of medical practice in general. Addressing isolated major and glaring medical errors is a critical step, but it is not a sufficient step. The quality of the practice of medical care must also be evaluated and maximised. This must include independent peer review, where a subject matter expert can evaluate the quality of the work performance and provide guidance to improve it when appropriate.

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Stephen F. Kry, PhD
Associate Professor / Director
Imaging and Radiation Oncology Core
Tel: +1 713 745 8989
sfkry@mdanderson.org
http://irochouston.mdanderson.org/

A digital focus in the fight against skin cancer mortality

Jon Friis, Founder and CEO at Miiskin,
states the case for a digital focus in the fight against skin cancer mortality



Skin cancer impacts the lives of millions worldwide, with healthcare services and charities stressing the importance of routinely checking for warning signs.

It is emphasised by dermatologists that, if caught early, most skin cancers can be treated successfully – yet we are still seeing concerning numbers of deaths from the disease.

In the UK alone, official figures show more than 140,000 annual incidences of skin cancer and 15,000 of these are melanoma, the most dangerous form. Despite public health campaigns about the risks of skin damage, deaths from skin cancer continue. The UK recorded more than 2,600 skin cancer mortalities in the latest annual statistics from 2019[1].

While we are yet to see the full picture of data since the pandemic, healthcare systems are working hard to reduce skin cancer mortality rates and support people who had not previously come forward to get symptoms checked.

From a skin cancer perspective, there is a job to be done to remind people of the importance of being aware of changes to their own skin. Tech can play a

significant role here – to encourage regular skin self-examinations and for those who spot worrying changes to seek medical advice.

Self-examination of the skin

Individuals are often the first to notice a change to their own skin, but if the warning signs are not on a person's radar, early skin cancer signals could be overlooked.

Regular self-examinations are therefore important for early detection – including changes to existing moles, as well as new marks and moles on the skin. It is reported that seven in ten melanoma cases in adults appear as a new mark or mole on the body, rather than being associated with existing mole[2].

However, new research commissioned by Miiskin in May 2022 showed that a third (36%) of UK adults never check their skin for signs of skin cancer, despite 29 per cent doing so at least once a month[3].

The challenge is twofold. Some are not aware of the importance of checking their skin, while others find the process of checking their own skin difficult. When I was first told by a doctor seven years ago that best practice for tracking changes at the time was to use pen and paper, I thought there must be a way for technology to help.

Role of consumer tech in reducing skin cancer mortality rates

Independent research shows that one in five (22%) people in the UK take photos of moles on their body to track for changes[3] – and an estimated 300 million potentially life-saving snapshots are being taken a year, in the UK alone.

It is a similar story in other countries too, with smartphones providing access to an easy way to track changes to skin over time. This correlates with technology developments over recent years and the growth in apps designed for dermatology purposes.

Consumer tech can be a powerful tool if used in the right way. It can deliver the important reminder to check but also the tools to make the job simpler and digitally document changes.

Machine learning, computer vision and augmented reality are helping to bring technology to smartphones that was not previously openly available for patients – which can help them spot changes such as to the size of a mole, its appearance and how it is evolving, as well as identifying new lesions on the body. But it is crucial that tech supports clinical expertise, rather than seeking to replace it.

The pandemic has seen consumer tech taking a more prominent role in virtual collaboration between patients and their doctors or dermatology specialists too, following a rapid switch to virtual consultations. It is a trend that is continuing.

Digitally raising awareness

On a more basic level, consumer tech can provide that crucial regular reminder to check the skin and a means to capture high-quality images. While apps should never replace medical guidance, they can help deliver a potentially lifesaving message.

At a time when skin cancer is one of the most common cancers, we need to emphasise the message and continue to refine the digital tools available to support patients around the world and eventually lower skin cancer mortality rates.

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Jon Friis
Founder and CEO
Miiskin
contact@miiskin.com
https://miiskin.com/
https://twitter.com/miiskinapp

Part 3: Scientific sunburn & skin cancer

Chanda Siddoo-Atwal, President and Primary Biochemist of Moondust Cosmetics Ltd. continues her discussion on sunburn & skin cancer science

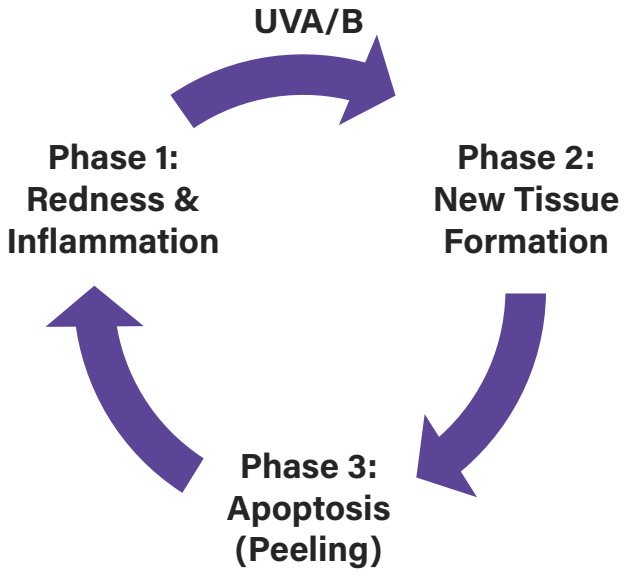
Looking at the role of resveratrol & phytochemicals in skin cancer chemoprevention/therapy (an excerpt from a chapter in "Comprehensive Clinical Oncology", 2nd/3rd editions), Siddoo-Atwal comments further on sunburn & skin cancer science.

Resveratrol belongs to a class of phytochemical compounds known as polyphenols. Specifically, it is a phytoalexin that is found in many edible plants including grape skins, hops, peanuts, pines, and numerous berries (blackberries, black currants, blueberries, mulberries, and cranberries) [1].

Although natural products have been used to treat chronic diseases including cancer since ancient times, there is current interest in the use of natural compounds as chemopreventive and therapeutic agents for human populations since there are many unpleasant side-effects associated with cancer chemotherapy and radiation therapy.

In addition to resveratrol, some other prime phytochemical candidates include procyanidins derived from grape seeds, which induce apoptosis (programmed cell death) in human prostate carcinoma cells. A polyphenol derived from green tea, particularly, epigallocatchin-3-gallate (EGCG), applied topically or taken orally in tea displays an inhibitory effect on skin carcinogenesis via the selective stimulation of

Diagram 1. The Human Sunburn Cycle



**Apoptosis is Programmed Cell Death - continuous apoptotic activation in a specific area in response to a carcinogen like UV light can cause skin cancer; sunscreen that prevents apoptotic sunburn can stop this cycle [3]*

apoptotic activity in UV-induced mouse skin tumours and precancerous lesions, respectively. Lastly, Chinese bee propolis, has anti-proliferative activity in colon cancer cells [2].

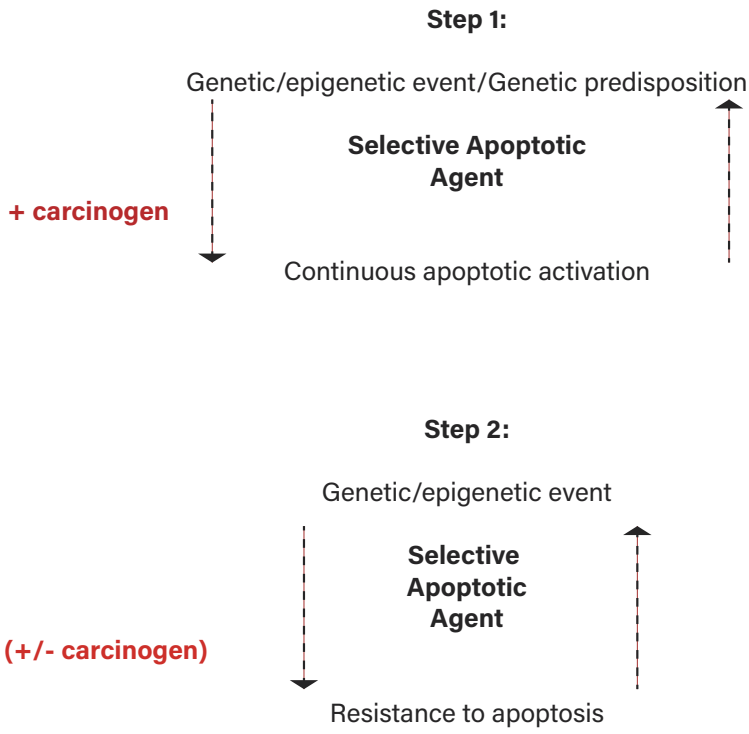
Preneoplastic lesions in sunburn & skin cancer

The first successful pre-clinical study with resveratrol was reported in a two-stage mouse carcinogenesis model utilizing 7,12 - dimethylbenza[a]anthracene [DMBA] as the initiator and 12-O-tetradecanoyl-13-acetate [TPA] as the promoter. Resveratrol inhibited tumorigenesis in this mouse skin cancer model and it also prevented the development of preneoplastic lesions in carcinogen-treated mouse mammary glands in cell culture.

Other similar studies followed confirming that topical resveratrol treatment reduced tumour incidence, multiplicity, and volume while delaying the onset of tumorigenesis. One of the most notable set of studies was conducted in SKH-1 hairless mice, which are susceptible to ultraviolet radiation-induced skin cancer via a similar mechanism to those specific humans who experience apoptotic sunburn or "scientific sunburn".

Ultraviolet radiation (UV) is a complete carcinogen in this particular mouse model and DNA damage such as double-strand breaks caused by the radiation directly stimulates cell death. It is the repeated activation of these apoptotic mechanisms in skin

Diagram 2. Two Stage Model of Tumour Formation and Action of Selective Apoptotic Agent [4]



cells by ultraviolet rays that appears to be directly linked to tumour formation in this model. It has been demonstrated that resveratrol protects against UVB exposure-mediated skin carcinogenesis in SKH-1 hairless mice by selectively inducing apoptosis in premalignant and malignant cells.

Naturally, it cannot always be assumed that test results obtained in animals will hold true in humans due to significant differences in some biochemical pathways. Resveratrol has already been shown to display selective apoptotic properties inducing programmed cell death in pre-cancer and cancer cells in a mouse skin carcinogenesis model. Similarly, a comparable cancer model in humans involving susceptibility to apoptotic sunburn [Diagram 1] can result in abnormal growth or "tumour" formation and/or skin cancer without proper sunscreen protection, as previously described.

Resveratrol ointment and its benefits

In a case-study, following daily topical application of a resveratrol ointment {50 mg/ml} in an aloe base, considerable regression of a growth induced by UVA/UVB radiation was observed within 10 days. Moreover, with the diligent application of a zinc oxide sunscreen formulation previously reported to block UV-induced apoptosis, there was complete remission and there has been no recurrence of the lesion since.

These results taken together with laboratory studies on animals are suggestive that tumour formation requires at least two discrete events to take place in response to a carcinogen. The first involves an elevation of apoptosis in a particular tissue due to a genetic predisposition, stress, or mutation.

The second confers resistance to apoptosis in that same tissue resulting in the formation of an abnormal growth due to a dysregulation of cell number homeostasis. In addition, this case-study suggests that both these events can be reversible when treated with a selective apoptotic agent like resveratrol and, hence, they may be either genetic or epigenetic in nature [Diagram 2].

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Part 1 Part 2

Chanda Siddoo-Atwal
BSc University College London
PhD Simon Fraser University
Post-Doctoral Fellow Medical College Wisconsin
President and Primary Biochemist of
Moondust Cosmetics Ltd.
West Vancouver, Canada
Tel: +1 604 926 9800
info@moondustcosmetics.com
www.moondustcosmetics.com
https://twitter.com/moondustsuncare
www.facebook.com/DrMoondust
www.instagram.com/moondust_cosmetics/



Beating lung cancer with the AI edge

Prashant Warier, CEO and Founder, Qure.ai, explains beating lung cancer with the AI edge

10 million. That's the number of people who lost their lives to cancer in 2020, making it the leading cause of death worldwide. Of this, 1.8 million fatalities were caused by lung cancer, making it the leading cause of cancer-related deaths and the second most common form of the disease overall. And the future makes for grim reading – Lung cancer incidents are projected to rise by 38%, and mortality is projected to increase by 39% by 2030.

70% of lung cancer diagnoses are late-stage

Research from Europe suggests that almost 70% of lung cancer diagnoses are late-stage – the main reason behind low survival rates. Although five-year survival rates have improved recently in the United Kingdom, they remain low, with approximately 30% of patients dying within 90 days after diagnosis. The importance of early diagnosis can be gauged from the fact that the five-year survival rate for those diagnosed in the early stages is 57% vis-à-vis 3% when made in the later stages.

It is evident that accurately and rapidly identifying physiological signs indicative of lung cancer can significantly impact treatment and survival. In this regard, artificial intelligence (AI) can be used to augment the expertise of physicians and impact the cancer care pathway, especially the identification of signs of lung cancer. However, if we pause and take a more macroscopic view of the overall cancer landscape, technology and machine learning can also contribute to drug treatment, chemo & radiotherapy, and management.



Prashant Warier

Deep learning tools can change the future of treatment

Deep learning tools have been created and trained to be capable of mining for specific characteristics from

vast data sets. It is also possible for these tools to identify information in images that are beyond the scope of the ordinary human eye. These features and abilities of AI have enormous implications for lung cancer diagnosis based on images – from being able to examine chest X-rays rapidly and CT scans to triage cases for follow-ups with physicians.

AI also has a role to play in the development of drugs to treat cancer and predict the sensitivity of the drug. Depending on the type of cancer and the stage at which it is being treated, the same anti-cancer drug could have different reactions. Machine learning models have also successfully predicted the sensitivity of patients to anti-cancer drugs as well as resistance to certain types of drugs. And that's not all. AI can learn and analyse data related to drug-resistant cancers to highlight how cancer cells develop resistance to drugs and implications for development and use.

The three ways that AI can be used in cancer care

When it comes to chemotherapy for cancer, AI can be used in three distinct aspects: managing drug use, predicting the body's tolerance to chemotherapy drugs, and optimising the treatment schedule. In addition, studies have shown that AI can optimise the combined chemotherapy process – that is, rapidly assessing the ideal drug dosage to ensure that the treatment regimen is effective.

AI can also assist radiologists in accurately planning targeted radiotherapy and scheduling radiation treatment regimens. In combination with automation, deep learning technology has helped considerably reduce the time taken to map out radiation treatment calendars and suggested therapy plans that are comparable to those developed by human experts.

Deep learning technology can assist physicians across the clinical decision support system in making more accurate choices on managing cancer, suggesting apt treatment plans, and reducing the chances of both overtreatment and superfluous surgical options.

Beating lung cancer via Artificial Intelligence

Perhaps one of the most critical areas for AI to contribute is developing anti-cancer drugs. The average drug takes anywhere between six to 12 years to develop from discovery to approval. Effective new drugs prolong survival rates. Research also suggests that improving new drug development efficacy impacts patient lives. Developing new drugs leads to enormous volumes of data being generated, and AI tools can be taught to read and process data, reverse-engineer molecule synthesis pathways, help accelerate drug discovery, and make knowledgeable decisions.

AI is primed to make significant contributions to cancer-related medicine, treatment, and management. When it comes to cancer, the earlier it is identified, the better. So, the fact that AI solutions are already making a mark in identifying signs of the disease is a tremendous step forward. Technology can also help fast-track the discovery of new drug materials and development. However, AI must receive support to ensure that it continues to augment the role of physicians and scientists and drive significant cross-domain evolution in healthcare.

AI-driven diagnostic software

When it comes to what AI can do for Breast Cancer Screening, a study run by King's College London is evaluating an AI-driven diagnostic software. Professor Sarah Pinder, lead specialist breast pathologist at Guy's and St Thomas', said: "This has the potential to improve the accuracy and the speed of assessment, with benefits both to the NHS and to patients."
Paige Lymph Node, created by a digital diagnostics software company, is an AI software system that can actually help pathologists to decide whether breast cancer has spread to the lymphatic system.

Healthcare experts believe this technology can change the future.

https://www.guysandstthomasbrc.nihr.ac.uk/2022/02/01/ai-technology-investigated-for-breast-cancer-diagnosis/

Prashant Warier
CEO and Founder
Qure.ai
partner@qure.ai
https://qure.ai/
https://twitter.com/qure_ai

Using Artificial Intelligence to diagnose 'Glue Ear' in Children

Glue ear is a common cause of hearing impairment and disability amongst children. AI can improve accuracy of diagnosis and cut down annual NHS costs.

Otitis Media with Effusion (OME), commonly known as "Glue Ear" is one of the most common causes of childhood hearing impairment and disability. It is estimated that more than 80% of children will have an episode of otitis media before the age of 10. This high prevalence places a significant cost burden on the NHS with approximately 200,000 children with glue ear seen annually in primary care (Williamson et al., 2006).



Image: © John Wollwerth | Dreamstime.com

Glue ear is one of the biggest challenges for non-ENT/Audiology professionals

The lack of clear infectious symptoms (e.g., earache or fever) and difficulties in assessing the hearing status of young children (particularly as there are no audiology specific diagnostic facilities in the primary care setting), result in only 50% of glue ear cases being correctly diagnosed by paediatricians, in comparison to 73% by otolaryngologists (Pichichero and Poole, 2001). Poor diagnostic accuracy leads to delayed diagnosis and inappropriate intervention decisions, such as re-assurance without appropriate treatment, or referral to ENT unnecessarily by GPs. Consequently, OME is one of the biggest challenges for ENT specialists according to the ENT Elective Care Handbook (2019).

Watchful waiting is an option recommended in the NICE guidelines for the initial clinical management of OME (NICE, 2021). However, limited diagnostic information, particularly in children unable or unwilling to cooperate with tests can leave parents unclear as to the problems caused by OME and can cause them to have unrealistic expectations or even anxiety. Indeed, many parents are upset when told to wait for 3 months (in line with NICE guidance) before any intervention can be considered. Furthermore, delayed diagnosis and poor management can result in severe and persistent OME with surgical treatment becoming the only management option, leading to long waiting times and excessively high costs for the NHS.

AI tools can diagnose OME with an accuracy of 95%

The field of Artificial Intelligence (AI) is rapidly evolving and has already been used to support and improve health services in many areas. A number of studies have shown, for example, that AI provides an effective tool to classify pathological conditions from medical images, which can then support diagnosis and management. AI applications to the field of ENT and Audiology have provided automated tools for the diagnosis of middle ear disorders by analysing clinical data, e.g., otoscopic images and computed tomography scans. Consequently, implementation of AI tools presents

possibilities for use in hearing healthcare services as a clinical decision support system.

Clinical decision support (CDS) systems are designed to assist clinicians in their diagnostic decision-making by using the individual patient's data to arrive at a patient-specific diagnosis or recommended intervention. Our recent research into AI has made great progress in demonstrating its potential for the accurate diagnosis of OME (Grais et al., 2021). This novel research measures energy absorbance of the middle ear at varying frequencies and pressures in normal ears and ears with OME. With this information the AI tools will provide an accurate automated diagnosis which can support the clinician in their decision-making process.

Our results prove the capability of AI tools to diagnose OME automatically with an accuracy of 95%. Implementing the AI-CDS for automated diagnosis in children with OME has the potential to drive evidence-based standardisation of childhood OME diagnosis to improve care delivery and patient outcomes. This work will have significant and direct impact on clinical assessment and diagnostic concepts for OME in professional communities, and thus NICE guidelines for OME treatment.

AI has the potential to improve efficiency and cut down costs

Furthermore, the important research outputs indicate that AI has great potential for the development of a quick, accurate, non-specialist diagnostic tool for the identification and management of childhood OME in the primary care setting and community clinics. As a result, it will provide long-term benefits to the wellbeing of children with glue ear and their families. In the meantime, the accurate, timely, efficient, equitable and patient-centred delivery will improve the capacity of ENT and Audiology services, so that they can provide more efficient and cost-effective services and avoid 'unnecessary' referrals. This will also cut down the waiting times for children with OME, and consequently provide economic benefits in terms of reducing service delivery cost.

Overall, the future development of low-cost AI-CDS for automated diagnosis of OME provides solutions to a number of challenges, including the shortage of specialist training and unaffordable equipment. It thereby establishes a cost-effective and sustainable hearing healthcare service model, which could be used globally, particularly in Low-and Middle-Income Countries (LMICs).

Author and funding

Dr Fei Zhao, Reader in Hearing Science, Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University. He has been awarded an Artificial Intelligence in Health and Care Award, through the National Institute for Health Research (NIHR). Dr Zhao also won Global Academies and Santandar 2021 Fellowship Award. This funding enables Dr Zhao to collaborate with a world-leading scholar in this field, Professor De Wet Swanpoel from the University of Pretoria in South Africa. Professor Swanpoel also serves as the scientific advisor of an award winning digital health company, the HearX Group, which specialises in mobile health solutions for ear and hearing care. Further development and implementation of effective and non-specialist AI tools will improve accessibility and quality of global hearing healthcare for children living with hearing impairment.

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Fei Zhao
Reader in Hearing Science
Cardiff Metropolitan University
Tel: +44 (0)29 2041 7290
fzhao@cardiffmet.ac.uk
https://www.cardiffmet.ac.uk/health/staff/Pages/Dr-Fei-Zhao.aspx

The impact of new minimally invasive lung cancer diagnosis and treatment

Elize Sturkenboom – van de Wetering, Venture Leader of Lung Oncology at Phillips Healthcare, discusses the diagnosis and treatment of lung cancer through new minimally invasive therapy

Lung cancer kills around 1.8 million people in a year worldwide. It is the leading cause of cancer death globally[1], accounting for greater loss of life than breast, colon, and prostate cancer combined. While early diagnosis and treatment are critical to better outcomes and quality of life, the majority of lung cancers are currently diagnosed too late, with minimal chance of a surgical cure. Only 21% of all people diagnosed with lung cancer will survive 5 years or more. When lung cancer patients are diagnosed early and treated immediately, a patient's chance of survival at 10 years jumps to 92%[2].

New hope on the horizon for lung cancer screening

Changes in healthcare policies and government involvement have increased lung cancer screening. The implementation of lung cancer screening programs with low-dose CT scans are driving a shift resulting into a more patients with curable lesions.

> "These days, even barely visible nodules of just 8mm can be diagnosed and treated through new minimally invasive techniques."

This comes with its own challenges. Small peripheral nodules are typically more complex to reach and localize during biopsy and surgery. The good news is that more and more physicians are adopting new techniques to diagnose and later treat these tiny lesions that are so difficult to catch.

The impact of new image guidance technology on early diagnosis and treatment

More and more accurate and less invasive methods are being introduced and adopted in clinical practice and have started a new era. These days, even barely visible nodules of just 8mm can be diagnosed and treated through new minimally invasive techniques. Advanced imaging integrated into operating rooms and bronchoscopy suites can be combined with navigation bronchoscopy to achieve high precision diagnosis and fulfill the need to combine diagnosis and staging with minimally invasive therapy in one room.

"Cone-beam CT is the critical step towards targeting sub-20 mm nodules and an essential tool for the transition towards bronchoscopic microwave ablation of peripheral lung lesions," said Professor Shah Pallav, MD., consultant respiratory physician at Royal Brompton Hospital in London, UK.

Diagnosis of small peripheral lung lesions

Recently, Radboud university medical center (Radboudumc), a leading Dutch academic research and teaching hospital (Nijmegen, the Netherlands), have announced the positive results of a clinical study aimed at setting a new standard of safety and accuracy in the diagnosis of small peripheral lung lesions. The study has set a new milestone with 90% diagnostic accuracy of lung nodules suspicious of cancer using Philips Lung Suite technology combined with the company's Image Guided Therapy System – Azurion for bronchoscopy procedures

Philips' solution uses real-time 3D imaging with augmented fluoroscopy to support high precision diagnosis and minimally-invasive therapy in one room. The results of the study were published in the October 2021 issue of the Journal of Bronchology & Interventional Pulmonology: Volume 28 - Issue 4.

Bronchoscopy procedure performed with Philips advanced imaging.

This Philips' platform also offers the promising outlook to not only diagnose but immediately treat these lung cancer patients using novel procedures such as tumor ablation.

Dr. Kelvin Lau, consultant and lead thoracic surgeon at St Bartholomew's Hospital, London, successfully diagnosed and treated lung cancer



patients using cone beam CT for biopsy, bronchoscopic microwave ablation, all in one procedure, during initial clinical trial.

Advanced imaging with Philips Lung suite is used during procedures for real-time 3D image guidance and confirmation. Additional clinical trials at various hospitals are expected to start soon.

All-in-one lung cancer diagnosis and treatment

Philips Lung Suite enables all-in-one lung cancer diagnosis and treatment. It provides advanced real-time 3D imaging with augmented fluoroscopy on the company's Image Guided Therapy System – Azurion, combined with dedicated software. With Philips' Cone Beam CT imaging, the X-ray detector rotates around the patient to generate a CT-like image in around 5 seconds, providing clinicians with a high-resolution 3D view of the target lesion and other anatomical structures. This allows the clinician performing the biopsy procedure to be continually guided by high-quality real-time imaging to advance a catheter towards the lesion through a bronchoscope. Once done, its position can be confirmed in real-time using the same imaging modality and a biopsy sample removed.

Philips has a comprehensive portfolio of lung cancer diagnosis and treatment solutions. In addition to Philips Lung Suite, the company's Lung Cancer Orchestrator provides an integrated lung cancer patient management system for both CT lung screening programs and incidental pulmonary findings programs that manages and monitors patients every step of the way in their lung cancer screening and treatment decision journey.

Several centers around the globe have implemented this cutting-edge technology and innovating the procedure with the aim to shorten the patient pathway, improve first time right diagnosis and reduce the overall cost of care.

"Philips aspires to transform lung cancer from a deadly disease to a managed condition, by leaving no patient behind with early-stage lung cancer. Philips was there when cardiac surgery transformed into coronary stenting, and are here right now to drive that change for lung cancer patients." tells Elize Sturkenboom, Venture Leader IGT Lung Oncology.

The knowledge and the technology are now available to diagnose and treat lung cancer earlier, more accurately and less invasively than ever. It's now time to move the needle and make a difference.

[1] https://www.who.int/news-room/fact-sheets/detail/cancer

[2] https://www.cancer.org/cancer/lung-cancer/detection-diagnosis-staging/survival-rates.html

PHILIPS

Elize Sturkenboom – van de Wetering
Venture Leader Lung Oncology Philips IGT
Philips Healthcare
Tel: +31 652 627 111
elize.sturkenboom@philips.com
Lung suite | Image-guided therapy | Philips Healthcare



Using AI to Deliver High Quality, Personalized Breast Cancer Screening

Ralph Highnam, PhD, Chief Science & Innovation Officer at Volpara Health, looks at the future of breast cancer screening and the use of AI

Breast cancer screening saves lives, but groups around the world are evaluating ways to personalize screening based on each woman's breast density and on her risk of developing breast cancer. This includes the PROCAS project in Manchester UK, which is researching the impact of adjusting screening intervals based on breast density and other risk factors; and the BRAID Trial in Cambridge UK looking at which imaging technologies to use for each woman, based on her breast density.

Artificial Intelligence (AI) is being used regularly in breast imaging to ensure high image quality, improved cancer detection and accurate determination of breast density. To optimize the delivery of high quality, personalized screening, we must also consider the IT infrastructure required to support the expanded use of AI.

Evolving Role of AI in Breast Imaging

AI simply means programming a machine to simulate human intelligence. The history of AI in breast imaging dates back to the first paper on computer aided detection and the feasibility of automated reading of mammograms, which was published in 1967. In 1976, Wolfe first researched the relationship between tissue patterns captured in a mammogram and the risk of developing breast cancer.[1] Boyd and Yaffe then applied AI in the form of computer-vision to make breast density a more quantitative assessment.[2]

Volpara Health's approach to AI for breast imaging is a blend of medical physics, computer vision and deep learning that we use to take subjective decisions and make them objective. We focus on areas where AI can be used to improve patient care while increasing productivity and quality. We also focus on where users typically struggle, such as repetitive quantification including image quality analytics, automated breast density assessment and evidence-based risk assessment.

Breast Cancer Risk, Breast Density and Screening

The European Society of Breast Imaging recently published new guidelines recommending that all women in Europe should be told their breast density and those at the higher density be offered breast MRI every 2-4 years. Those guidelines were based on results of several large trials such as DENSE Trial, which showed that screening women with extremely dense breasts using MRI in addition to mammography dramatically reduced the number of interval cancers.

Volpara was heavily involved in the DENSE Trial with our objective, quantitative, AI-based TruDensity™ scoring system, which automatically assesses breast density on a continuous scale. Its accuracy has been validated by many independent studies, showing high correlation to breast MRI, which is considered the source of ground truth in breast density. Because TruDensity is quantitative and continuous rather than grouped into broad

categories, screening programs can flex how they personalize screening according to resources.

In the US, the American College of Radiology and Society of Breast Imaging recently joined other cancer and women's health professional societies in recommending women have a breast cancer risk assessment at age 30, prior to the typical beginning of mammography.[3] This early risk assessment is an important step that can help identify women who may benefit from genetic testing or earlier screening.

The next critical piece in understanding the woman's risk comes with the woman's first mammogram, which provides an important baseline breast density measure and thus, the opportunity to compute a revised risk assessment. High breast density has been found to increase the risk of developing breast cancer and reduce the benefit of mammography by masking, or hiding cancers. The incorporation of breast density in the Tyrer-Cuzick breast cancer risk model provides a more comprehensive risk assessment.[4]

Breaking Down Barriers to Access Personalized Screening

The goal of personalized screening is to identify breast cancers early when treatment is most effective. This is very difficult for providers in traditional clinics who lack the IT infrastructure and AI tools to make it all work efficiently.

Fortunately, modern electronic health record systems and breast patient management systems are integrated with AI and clinical decision support tools to help identify how to navigate



Ralph Highnam

different patient pathways. Developing a personalized breast care plan for each woman based on her specific risk factors – including breast density – means that we can better balance the costs and benefits of screening and healthcare resources, especially for those women at the highest risk and whom we know are underserved by routine care.

Volpara Risk Pathways™ software enables clinicians to identify, manage and track high-risk patients who may benefit from intervention. This market-leading software, which is currently used to perform more than 2 million risk assessments every year in the US, helps clinicians confidently make informed decisions for triaging patients to supplemental imaging and/or genetic testing based on their individual risk profile.

For example, women in the US with a lifetime risk greater than 20% are recommended for mammography and MRI screening. For women with dense breasts but with lower risk, screening may include mammography and breast ultrasound. For women who do not have dense breasts and are at low risk of developing breast cancer, mammography continues to be the gold standard in screening.

Taking Action on Personalized Breast Cancer Screening

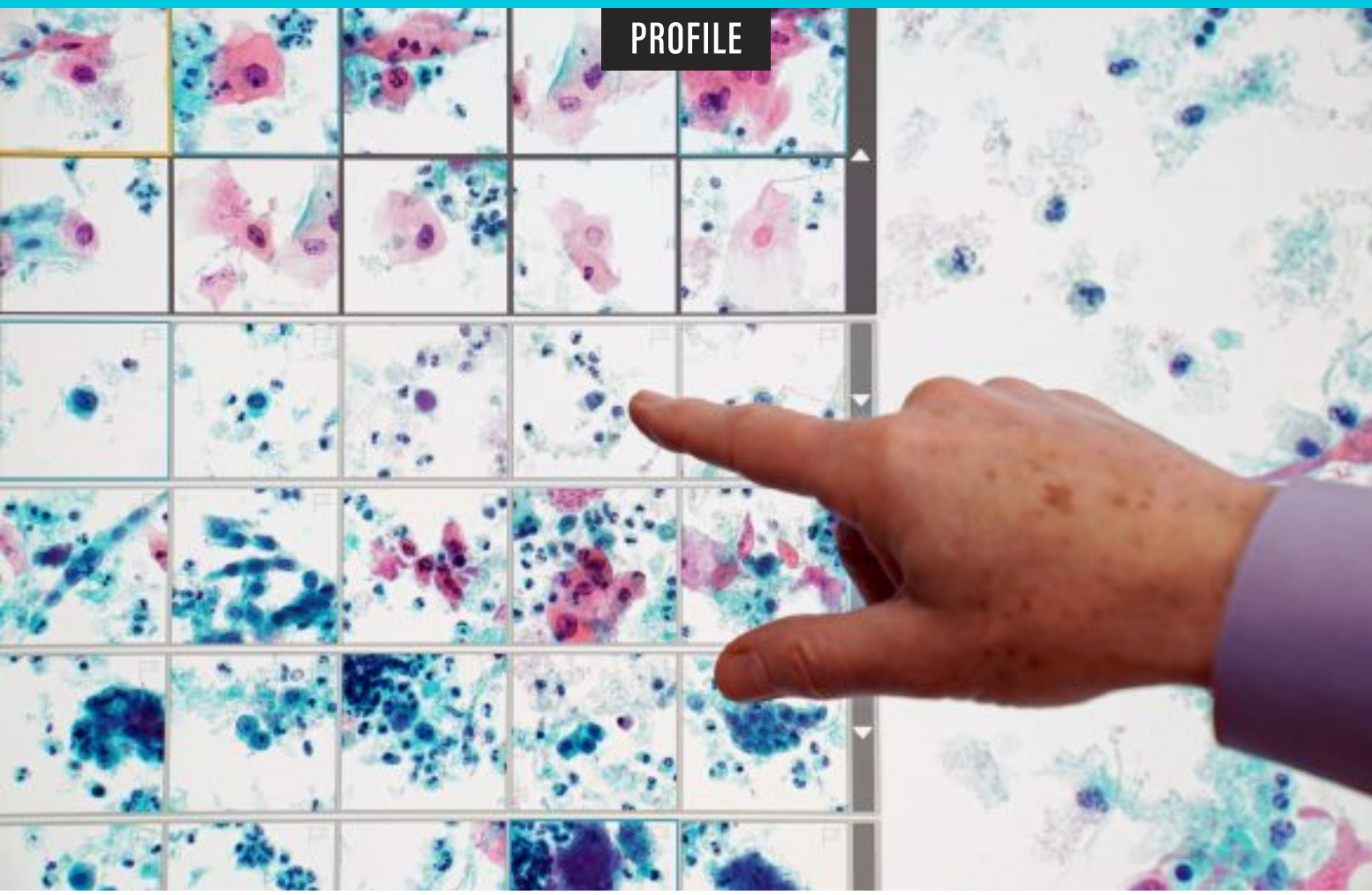
AI is already being used around the world to help deliver high quality screening including accurate breast density measurements and thus more accurate breast cancer risk estimates, and women are being recommended additional imaging or even genetics testing, based on those measurements.

As we continue to advance personalized breast cancer screening strategies, we will need smooth IT workflows and AI to help provide objective decision making and provide more content to explain to the clinicians and patients why certain pathways are being followed. These strategies hold promise to be able to direct women at all risk levels to a screening or prevention path based on their personal risk factors.

** References available upon request.*

Volpara HEALTH

MaryAnne Molter
Director, Clinical and Consumer Marketing
Volpara Health
Tel: +1 414 339 9900
maryanne.molter@volparahealth.com
volparahealth.com
https://twitter.com/Volpara



Digital cytology and the future of cervical cancer screening

Cervical cancer is a disease affecting thousands of women in the UK with around 3,200 new cases diagnosed every year[1], can developments in cervical screening and digital cytology help?

There have been notable developments in recent years, with the introduction of the Human Papilloma Virus (HPV) vaccine and the switch to HPV primary screening programmes across England, Scotland and Wales.

While screening plays a key role in ensuring early and accurate diagnosis, we know that more can be done to ensure women take up their invitation. Earlier this year the Government launched a campaign to drive screening attendance as new data showed nearly 1 in 3 do not take up the offer of cervical screening. Of those surveyed, many cited embarrassment or nerves as the reason.[2]

Raising awareness of the importance of screening and busting myths is important, but we must also ensure the screening process is efficient and accurate to boost women's trust in the system and results.

Introducing digital cytology

Cervical cancer screening is crucial in the fight against the disease and an exciting development in screening technology could hold the key to ensuring less women go on to develop cervical cancer, not just in the UK but around the world.

At Hologic, we invest in developing technologies to improve women's health and we are proud to introduce our digital cytology system, which harnesses the power of artificial intelligence (AI) and advanced imaging.

Digital cytology has the ability to ensure earlier detection of pre-cancerous

cells, saving people from undergoing life changing treatment and potentially saving lives.

The cutting edge technology creates digital images of cervical smear slides from samples that have tested positive for HPV. These images of test slides can be rapidly reviewed using an advanced algorithm, which assesses the cervical cells in the sample and provides the screener with an image gallery of the most diagnostically relevant cells. This helps medical experts more rapidly identify and accurately diagnose abnormalities as they have fewer cells to analyse.

A cytologist working in cervical cancer screening has to painstakingly search for abnormal cells and then interpret them. In some cases there are only around 50 abnormal cervical cells in a sample that may contain 15,000 normal cells. This takes considerable time and concentration and has the potential for false negatives.

Using digital imaging and AI increases the likelihood of picking up abnormalities that may be missed by human assessment, and while accelerating detection and diagnosis, digital cytology does not compromise on accuracy.

The technology also enables screeners to spend more time diagnosing and less time searching for abnormal cells. Increasing efficiency is a huge benefit as there is a relatively small number of labs left in the UK and limited specialist staff, so it helps those in labs to use scarce resources more effectively.

Promising impact for the UK and around the world

The technology is being piloted in a UK first at University Hospital Monklands with some positive preliminary results. The team has reported increased capacity by around 25% in the slide assessment and improved analysis turnaround times, as well as allowing screeners to dedicate more time to training on the latest technologies and dealing with difficult-to-diagnose cases.



The use of digital images is also critical for bringing this technology to women around the world. The 2D images of cells are digitised meaning they can be viewed from multiple and remote locations. This collaboration enables the sharing of resources and expertise to help boost equity of healthcare and ensure all women can access the benefits of digital cytology.

Innovation holds the key to a better future

At Hologic we believe in a future where cervical screening is available to every woman and we can create a world where no woman dies from cervical cancer. Digital cytology is a key part to achieving this and we look forward to bringing the power of AI and advanced imaging to more labs than ever before and ultimately improve health outcomes for women around the world.

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Tim Simpson
General Manager, Hologic UK & Ireland
Hologic
Insights - Hologic
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WSK Medical: Changing healthcare by leveraging innovative AI solutions

Using AI solutions to assist clinicians and doctors in the quest for early cancer detection through software

WSK Medical is an innovative software company that is focused exclusively on developing leading-edge Artificial Intelligence (AI) solutions to assist clinicians and doctors in the quest for early cancer detection. The company aims to create the most advanced, flexible AI technologies to improve patient cancer care.

AI solutions for early cancer detection

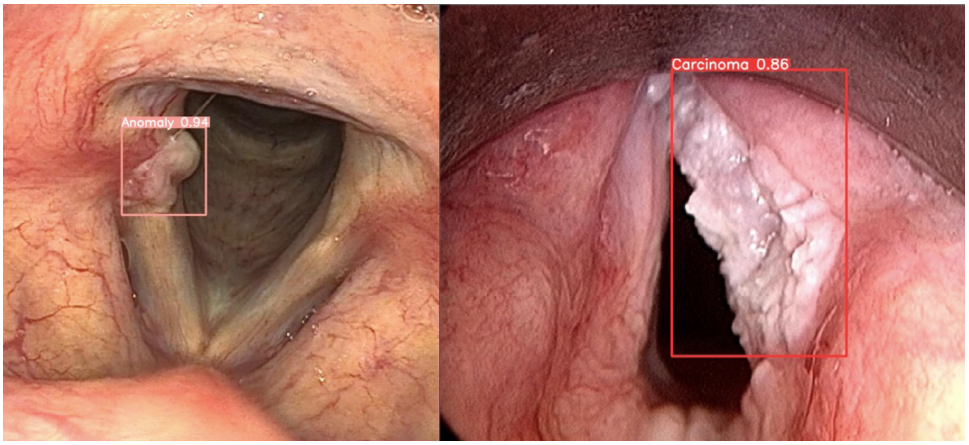
WSK Medical's mission is to bridge the gap between the medical community and AI research by developing easy-to-use, workflow-integrated, clinically valuable AI solutions for early cancer detection. The time has come to move AI out of the research domain and bring it into the general clinical environment. WSK Medical does this by translating complex, medical problems into solutions that assist doctors and clinicians in their daily work.

> "Zeno Pathology, WSK Medical CE-certified AI digital pathology solution, is now available on the European market and is beginning to build traction."

WSK Medical is currently developing AI solutions for Pathology, and Ears Nose & Throat (ENT) oncology. In the Netherlands, the company is collaborating with two renowned institutions, (Radboud University Medical Centre & Netherlands Cancer Institution / Antoni van Leeuwenhoek Hospital) on both medical specialisms.

Double the power = double the success

WSK Medical was founded by Derick Montaque (CEO/CTO) and Marius Wellenstein (COO). Derick manages the development team and oversees WSK Medical's strategy while Marius is responsible for the business development and daily operations. They met in 2018 and decided to set up WSK Medical because they both saw a lot of opportunities to innovate the healthcare industry with the use of AI. Their joint goal was to develop AI solutions that assisted doctors and clinicians in their daily work without replacing them. Both Derick and Marius believe in human-machine collaboration to add value to cancer care and potentially save lives.



This picture demonstrates Zeno AI detecting and 'Anomaly' an Carcinoma during a laryngoscopy.

Zeno Pathology, AI solution for digital pathology

Zeno Pathology, WSK Medical CE-certified AI digital pathology solution, is now available on the European market and is beginning to build traction. Zeno Pathology provides users with a fully automated AI analysis pipeline that performs whole slide image analysis as a background task. It can be integrated into your existing workflow to achieve seamless integration to all relevant clinical/administration systems, therefore enhancing your overall workflow for H&E and IHC analysis.

Zeno Pathology is a flexible system that can be configured with the following modules: Mitosis counting based on Nottingham Grading, (H&E); Nuclei detection & heatmap of tumour probability (H&E), TIL detection (H&E), ER/PR detection (IHC), HER2 detection (IHC), and Ki-67 detection (IHC).

Zeno AI, throat cancer detection

Zeno AI, WSK Medicals AI throat cancer detection solution for ENT-surgeons (currently under MDR CE certification evaluation) focusses on detecting certain forms of throat cancers to assist ENT-surgeons during endoscopic examinations in the outpatient clinic.

Identifying and classifying (pre)malignant laryngeal tumours can be difficult for an ENT-surgeon. The expertise of Head & Neck surgeons is crucial for detecting head and neck tumours in an early stage. The problem with throat cancer detection is the fact that ENT-surgeons – when in doubt – have to call upon the Head & Neck surgeon for further investigation. Head & Neck surgeons are a finite resource within the Netherlands as they are typically found in academic hospitals. This can create problems when a non-academic hospital requires a specialist Head & Neck surgeon.

> "Earlier detection of malignancy results in a faster time to diagnosis and time to treatment, with significant impact on survival."

By aiding the doctor in the choice whether or not to perform an invasive procedure (i.e., biopsy under general anesthesia), patients can be spared the potentially unnecessary surgical procedure and associated general anesthesia. Furthermore, earlier detection of malignancy results in a faster time to diagnosis and time to treatment, with significant impact on survival. Current waiting times in the Netherlands are 2 to 3 weeks.

What Zeno AI offers

Zeno AI provides users with a ready-to-use, fast AI analysis platform to assist in the early detection of throat cancer during a laryngoscopy (endoscopic examination of the larynx). Zeno AI supports integration into your existing clinical workflow and thus reduce the time to analyse complex, medical data - Therefore reducing possible delays and improving patient care. This means by using Zeno AI, the time to diagnosis can be brought back from weeks to the same day. Faster throat cancer diagnosis can reduce healthcare costs and enables a faster care plan for patients.

WSK MEDICAL

Marius Wellenstein
COO and Co-Founder
WSK Medical
marius.wellenstein@wskmedical.org
www.wskmedical.org
www.linkedin.com/mariuswellenstein

A new generation of testing for cancer: tools for navigating data in clinical decision making

Are we getting the most out of first order tests for symptomatic cancer patients?

At PinPoint Data Science we are committed to helping the NHS realise its ambitious target for the early detection of 75% of all cancers by 2028. Working with NHSEI, the National Cancer Team and Cancer Alliances we have been gathering 'real world evidence' that is set to revolutionise cancer diagnostics in the UK and beyond. We aim to deploy our first products into clinical practice by the end of 2022. Here we explain the current scenario and how The PinPoint Test, an advanced 'Multi-Cancer Early Detection' test, will make a difference.

The way our healthcare system currently manages patients who seek help for worrying symptoms is based on the fundamental approach of taking a history, conducting an examination and usually a first order of diagnostic tests – predominantly blood tests. Thereafter, a differential diagnosis is typically worked through by a combination of consecutive further tests and referral for specialist advice, potentially from more than one Consultant. Eventually a diagnosis is narrowed down but with a heavy reliance on costly and often invasive second-order testing. It can be a long and drawn-out process.

What if, at the very start of the patient pathway, the first order test gave better, more insightful information? Could it shorten the differential diagnosis list? Could it more accurately determine the next step and most appropriate specialism? Could it prioritise the second order test a patient requires and how urgently?

As a patient, what is the question you want answered when you receive a diagnostic test? Very simply, you want to know what (if anything) is wrong with you, so that your doctor can help you if needed or reassure you if not.

But is this the question *current* diagnostic tests answer? Well, sometimes.

The problem with complexity

Let's consider blood tests. If you're really lucky, there's a single analyte the lab can measure that will give your doctor a clear answer. If not, there may be a combination of analytes that when looked at together, can provide an answer, but often this isn't the case and the road to diagnosis becomes longer and less clear.

The human brain has evolved to recognise patterns and extrapolate conclusions, but there are limits to the number of interdependent data points we can process effectively at any one time. With a data set as complex and fluid as an individual patient's biology, the absence of a red-flag test result can leave even the most experienced GP or Consultant forced to rely on intuition and a process of elimination and deduction.

But what if the answer is available in that first blood test, it's just spread across tens or hundreds of analytes?

Cancer is a particularly challenging example. While there are a few specific cancers where a single analyte is useful (e.g., PSA for prostate cancer), for most cancers this is not the case. And yet, scientific literature reports many examples of signals that can be measured in blood and that are known to carry trace amounts of information about cancer.

The difficulty is that these individual analytes are often not informative enough on their own to be useful in forming a diagnosis. An elevated platelet count might be a warning sign for cancer [1]; a range of immune-related biomarkers are associated with increased cancer risk [2]; C-reactive protein (CRP) can be elevated in ovarian cancer patients [3] and is even more significant when combined with CA-125 and HE4; serum bilirubin levels are negatively associated with both lung and cervical cancer risk [4]. The list goes on.

Some tumour markers already in use have been shown to be more broadly informative than for just the cancers they are primarily used to investigate. For example, in primary care patients with elevated CA-125 (an ovarian cancer tumour marker), not only were 10.1% of patients diagnosed with ovarian cancer, but a further 12.3% were diagnosed with a completely different type of cancer [5].

Despite the name, Prostate Specific Antigen (PSA) is known to also be

produced in lower levels by other tissues and to have potential as a marker for colon and breast cancer [6, 7].

All of these analytes, and others not discussed here but linked to cancer risk, are easily measured in NHS pathology laboratories. They are routine, established and importantly, they are affordable to process. Without the right tool to interpret them, however, these analytes are a largely untapped resource.

A test with the ability to combine these individual signals into a single, more informative, calibrated result could be transformational for early diagnosis.

Machine learning: unlocking the next generation of blood tests

The PinPoint Test is a software in vitro diagnostic device for the detection of cancer across 9 referral pathways, representing 98% of all suspected cancer referrals in the NHS. The algorithm employs machine learning to analyse 31 standard analytes, plus the patient's age and sex. It is able to calibrate and aggregate these individual signals into one strong and highly accurate result: the chance that a patient has cancer.

The result is designed to be a tool for supporting clinicians in the diagnostic process. It does what a person cannot: accurately calculate a patient's risk profile for cancer based on data from more patients than a GP could see in a lifetime. A simple answer to a complex question.

The PinPoint Test isn't alone. There are a number of different approaches to multi-cancer early detection that are at various stages of development. Many of those more widely known are focused on the detection of circulating tumour DNA (ctDNA) in the blood. Companies in this area include GRAIL [8], CancerSEEK [9], Freenome [10] and Guardant [11], all of whom are developing tests that identify multiple pieces of information from ctDNA and in some cases, other analytes.

Just like PinPoint, tests such as that being developed by GRAIL also use machine learning to analyse data and produce a probability of cancer; and just like PinPoint, all of these tests are sensitive to multiple cancers. The potential for ctDNA testing in future screening programmes is exciting but PinPoint addresses a more immediate problem faced by the NHS today: systemic overloading in cancer services and the lack of an affordable tool to accurately stratify patients at, or potentially before, the start of an urgent cancer referral.

Unlike many of our counterparts, PinPoint does not require investment in new physical infrastructure. Blood samples are processed using standard equipment in NHS labs and the algorithm exists within NHS IT systems for data security and ease of use. As a result, it can be adopted at high-speed and low-cost across regions.

"An algorithm will never replace a clinician"

The trend is clear: to get the most out of first order testing, we need to apply new tools to an old process. A test like PinPoint can cut through the complexity of medical data to produce an accurate and repeatable result. This new generation of tests should give doctor's extra confidence in their decision-making process. An algorithm will never replace a clinician but like any other medical device, it will answer questions and perhaps raise valuable new ones.

We live in an era where artificial intelligence, machine learning algorithms, and statistical models are increasingly able to offer insight and constructive support in the clinical space. After Deep Blue defeated Gary Kasparov in the late 90s, the best chess players weren't computers, they were teams of humans using computers to help them. The chess-playing software became a useful tool, and one that gave the human experts new perspectives to help them identify a more effective and successful route forwards. This is a useful way of thinking about the new generation of blood test-based clinical decision support systems for cancer. They provide new sources of information for the trained clinical expert; they can support and enhance a doctor's clinical intuition; they are new tools with which to diagnose and guide treatment for patients.

Far from being a threat to that vital human element in healthcare, the next generation of blood tests will be a powerful ally for doctors and patients alike.

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Authors
Dr Richard Savage, Professor Sean Duffy and Dr Nigel Sansom.

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PinPoint Data Science Ltd
info@pinpointdatascience.com
https://www.pinpointdatascience.com/

Prioritising structured diabetes education for better health outcomes

Karrie Wallace, Education Services Clinical Lead, Spirit Health, explains the elements that comprise diabetes education & how education at an early stage can have a significant impact on health outcomes & NHS resources

Diabetes accounts for 10% of the total NHS expenditure in England and Wales. The number of patients diagnosed with diabetes increases year on year – and 92% of people with diabetes have type 2 diabetes. Therefore, having access to diabetes education remains an NHS priority.

Nationally, 80% of the costs of diabetes are associated with the long-term complications of poor health management, particularly glycaemic control and excess weight. The United Kingdom Prospective Diabetes Study, which looked at type 2 diabetes outcomes, outlines the correlation between a lack of treatment for diabetes and other long-term health problems, including heart disease.

The financial burden of diabetes-related expenditure can be reduced if patients are provided with a service to understand their condition and how to manage their diabetes. Here, I explain the elements that comprise diabetes education, and how education at an early stage can have a significant impact on health outcomes and NHS resources.

Uptake of structured diabetes education

The National Institute for Health and Care Excellence (NICE) recommends that people with type 2 diabetes should have access to structured diabetes education (SDE), with SDE courses able to help motivate patients with diabetes to improve their knowledge and skills, enabling them to better self-manage their condition.

Despite all newly diagnosed patients being offered a place on an SDE programme, uptake can be low. The National Diabetes Audit demonstrated that just over 15% of those newly diagnosed with diabetes accessed SDE in England (*while also acknowledging that SDE attendance is often under-reported*). Overall, it is believed that uptake is under 20% nationally, highlighting the poor national takeup rate of SDE. The need for a new approach is clear.

Changing diabetes education

As a nation, we have embraced new levels of flexibility and digitisation in the last two years. Similar models need to be brought to diabetes education, providing access in a way that fits in with patients' lives - be that as a fully managed service, which can be delivered locally and at convenient times across a variety of locations, including virtual self-service education, for improved uptake.

When choosing a provider, key considerations include whether they have been externally validated against the NICE criteria or are certified according to the QISMET Diabetes Self-Management Education quality standard. Programmes should consist of a structured curriculum that encourages practical involvement of participants, along with the use of problem-solving models, aids identification, and planning of individualised strategies to facilitate diabetes self-management.

Person-centred and discussion-oriented courses can focus on what the participants want to get out of the programme, while building upon attendees' experiences. Participants should set themselves goals, and clinical and biometric data should be captured at six and twelve-month time points in order to analyse progress.

Meeting the needs of the diverse & remote population

Due to the impact of COVID-19, many healthcare providers were unable to operate face-to-face consultations during the peak of the pandemic. It also

changed the need for people to leave their homes, accelerating the need for digital transformation across the industry.

Agility and flexibility have been fundamental to the continuity of healthcare, and therefore, structured diabetes education providers must adapt to this change and offer an alternative virtual model. By using video conferencing and chat facilities to provide specialist education, this can help to engage patients and encourage dialogue, which is an important part of these programmes – while keeping access to education running wherever the individual may be, or on a digital self-learning basis.

Digital self-learning SDE enables the user to gain access and learn about their condition in their own time, wherever suits them, and at their own pace. This enables the learning to be based around the person's needs and lifestyle. By having these various options available, SDE courses can remain flexible – which will help to keep the person motivated to attend as and when suits them.

It is also fundamental that SDE courses are made available in a range of languages to suit the patient population and expand upon programme accessibility. Having access to education for patients who are newly diagnosed with diabetes from all ethnicities is crucial, as many will be anxious about their condition and must be supported. Healthcare providers should ensure that their SDE courses are universal in order to meet more patients' needs, particularly for those people who may not have English as their primary language.

Beneficial outcomes of understanding diabetes

By having SDE programmes in place, with a specific focus on goal setting and a change of diet, the benefits for both patients and the NHS are significant. In terms of lifestyle, by having a diabetes educator available to assist and educate patients, they will become more confident and gain a better understanding of their condition.

This permanent change in mindset empowers patients to take control, and by having the insight into foods with lower glycaemic indices and portion control, as well as the benefits of regular exercise, it can lead to improved clinical outcomes such as weight loss, a reduction in HbA1c and improved glycaemic control.

Consequently, patients having more confidence and improving their overall health and lifestyle choices has a knock-on effect on also benefiting the NHS – both in terms of costs and resources. By reducing the number of diabetes complications, as well as the medicines used, cost savings can be achieved across the healthcare industry. Additionally, increasing the provision and uptake of diabetes self-management and education courses can also reduce risk factors and minimise the chance of developing further health complications, ultimately reducing NHS resources due to needing fewer care interventions, as well as costs.

Building confidence and self-management of diabetes

By putting the patient in control of their condition and helping them to achieve a better understanding of type 2 diabetes through SDE courses, they can build their confidence and self-management of their condition to make positive lifestyle changes and live happier, healthier lives.

It's important to make more people aware of the help and support that is available, both physically and virtually, while ensuring that SDE courses are designed to increase uptake and help patients gain a better understanding – while empowering them to take control of their condition.



Karrie Wallace
Education Services Clinical Lead
Spirit Health
Tel: +44 (0)800 881 5423
info@spirit-health.com
www.spirit-health.co.uk
https://twitter.com/spirithealthuk

The link between imbalanced hormones & osteoporosis

Dr Ghazala Aziz-Scott, Hormone Specialist, examines the link between imbalanced hormones and osteoporosis and why hormone treatment is so important

Hormone replacement therapy is often associated with the relief of typical symptoms of the menopausal phase, such as hot flushes and night sweats. However, the longer-term health benefits are so important for future quality of life and it can reduce the risk of heart disease, cognitive decline and osteoporosis risk.

Earlier HRT treatment is truly preventative

Our bones and skeletal system give structure to the body and all 206 bones in the human body are in constant use for mobility, anchoring muscles and protecting our internal organs, so investing in bone health is crucial at all phases of life but particularly as we age.

Many women present for HRT treatment after they have experienced a fracture, not realising that earlier treatment is truly preventative, so increased awareness and education about how to preserve bone health are key public health messages. The consequences of a fractured hip in the elderly are not just the cost and inconvenience of surgery, but the associated loss of mobility can have a wider impact on overall health. Indeed, the World Health Organization considers prevention of osteoporotic fracture one of the largest public health priorities.

Osteoporosis literally translates as "porous bone" and is a condition where bones become weak, fragile and vulnerable to fractures. Microscopically, bone has a honeycomb-like structure but when bone mineral density is lost, the honeycomb structure becomes much larger and the texture becomes brittle.

Throughout the lifespan, our bones are continuously remodelled by cells called osteoclasts, which breakdown old bone, and osteoblasts, which form new bone.

Peak bone density happens around age 30

In our younger years, the rate of bone growth is high and peak bone density is reached around age 30, after which bone density gradually declines. Osteoporosis occurs when the rate of breakdown is greater than the rate of bone synthesis.

So, gradual loss of bone density is a natural part of the ageing process, but its rapid loss that leads to osteoporosis. In the UK, three million people have osteoporosis and it affects both men and women but the incidence and fracture risk in women is significantly higher (85%) because bone formation and maintenance is physiologically linked with our sex hormones and the menopause.

Bone cells called osteoblasts and osteoclasts are regulated by the hormones oestrogen and testosterone.

Oestrogen plays a major role in maintaining bone density and inhibits the activity of osteoclasts which cause bone breakdown. The menopausal transition that occurs for all women at midlife causes oestrogen deficiency as ovarian function declines and osteoclast activity increases, causing an increased rate of bone breakdown. Other factors which influence osteoporosis risk are genetic tendency, smoking, low body weight, medications such as thyroxine, steroids and proton pump inhibitors, low dietary intake of calcium, vitamin D and vitamin K, inactivity and bone density before menopause.

Women lose 10% of their bone density during menopause

During menopause, on average, women lose about 10% of bone density but for some women, it can be as high as 20% and this decline continues with age. Unfortunately, 30% of postmenopausal women in US

and Europe have osteoporosis. Fractures associated with osteoporosis can occur with minimal amounts of stress and the bone can literally snap, the commonest sites being the vertebral column, hip and wrist.

"Women who have premature ovarian insufficiency or a premature menopause before the age of 45 are at particular risk if they are not treated and should continue HRT until the age of natural menopause at least."

To reiterate, this is a preventable health issue with the correct treatment and lifestyle advice. Women who have premature ovarian insufficiency or a premature menopause before the age of 45 are at particular risk if they are not treated and should continue HRT until the age of natural menopause at least. Bone density is easily measured with specialised scan called a DEXA.

Testosterone regulates bone growth and maintenance by stimulating osteoblasts involved in new bone generation. Testosterone also converts to oestrogen in both men and women, which inhibits osteoclasts and protects bone. Men have a gradual decline in testosterone with age but the so-called andropause doesn't affect all men and is also impacted by metabolic conditions such as diabetes and cardiovascular disease. Women have smaller amounts of testosterone produced by the ovaries and adrenal glands, which also decreases after menopause and therefore impacts bone health too.

Hormone replacement therapy is crucial to preventing osteoporosis

Research studies have confirmed the huge importance of hormone replacement therapy in the prevention of osteoporosis and is supported by the Royal Osteoporosis Society. However, the decision to take HRT should be made after full discussion and consideration of the risks and benefits, with regular review. For the majority of women, the benefits of using bioidentical or regulated bodyidentical HRT far outweighs the risks and will protect against osteoporotic fractures and also improve overall quality of life.

HRT is energising and enables continuing exercise and mobility, which is also crucial in maintaining bone density and reduces the rate of decline with age. Weight-bearing exercise on your feet is very effective, both low impact with brisk walking and climbing stairs and higher impact such as running, dancing and jumping. Resistance training with weights strengthens muscles, naturally raises testosterone and supports bone formation too, while body work such as pilates and yoga helps posture and balance, reducing the risk of falls.

Optimal nutrition also prevents osteoporosis and is important in bone metabolism. Calcium is the building block for bones, vitamin D supports effective calcium absorption from the intestine and vitamin K works in conjunction with D to ensure calcium is deposited in the bones. Vitamin C is implicated in the synthesis of collagen which is part of our connective tissue. Minerals such as zinc, magnesium and boron are also important for bone mineralisation and development of bone structure, so good sun exposure, a nutritious diet and regular supplementation will ensure the best bone health, but hormone replacement really is the secret to strong bones and the ultimate vitality.



Dr Ghazala Aziz-Scott

Dr Ghazala Aziz-Scott
Hormone Specialist
The Marion Gluck Clinic
Tel: +44 (0)20 7191 2378
secretary@mariongluckclinic.com
www.mariongluckclinic.com

Cellular & biological pathways from studies on communicable diseases

Adonis Sfera and Zisis Kozlakidis provide recent insights into cellular and biological pathways from studies on communicable diseases

The human body, with its complex networks of cellular and biological pathways, has evolved a large number of mechanisms to control the different imbalances that might arise. These imbalances, if remaining unchecked, can eventually manifest as non-communicable diseases, such as cancer, or as a result of communicable diseases, such as after infection by a virus such as SARS-CoV-2, causing COVID-19.

The intense study of the latter over recent years has resulted in the significant production of scientific knowledge for the immediate necessity of not only controlling the pandemic but also towards gaining a deeper understanding of existing cellular and biological pathways. It is anticipated that the recent discoveries will add to the existing body of knowledge and further facilitate the understanding of the link(s) between biological mechanisms and the development of different diseases, paving the way at the same time for the development of new treatments.

Here, we present only an indicative few of the recent COVID-19 derived discoveries and working hypotheses, as applied to the cellular mechanisms and their relevance for better understanding the mechanisms behind different clinical conditions.

Endothelial senescence, chronic fatigue syndrome and COVID-19

The first such example is Myalgic encephalomyelitis/ chronic fatigue syndrome, a serious illness of unknown cause. It is characterised by some or all of debilitating exhaustion, memory impairment, pain and sleep abnormalities.

According to the Centers for Disease Control and Prevention (CDC), it is estimated that in the US alone, 836,000 to 2.5 million Americans may be suffering from ME/CFS. Importantly, the majority of people with ME/CFS remain undiagnosed as there are no laboratory tests that can provide such a diagnosis. Thus, diagnosis takes place empirically, based on in-depth evaluation of a person's symptoms and medical history by their treating clinicians. Viral infections are believed to initiate the pathogenesis of this syndrome although the definite proof remains elusive.

With the unfolding of COVID-19 pandemic, the interest in this condition has resurfaced as excessive tiredness, a major complaint of patients infected with the SARS-CoV-2 virus, often lingers for a long time, resulting in disability and poor life quality.

Long-lasting myalgia and exhaustion were reported in over 40% of COVID-19 patients during the first two waves of the pandemic. Indeed, as muscle cells express abundant angiotensin converting enzyme-2 (ACE-2), the virus likely exploits the myocytes, engendering disabling symptoms such as fatigue and weakness. For example, preclinical studies have demonstrated that SARS-CoV-2-upregulated angiotensin II (ANG II) disrupts the muscle cell autophagy, impairing both the metabolism and contractility [(1)].

However, aside from directly accessing the myocytes, this virus can induce myopathy, muscle weakness and atrophy indirectly by upregulating proinflammatory cytokines, such as interleukin 1 beta (IL-1β) and 6 (IL-6), C-reactive protein (CRP) and tumour necrosis factor (TNF). When persistent, exertional and unrelieved by rest, myopathy may gradually morph into ME/CFS [(2)]. Thus, a pre-existing working hypothesis has been further enhanced due to the intensity of research into COVID-19.

Membrane fusion in neurodegenerative studies

Using a similar approach, inroads can be achieved in our current understanding for some of the neurodegenerative disorders. A growing body of epidemiological and research data has associated neurotropic viruses with accelerated brain ageing and increased risk of neurodegenerative disorders.

Many viruses replicate optimally in senescent cells, ie in cells that have stopped multiplying but don't die off when they should, and as such they offer a hospitable microenvironment with persistently elevated cytosolic calcium, abundant intracellular iron and low interferon type I.

As cell-cell fusion is a major driver of cellular senescence, many viruses have developed the ability to promote this phenotype by forming syncytia, large multinucleated cells produced by two or more cells fusing. Cell-cell fusion is associated with immunosuppression mediated by phosphatidylserine externalisation that enable viruses to evade host defences. In hosts, virus-induced immune dysfunction and premature cellular senescence may predispose to neurodegenerative disorders. This concept is supported by novel studies that found post-infectious cognitive dysfunction in several viral illnesses, including human immunodeficiency virus-1, herpes simplex virus-1 and SARS-CoV-2 [(3)]. Therefore, the current strides in biological understanding should be able to elucidate pathways and clinical conditions well beyond the narrow research aims relating to the viral ability to infect cells and divert the normal functioning of the body towards the production of viral particles.

Conclusion

The current pandemic, caused by the SARS-CoV-2 virus, may be a catalyst for a better understanding of the role of viruses in the pathogenesis of many illnesses. As SARS-CoV-2 (and probably other viruses) utilise the molecular machinery involved in many different disorders, the clarification of these biological mechanisms may help with the development of better therapies.

Furthermore, by employing collaborative approaches from different clinical fields, conserved biological mechanisms can start to emerge, eventually being further investigated for potential drug targets.

Disclaimer

Where authors are identified as personnel of the International Agency for Research on Cancer/WHO, the authors alone are responsible for the views expressed in this article and they do not necessarily represent the decisions, policy or views of the International Agency for Research on Cancer/WHO.

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Adonis Sfera
Patton State Hospital, San Bernardino, CA, United States
Department of Psychiatry, Loma Linda University, Loma Linda, CA, United States

Dr Zisis Kozlakidis
International Agency for Research on Cancer
World Health Organization Lyon, France
www.iarc.fr
www.twitter.com/iarcwho

Lessons from the mouse model of cutaneous leishmaniasis

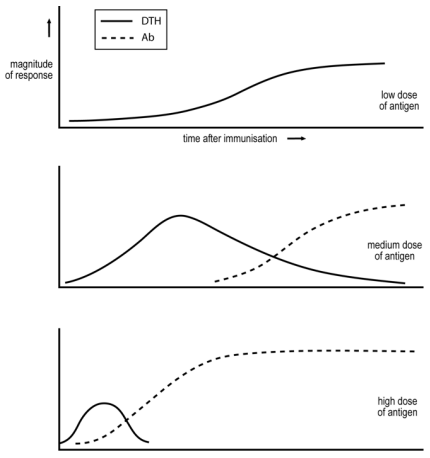
Peter Bretscher, from the University of Saskatchewan looks at whether mouse models of cutaneous leishmaniasis are pertinent for vaccination against and treatment of AIDS, infectious diseases, and cancer

How general might lessons be of Mouse cutaneous leishmaniasis?

The immune system has two major means of fighting a foreign invader and, on encountering such an invader, employs a decision-making process as to which means to employ. Vaccination as currently practiced increases the tempo and size of the IgG antibody response, and so is effective only against invaders and pathogens susceptible to such antibody.

However, clinical observation and experimental studies show that cell mediated immunity is required to contain most cancers, and certain pathogens, such as those causing AIDS, tuberculosis, leprosy, cutaneous and visceral leishmaniasis. Standard vaccination increases the antibody response on infection. This is associated with a downregulation of the cell mediated response. It is for this reason that standard vaccination is ineffective against invaders primarily susceptible to cell-mediated attack.

Mouse cutaneous leishmaniasis is the most intensively researched model of a human disease caused by a pathogen uniquely susceptible to cell-mediated attack. How general might the lessons be from studies in this model?



Click to enlarge

The two main forms of cell-mediated immunity are cytotoxic T lymphocytes (CTL) and delayed type hypersensitivity (DTH); they are coordinately generated. Their optimal generation can occur in the absence of IgG antibody production. Th1 cells mediate DTH and are protective against Leishmania major, the parasite responsible for cutaneous leishmaniasis.

CTL are protective against most cancers and associated with the generation of Th1 cells. It thus appears plausible that a way of guaranteeing a strong Th1 response against L major is also applicable to guaranteeing a strong CTL response against cancers. Protocols for treating people and animals, who are ill because generating a predominant and ineffective antibody response, instead of a protective cell-mediated response, are also, I will argue, likely to be generally applicable.

The problem for universally efficacious vaccination posed by genetic diversity

Vaccination in use against covid and other pathogens is standard: the same vaccination protocol is given to people of the same age. This might be considered surprising. We and animals are extraordinarily diverse genetically, as I shall indicate, so how come the same amount/form of antigen can protect us all?

I have discussed *elsewhere (eBook 1)* how and why different variables of immunization affect the cell-mediated/antibody nature of the ensuing response. Studies in inbred strains of mice, for example, show the importance of antigen dose. Relatively low doses of antigen are known to generate exclusive, Th1 responses and higher doses transient Th1 responses that decline as antibody is produced and Th2 cells generated. This dose dependence seems to hold for many different types of antigen, and in different animal species, see the figure.

This generality is critical as vaccination, if to be universally effective, must

be based upon valid generalisations. A critical problem is that genetics determines what is a low and what is a high dose. A "low dose" in one mouse strain generates an exclusive cell-mediated response but can be a "high dose" in another strain, generating a predominant antibody, Th2 response. Suppose we vaccinate with a very high dose of antigen that induces antibody in all. This will be effective in all against pathogens susceptible to antibody. Such standard vaccination can thus be universally efficacious.

Is universally efficacious vaccination against L major possible?

Infection of mice with a million L major parasites results in "resistant strains" in a stable Th1 response and control of parasitemia; in "susceptible strains", a predominant Th2 response is rapidly generated and loss of control of parasitemia. We showed that infection of "susceptible mice" with 300 parasites results in a stable Th1 response; infection with a million parasites two months later also resulted in a stable Th1 response and control of parasitemia, i.e. in resistance. This low dose vaccination strategy appears to work in mice against tumors, and in cattle and mice against mycobacteria, responsible for tuberculosis and leprosy, *see elsewhere eBook 1*.

Can a form of the low dose vaccination strategy be developed that is universally efficacious despite genetic diversity of the vaccinated? We thought this could be a major problem and sought a way to transcend it.

Valid generalisations must underlie any universally efficacious vaccination strategy. We sought to examine in diverse mouse strains whether the dependence of the Th1/Th2 phenotype of the response always depends upon the parasite number employed for infection. We found that infection with relatively low and high numbers of parasites resulted respectively in stable Th1 responses and in responses with a significant Th2 component. We could thus define for a mouse strain a transition number, Nt: infection with a number below Nt resulted in a stable Th1 response; infection with a number above Nt resulted in time in a response with a substantial Th2 component. The higher the number was above Nt the faster was the generation and the size of the Th2 component. Remarkably, the value of Nt varied in our study over a 10,000 fold range. Nt was 500 parasites in the most susceptible strain and 5,000,000 in the most resistant strain. This study led us to two conclusions. Genes dramatically affect the Th1/Th2 phenotype of the ensuing response. Most importantly, this phenotype generally does depend on the parasite number employed in the infection. Suppose we infected diverse mice with 250 parasites, below the transition number for any individual. As these parasites are alive and replicate, they would be expected to generate Th1 responses and Th1 imprints in all mice, thus constituting universally efficacious vaccination. We refer to this as the very low vaccination strategy to achieve universally effective protection.

It appears this strategy may be the basis of leishmanization as carried out in the Middle East. Parents expose the bottoms of their babies to infected sandflies, the insect vector for the parasite, and thus avoid the formation of pockmarks on the face later in life, that are socially disadvantageous. Vaccination with live parasites will be unacceptable in the west. I suggest vaccination with very low doses of slowly replicating vectors, encoding immunodominant parasite antigens, could be employed.

Treating visceral leishmaniasis

It is standard practice in tropical, endemic areas to treat otherwise lethal visceral leishmaniasis with a short course of drugs that kills the parasite. We and others showed such treatment modulated the immune response from a mixed Th1/Th2 to a Th1 phenotype. Treated individuals are resistant to becoming ill on reinfection. We argue that this modulation is because the drug, in killing the parasite, lowers the antigen load. I suggest treatment of HIV infections and of cancer can similarly be treated by harnessing protective, Th1 immunity, by reducing the antigen load by one means or another.

Peter Bretscher
Department of Biochemistry, Microbiology and Immunology
University of Saskatchewan
Tel: +1 306 665 0756
peter.bretscher@usask.ca
https://medicine.usask.ca/profiles/biochemistry-microbiology-immunology/peter-bretscher.php

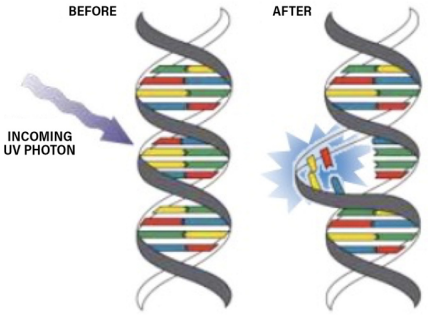
UVGI Solutions for Effective Infection Control

Ultra Violet Germicidal Irradiation (UVGI) refers to the use of UV radiation for the effective control of infections

The COVID-19 pandemic has prompted new research on Ultraviolet Germicidal Irradiation for infection control, with many new innovations now arising as a result. Dr Andy Davies, Director at Mackwell Health explains how new innovations around a mature technology have the potential to revolutionise the approach to preventing Healthcare Acquired Infections.

Ultra Violet Germicidal Irradiation (UVGI) refers to the use of UV radiation, usually UV-C between 200 and 280nm, to target DNA or RNA in pathogens, disrupting their structure so that they are no longer able to reproduce. The technology has been known for well over a century, having been the subject of a Nobel Prize in 1903 when the Danish Physicist Niels Finsen demonstrated its effectiveness at treating tuberculosis.

Prior to the COVID-19 pandemic, commercial adoption of products using UVGI was dominated by water treatment applications. However, as the pandemic progressed, debates ensued about methods of transmission of the virus. It is now widely recognised that SARS-CoV-2 transmits predominately via the airborne route. However, other pathogens of concern can transmit via surfaces, and many novel applications for UVGI have now been realised for both air and surface treatments.



Schematic illustration of the mechanism of UVGI

Whilst the science behind UVGI is well-established, there have been many barriers to its mass adoption for infection prevention & control. These include ensuring that it is safe to use - since UVGI can be damaging to human skin and eyes, and a lack of evidence showing efficacy against specific pathogens, especially when airborne. In addition, until recently it was only possible to generate UV-C radiation from mercury-containing discharge lamps, making its use impractical in many cases.

The Emergence of New UV-C Sources

Whilst traditional UV-C discharge lamps will continue to play an important role in many systems, newer technologies are now emerging at a rapid rate, thanks to the new impetus in R&D that has resulted from the pandemic.

LED Sources have emerged and have the potential to revolutionise UVGI applications in the same way that LED lighting has been transformed over the past decade. UV-C LEDs are less mature but have more than tripled in efficiency over the duration of the pandemic.

Whilst these efficiency values remain low, a unique attribute of UV-C LEDs is their small size, meaning they can be deployed in new applications versus traditional lamps. They also emit a highly controllable field of radiation, meaning that advanced optical materials can be used to capture the emitted radiation and direct it to the intended location.

An example of where UV-C LEDs have played a major role is the development of new generations of decontamination chambers. Combining small LED sources with highly reflective optics allows high irradiation intensities to be achieved through multiple internal reflections within the chamber. When combined with 3D CAD models of objects to be treated, the UV-C irradiance, and therefore the time needed to achieve the critical dose for effective decontamination can be modelled using advanced ray trace software. Healthcare institutions across Europe are now at advanced stages of trialling this technology on many objects that may spread infection around facilities, as well as investigating it as a decontamination tool allowing re-use of PPE such as protective eyewear.



New generation decontamination unit that uses UV-C LED sources embedded in highly reflective optical material. Unit has been shown to offer >99.99% decontamination of protective eyewear in a 4-minute cycle.

Far UV-C Excimer Lamps are also emerging as key sources since they emit at 222nm which is a wavelength that has been shown as very effective against airborne viruses as well as offering a potential higher level of safety for human exposure and therefore use in occupied spaces. (1) Modelling trials are also ongoing for Far UV-C systems in many applications such as healthcare and aerospace.



The ProtectivAIR® respirator: A novel use of UVGI which provides several orders of magnitude of increased protection against respiratory viruses when compared with standard filtering facepieces

Novel applications

Both traditional lamps and the newer LED and excimer sources have found novel applications during the pandemic, with UV-C efficacy data on SARS-CoV-2 now available from several peer reviewed studies. One application is the use of UV-C as an alternative to filtration on high efficacy respiratory protective equipment (RPE).

> "This technology offers renewed optimism in the efforts to drive down Healthcare Acquired Infections as these innovations get adopted around the globe."

In this application, air is drawn through an enclosed chamber comprising a UV-C emitter and with highly reflective materials covering all inside surfaces of the chamber. Flow rates are regulated between 30 and 50 litres per minute, and a silent fan then provides a constant flow of purified air to the nose and mouth via a re-usable facepiece with a filter for exhaled breath.

This concept has been tested at UKHSA on MS2 surrogate virus and is shown to deliver more than 99.9999% virus reduction to the user for such pathogens as SARs-CoV-2, influenza, measles, tuberculosis and poxviruses like that which causes Monkeypox. This makes it ideal for use in high-risk areas, particularly those which have to deal with new and emerging virus threats, or tropical diseases.

Whilst UVGI is not new, innovations in the field that have been prompted by increased R&D activity during the COVID-19 pandemic are now resulting in many exciting advances for infection prevention. This technology offers renewed optimism in the efforts to drive down Healthcare Acquired Infections as these innovations get adopted around the globe.

(1) ACGIH has recommended increase in 8-hour exposure limits for 222nm from 23mJ/cm^2 to 161mJ/cm^2 (eye) and 439mJ/cm^2 (skin). IEC international standard 62471 has still to be changed but is expected to follow.

mackwell health

Julia Vaughan
Marketing Manager
Mackwell Health
Tel: 01922 458255
Julia.vaughan@mackwell.com
www.mackwellhealth.com
www.linkedin.com/company/mackwell-health

Novacyt is powering ahead and tackling emerging health concerns

Empowering employees and examining emerging health threats in a new strategy for business growth is Novacyt CEO David Allmond's mission in the weeks ahead

Since taking the helm at Novacyt six months ago, David has been transforming Novacyt, from its concentration on meeting customer demands for COVID-19 testing to expanding the business portfolio to capture a more significant share of the life sciences and clinical diagnostics markets.



"We've been transitioning at breakneck speed, to diversify the business, but this is a mid-sized ship, not a speedboat, and although we've altered course, it takes time to head in a different direction."
- David Allmond, CEO of Novacyt.

Providing an effective response to infectious diseases

The overall aim is to be a leading global diagnostics company focused on unmet needs in infectious diseases. "The core strength of the company is infectious diseases and we have demonstrated our ability for agile response – not just to COVID but also to Ebola, Zika, Swine Flu and others."

"I have a passion for human health. I want all our employees to have a shared purpose beyond just making products to know that we are making clinical diagnostics that protect lives enabling informed decision-making, either for a clinical intervention or a public health response."

When David joined Novacyt as Chief Executive Officer last October, the company had a proven track record in COVID-19 diagnostics, stemming from their development of the first CE-marked COVID-19 PCR test in Europe, in early 2020. Now, his task is to lead the company beyond COVID-19, whilst maintaining their responsiveness to SARS-CoV-2 and any new variants of concern.

His strategy for growth post-COVID-19 is three-pronged:

1. Developing novel in vitro diagnostics in human health

2. Building on Novacyt's heritage to supply research laboratories and academic institutions with diagnostics innovation across multiple pathogens spanning the veterinary, water, food, and human health sectors

3. Developing Novacyt's integrated instrumentation workflows – both for research and clinical diagnostics.



Novacyt's mobile solution includes the VersaLab Mobile Laboratory featuring the highly-sensitive, compact, and light qPCR instruments (genesig q16 and q32 qPCR instruments) and its PROmate direct-to-PCR assays enable onsite testing, bringing tests near to the patient.



The MyGo range of qPCR instruments runs on open platform, offering mobile and rapid diagnostics testing on the frontline.

Testing mobility through the needs of the pandemic

Coping with the fast-changing needs of the pandemic also fuelled Novacyt's expansion of near-to-patient testing and mobile instrumentation – something that now stands it in good stead for meeting future challenges from emerging infectious diseases. Close partnerships with the World Health Organization and UNICEF, plus its own bio surveillance and ongoing research, give Novacyt the foresight to anticipate future need in a world with evolving health challenges.

The growth strategy for Novacyt includes fresh focus on several human health sectors:

- Respiratory diseases beyond COVID-19, including influenza and respiratory syncytial virus (RSV)
- Gastro-intestinal infections – currently resurging as society opens after COVID-19 and a particular threat to institutions with mass habitants like ships, prisons and care homes
- Transplantation – testing for viral load to monitor risk of rejection post-transplant
- Insect-borne viruses such as Yellow Fever, Zika, West Nile fever, Dengue, and chikungunya fever

"Novacyt will maintain its ability as a first-responder to infectious diseases, and continue innovation in products and instrumentation to support patients and clinicians on the front-line, wherever in the world they might be," said David.

Growth and expansion for Novacyt

Geographical expansion has also been a recent evolution for Novacyt. From being essentially a UK-based business serving the UK, demands for COVID-19 testing elsewhere meant 55% of Novacyt's business during 2021 was international.

Novacyt has invested in strengthening the commercial team in Europe, North and South America, and in the global accounts team looking after Asia Pacific. "More and more of our business growth will come from overseas, whilst we continue to serve our UK customers," he said.

One of the company's challenges as it transitions to a more diverse portfolio post-COVID is the fast-changing regulatory industry, particularly the new In Vitro Diagnostic Regulation (IVDR) in Europe, which came into effect this May. This new directive has clearer obligations for those involved in research and development, manufacturing and supplying IVDs, across the EEA– something David says Novacyt is well-placed to provide.

"We have the infrastructure in the company, from our clinical research, regulatory and product quality group, to manage this increased clinical and regulatory complexity," he said, adding that Novacyt can remain competitive in the marketplace.

"I want Novacyt to leave a legacy in healthcare – to have made a difference to how the world tackles infectious diseases," he said. "I believe people at Novacyt share that passion. We want to deliver frontline clinical diagnostics to enable informed decision-making that impacts patients' lives."

NOVACYT

Shiao Fong Yee
Marketing Communications Manager
Novacyt Group
Tel: +44 (0)7593 565 003
shiao.yee@novacyt.com
www.novacyt.com
https://twitter.com/NovacytGroup

Genomic characterisation for improved responses to dengue outbreaks in Tanzania

Gaspary Mwanyika from the SACIDS Foundation for One Health, Sokoine University of Agriculture, Tanzania details the importance of genomic characterisation in the control of dengue

Dengue is the most important mosquito-borne viral disease of public health concern. Globally, the disease affects approximately 400 million people, leading to over 25,000 deaths each year. The overall prevalence of dengue infection in Africa is 14%, with serotypes 1 and 2 being the leading causes of outbreaks in the continent. The control of dengue is faced by several challenges. Lack of vaccine against dengue viruses complicates control of the disease, hence increasing risk of the virus transmission. The disease often presents with non-specific symptoms similar to other diseases like malaria, yellow fever, Zika, chikungunya and flu, hence there is a need of rapid laboratory confirmation for correct diagnosis. This underscores the need for enhanced differential diagnosis of febrile illnesses in the continent. Vector control and early detection remain the foremost strategies to prevent and control dengue.



Dengue in Tanzania

Before 2010, very little was known regarding dengue epidemiology in Tanzania and its impact was under-reported due to inadequate capacity for surveillance and diagnosis. Since then, annual dengue outbreaks have been reported in Dar es Salaam city that has become the epicentre of outbreaks in Tanzania.

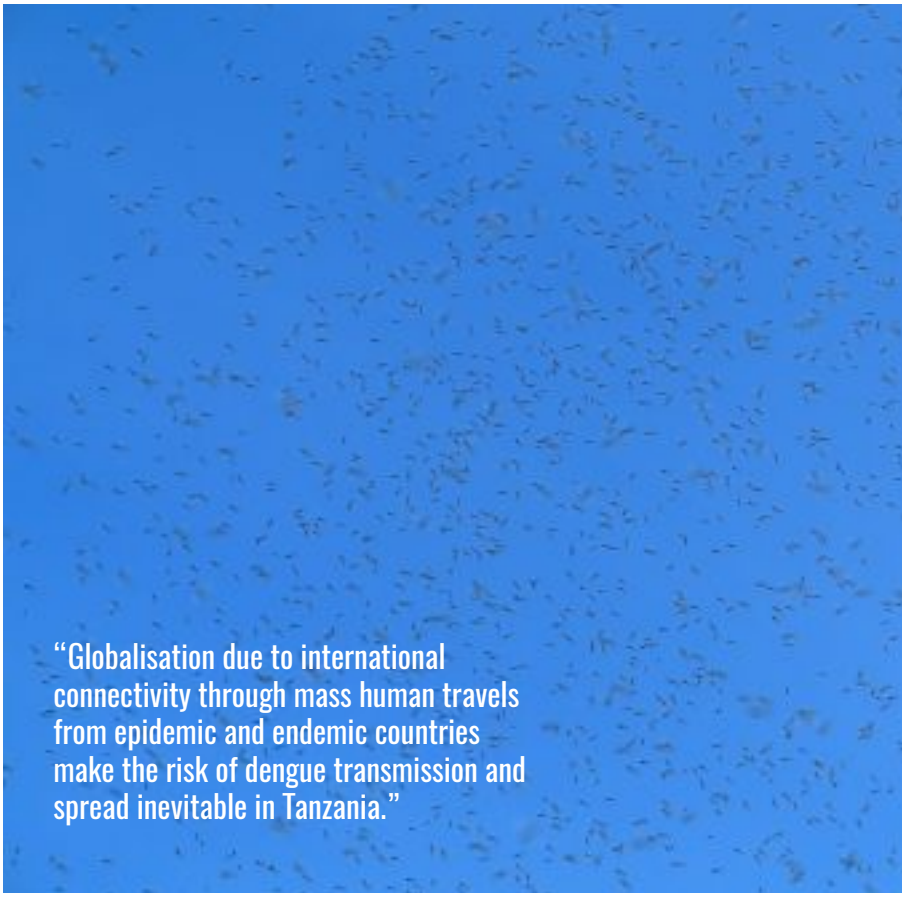
Studies in Tanzania show that dengue infections are common in both rural and urban communities. Misdiagnosis of dengue and co-infections with other febrile illnesses such as malaria and chikungunya have also been reported in Tanzania.

Dengue virus exposure in diverse ecological zones of Tanzania

Population-based serological studies have reported the presence of dengue viruses in human population across Tanzania with the highest seroprevalence reported in the north eastern part of the country; with an overall prevalence of 16.1%. These findings suggest a wide circulation of the viruses and that a large proportion of exposed individuals are unlikely to be diagnosed through routine health care services due to the unavailability of reliable rapid diagnostic tools. Therefore, it is important that surveillance and diagnostic platforms for dengue viruses are strengthened in Tanzania in order to improve early diagnosis, patient management and outcomes.

Dynamics of dengue virus serotype circulation in Tanzania: A lesson for future outbreak response

Studies in Tanzania have indicated that 1, 2 and 3 serotypes of dengue are prevalent. Nevertheless, genomic characterisation of circulating serotypes is not often conducted. Using field deployable Oxford nanopore MinION sequencing technology, a recent study confirmed for the first time the active transmission of dengue serotypte 1 during the 2019 outbreak.



The analysis indicates that there was a possible introduction of dengue virus serotype 1 genotype V into Tanzania from a single source in Asia. These observations suggest that introduction new serotypes and/or genotypes into Tanzania may increase the risk of severe disease outbreaks in the future. This is because immunity to previous serotypes does not confer a long-term cross protection against subsequent infecting serotypes. These findings advocate the need of genomic characterisation and surveillance of the viruses recovered from human population in Tanzania.

Opportunities to improve point of care diagnosis of dengue

Studies indicate that rapid diagnostic assays show poor specificity due to inherent cross-reactivity that can lead to misdiagnosis of dengue infection. In a study in Tanzania, we characterized antigenic determinants on dengue virus envelope protein domain III using bioinformatics tools.

The domain III protein harbors serotype-specific antigenic determinants and induces strong neutralizing antibodies that make it a suitable biomarker to develop new diagnostic tools. In our study in Tanzania, we have demonstrated that domain III proteins consist of conformational antigenic determinants that can be expressed in simple bacterial cells as potential targets to develop diagnostic nanobodies. The application of nanobody-based diagnostic tools can help to improve point of care diagnosis of dengue virus infection and minimise misdiagnosis with other infections.

The risk of dengue transmission and spread is inevitable in Tanzania

Dengue is prevalent in diverse ecological zones of Tanzania that can be partly attributed to tropical climate and human activities that favour the presence and abundance of mosquito vectors close to human habitats. The circulation of multiple dengue virus serotypes 1, 2 and 3 in Tanzania can lead to explosive outbreaks and increased risk of severe disease in the future.

Globalisation due to international connectivity through mass human travels from epidemic and endemic countries make the risk of dengue transmission and spread inevitable in Tanzania. Studies in Tanzania indicate the need to charaterize dengue virus genomes in order to monitor the spread of new/ emerging genotypes and develop reliable point of care diagnostic tests that can provide rapid evidence of the disease outbreak to guide public health interventions.

Gerald Misinzo
Professor
SACIDS Foundation for One Health
Tel: +255 787 058 805
gerald.misinzo@sacids.org
http://www.sacids.org
https://twitter.com/gmisinzo

Is human blood better than cell lines as a COVID-19 infection model?

Y-h. Taguchi, a professor at Chuo University, looks toward a COVID-19 infection model which uses human patients blood who have been infected by COVID-19

2020 onwards saw the COVID-19 pandemic started to converge in almost all countries. Although vaccines currently seem to be effective in lowering the COVID-19 mortality rate, the virus continues to mutate the likelihood of another lockdown being introduced continues to rise. In order to avoid these situations, we definitely need effective drugs that are not yet developed and an effective COVID-19 infection model.

In our previous articles published in the Open Access Government publication [1,2] we introduced our recent efforts to develop effective drugs to COVID-19 using computers.

However, our studies described in the previous articles could make use of only human and mice cell lines. If we can make use of measurements directly using human patients infected by COVID-19, we might be able to have better results.

Using human cell lines to understand COVID-19

Recently, the research groups headed by Assistant Prof Miyata, Ryukyu University and Prof Ikematsu, National Institute of Technology, Okinawa College, under the collaboration with us, employed our methods to analyse gene expression of blood retrieved from human COVID-19 patients [3].

This study has both advantages and disadvantages if compared with the studies described in the previous manuscripts [1,2]. Since it is the direct measurement from human patients, the measurement is more direct than those that used cell lines.

However, since it is not taken from the lung, where infection takes place, but instead from the blood, it is indirect in this sense. Thus, it is unclear if the replacement of human lung cell lines with human blood can improve the result or not. The only way to figure out this point is a practical trial.

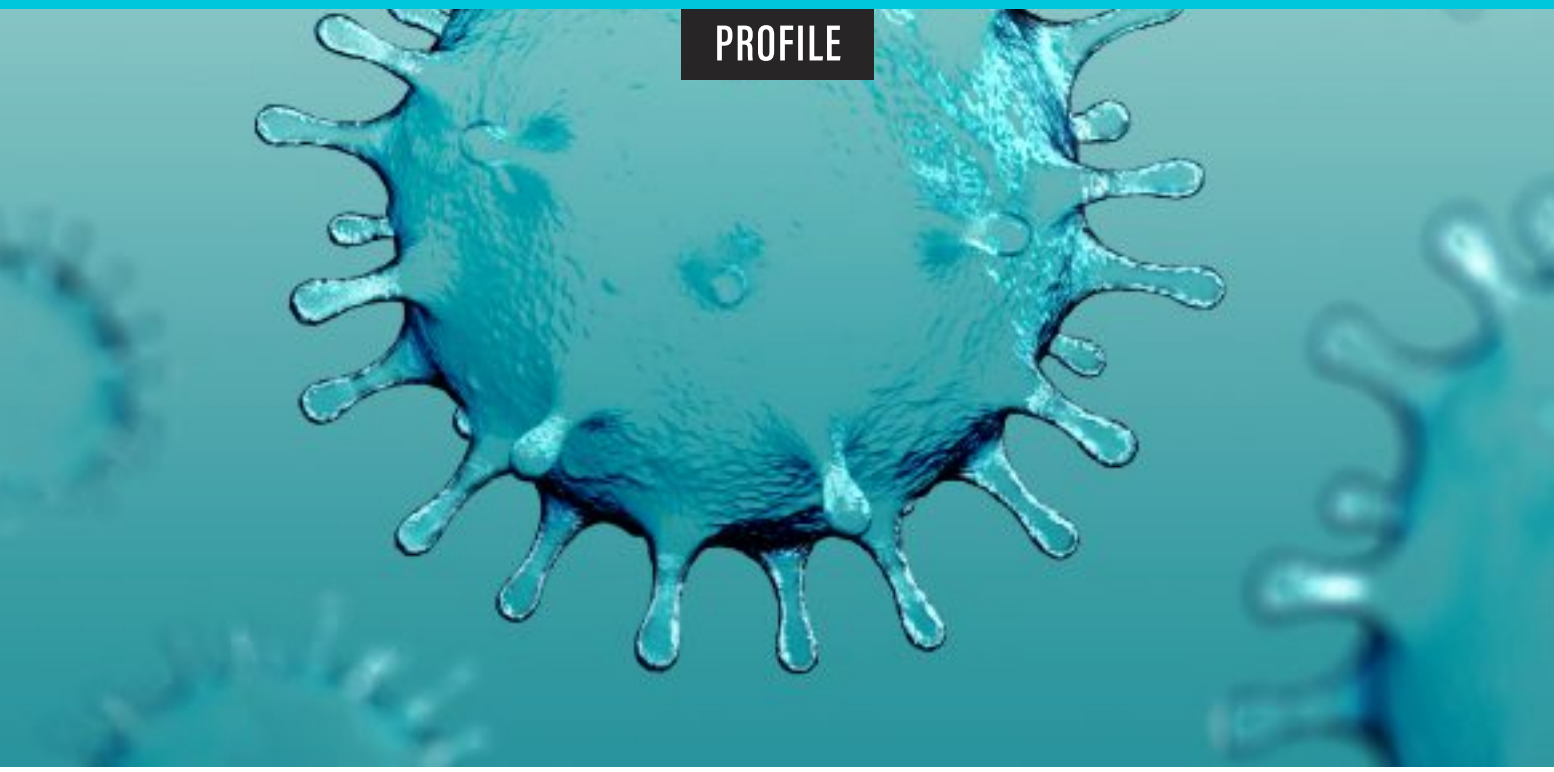
Practical trial of gene datasets

The research team downloaded two sets of publicly available datasets, and applied our method that they named PCAUFE, to it.

They found that as small as 123 genes are differentially expressed between healthy controls and COVID-19 patients in the first data set. Since the total number of human genes is 20,000, 123 genes are very limited and a small part of them.

To confirm if this appears too small a number of genes have the capability to differentiate COVID-19 patients from healthy controls, the research group constructed three machine learning models to classify two groups, patients and healthy control, only using the selected 123 genes; three models were tested using the second public data set independent of the first data set.

In order to validate the efficiency of classification performance, the research group employed AUC, which takes 1.00 for perfect performance and 0.5 for random selection. Three models trained by 123 genes could achieve AUC more than 0.9, which means excellent performance. Although the same procedure is repeated with exchanging two data sets, i.e., the model is trained with the second data set and is tested with the first data set, it can achieve similar performance. This means that the



results are robust. Thus, despite the very small number of selected genes, they can successfully discriminate COVID-19 patients from healthy controls.

In addition to this, to confirm the superiority of PCAUFE, the research group also employed other state of art methods to select genes that are differentially expressed between COVID-19 patients and healthy controls. Although classification performance using genes selected by the state of art methods is comparative with PCAUFE when only top-ranked same number of genes as those selected by PCAUFE are used. Whereas the number of probes selected by the state of art methods is as many as several thousand to eighteen thousand. Thus, the state of art methods has an inferior ability to restrict the number of genes used for the classification.

Enriching 123 genes

Next, the research group investigated what kind of functions are enriched in the selected 123 genes. Then they have found that the expression of many immune-related genes included in these 123 genes is downregulated in COVID-19 patients' blood. In addition to this, many biological pathways and transcription factors enriched in these genes are previously reported to suppress in COVID-19 patients.

These suggest that not only PCAUFE can identify genes whose expression can discriminate between COVID-19 patients and healthy control (i.e., biomarkers), but also it can identify a restricted number of probable disease-causing genes.

The finding that patients' blood samples can be made used for the COVID-19 disease investigation creating a COVID-19 infection model is remarkable.

First, if not lung tissue but blood can be an effective tissue to be investigated, it is much easier to collect. Collecting a massive number of lung samples from COVID-19 is hopeless, but collecting blood samples is feasible. Since blood samples can be used for diagnosing, it is easy to monitor disease progression, which enables us to find the timing to treat with drugs if identified.

Unfortunately, the research team has not yet started to identify possible drug candidate compounds using identified 123 genes, it will soon be performed, and they can get promising candidate drug compounds.

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Y-h. Taguchi
Professor
Chuo University
Tel: +81 3 3817 1791
tag@granular.com
https://researchmap.jp/Yh_Taguchi/
https://twitter.com/Yh_Taguchi

Unlocking dark matter in our genome to fuel immune responses

Dr Helen M Rowe at the Centre for Immunobiology at the Queen Mary University of London looks towards unlocking dark matter for the potential to boost immune responses in humans

Unlocking dark matter, after a closer inspection of this enigmatic DNA, reveals that it represents the fossil remains of millions of years of rare germline invasions of ancient viruses and 'transposable elements'. Dark matter refers to DNA of unknown function in the human genome.

The characterization of dark matter has recently become an area of intense research, particularly with mounting evidence suggesting that dark matter may play an important role in driving inflammation.

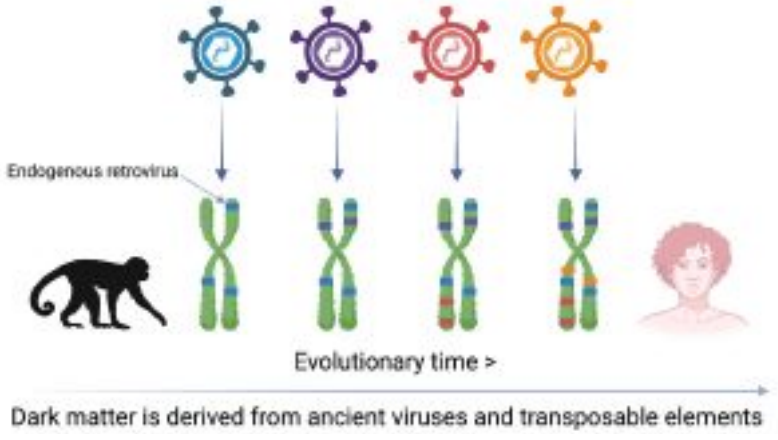


Figure 1: Dark matter has become part of our own genome

Why has unlocking dark matter become a cutting edge area of research?

With more than half of the human genome consisting of sequences derived from transposable elements, it is not surprising that this DNA contributes to health and disease processes. Perhaps most significantly, a particular configuration of dark matter in the genome, known as inverted-repeat Alu elements have been discovered to be at the heart of type I interferonopathies, such as Aicardi-Goutieres syndrome.

In this inverted repeat configuration, Alus form base-paired RNA that is recognized by a cytoplasmic receptor MDA5. In patients with gain-of-function mutations in MDA5 that increase its RNA binding affinity, normal levels of inverted-repeat Alus in the cell cytoplasm are sufficient to activate MDA5 and drive inflammation in the absence of an infection. Another ground-breaking finding leading on from this is that certain anti-cancer drugs can increase interferon responses fuelled by Alu elements to boost anti-tumour immune responses. LINE-1 elements are another class of transposable elements of intense interest because they too have been implicated in inflammation.

How is dark matter kept in a dormant state?

DNA is packaged into chromatin, which consists of repeating nucleosomes made of histone proteins that are often referred to as 'beads on a string'. The structure of the chromatin determines its function: For example, histone-modifying enzymes effect post-translational modifications of histone proteins that lead to changes in the ability of transcription factors to access the DNA and switch on expression of the underlying genes. LINE-1 elements are kept in an 'OFF' state through addition of methyl groups to lysine 9 on histone 3 (H3K9me3).

Our previous work and that of others has shown that LINE-1 elements are regulated by a chromatin-associated complex known as the HUSH complex. The HUSH complex interacts with the enzyme SETDB1 to maintain heterochromatin and with MORC2 to compact chromatin.

This is a key pathway of genome defence since LINE-1 elements are the only class of transposable elements in humans still able to replicate and jump in the genome. Mounting evidence suggests that LINE-1 elements may drive inflammation in a variety of disease settings from cancer to autoimmune diseases.

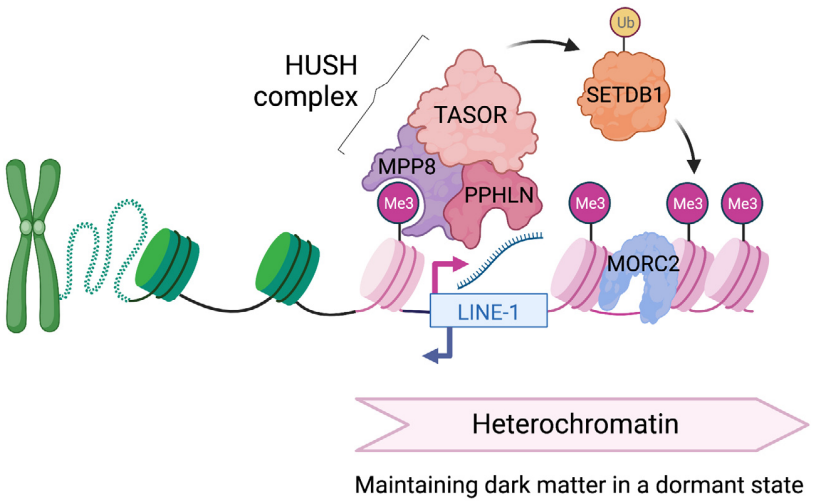


Figure 2: The HUSH complex regulation of LINE1 elements

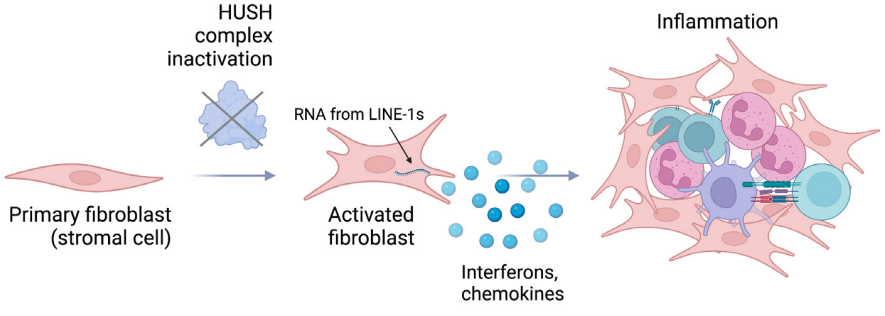
A second key pathway, which has some overlap of function with the HUSH complex but which recognizes different molecular cues is the KAP1/TRIM28 pathway, which we have previously identified to regulate a broad range of transposable elements.

What happens if ancient viruses residing in dark matter are resurrected?

Our research funded by the European Research Council and the Rosetrees Trust has illustrated that if we inactivate the proteins that assemble to form the HUSH complex on chromatin, there is a potent type I interferon response. Type I interferon acts on bystander cells to render them resistant to viruses and allows an influx of immune cells such as neutrophils, dendritic cells and T cells. Type I interferon responses are at the heart of immunity to viruses, including SARS-CoV-2 and they are also fundamental to anti-tumour immunity.

For these experiments, we used primary fibroblasts, which are representative of structural cells that act as a first line of defence by mounting immune responses to tissue damage or upon infection. Fibroblasts also gather to form connective tissue of lymph nodes, which act as the headquarters of where inflammation and adaptive immune responses converge. Fibroblasts in which the HUSH complex is inactivated transition to a state where they produce anti-viral defence proteins and secrete soluble factors that initiate adaptive immunity. An important application of our work is that the HUSH pathway could potentially be inactivated to induce type I interferon and harness the host immune response to initiate anti-tumour immunity.

Figure 3: LINE1 elements are implicated in driving interferons and inflammation



How do ancient viruses fuel human immune responses?

Our work and that of other labs has pinpointed several steps in the pathway of how ancient viruses can instruct host cells to secrete type I interferons. To find out how type I interferon is induced, we inactivated several cytoplasmic nucleic acid sensors, which reduced the interferon response. These sensors are part of a network of pathogen recognition receptors that represent an innate surveillance system of the host to monitor whether cells have been invaded by viruses.

When viruses replicate, they make double-stranded RNAs and it is this molecular pattern that the RNA sensors detect, which ignites interferon signalling pathways. Our work and that of others shows that in the absence of a virus, resurrected transposable elements can make nucleic acids that mimic viral replication intermediates. Read the research findings here.

Figures were created with BioRender.com

Queen Mary University of London

Dr Helen M Rowe
Group Leader
Centre for Immunobiology
Blizard Institute
Queen Mary University of London
4 Newark St, London E1 2AT, UK
h.rowe@qmul.ac.uk
https://helenrowelab.co.uk/

Mathematical modeling for optimization of COVID-19 vaccine dosing schedules in healthy and special populations

Carmine Schiavone[1], Vittorio Cristini[2,3,4,5], Prashant Dogra[2,6],*
[1] Università degli Studi di Napoli Federico II, Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale, Naples, Italy
[2] Mathematics in Medicine Program, Houston Methodist Research Institute, Houston, TX, USA
[3] Neal Cancer Center, Houston Methodist Research Institute, Houston, TX, USA
[4] Department of Imaging Physics, University of Texas M.D. Anderson Cancer Center, Houston, TX, USA
[5] Physiology, Biophysics, and Systems Biology Program, Graduate School of Medical Sciences, Weill Cornell Medicine, New York, NY, USA
[6] Department of Physiology and Biophysics, Weill Cornell Medical College, New York, NY, USA

*Correspondence should be addressed to: Prashant Dogra, Ph.D. Assistant Research Professor, Mathematics in Medicine, Houston Methodist Research Institute, Houston, TX. Assistant Professor of Research, Physiology and Biophysics, Weill Cornell Medical College, New York, NY. pdogra@houstonmethodist.org

From the beginning of 2020, the world we live in has been radically changed by the SARS-CoV-2 pandemic. The entire scientific community immediately mobilized to best combat this threat to the point where in about a year we were able to distribute the first doses of COVID-19 vaccines. After the first phase of enthusiasm due to a clear protective effect of the vaccines new challenges arose [1]. In the first instance, it was clear early on that the fraction of the population that was immunocompromised was more at risk than others despite the nature of the vaccine [2], and that simultaneously the immunity acquired through the vaccine tended to wane over time [3]. To add further concern the recently emerged Omicron variant has threatened the protection of many people leading to high numbers of breakthrough infections [4]. It is for these reasons that we wonder if the vaccination dosing schedules that have been using so far are the most appropriate ones, and if it is possible to find a better solution that safeguards the health of the public.

An approach based on mathematical modeling allows to unravel great insights into the complexity of biological systems and to obtain optimized solutions for individual patients. Our team has worked on developing mathematical models that can find optimal solutions to problems in clinical settings [5-9]. In the context of studying useful clinical strategies against COVID-19, we worked in the past on various aspects related to the pandemic. From a biological point of view, we have investigated the role that innate immunity plays in combating the SARS-CoV-2 infection and analyzed the clinical parameters that had the greatest impact on the reduction of viral load [10]. From an epidemiological perspective, we identified similarities between trends of infection across countries and the predictions of the Elliott Wave Principle, which models the price fluctuations of the financial markets, thereby providing a novel method of predict future trends in the evolution of the pandemic and highlighting how some preventive measures and the use of vaccines can play a critical role in preventing future waves of the pandemic [11].

In our most recent work (unpublished), we have built a model that simulates the immune response of a subject undergoing vaccination for SARS-CoV-2, because of which, the model we can predict the antibody level kinetics of a vaccinated subject. We used this model to simulate the immune status of an immunocompromised subject to obtain quantitative information about the antibody levels developed by these subjects over time allowing us to answer some preliminary ques-

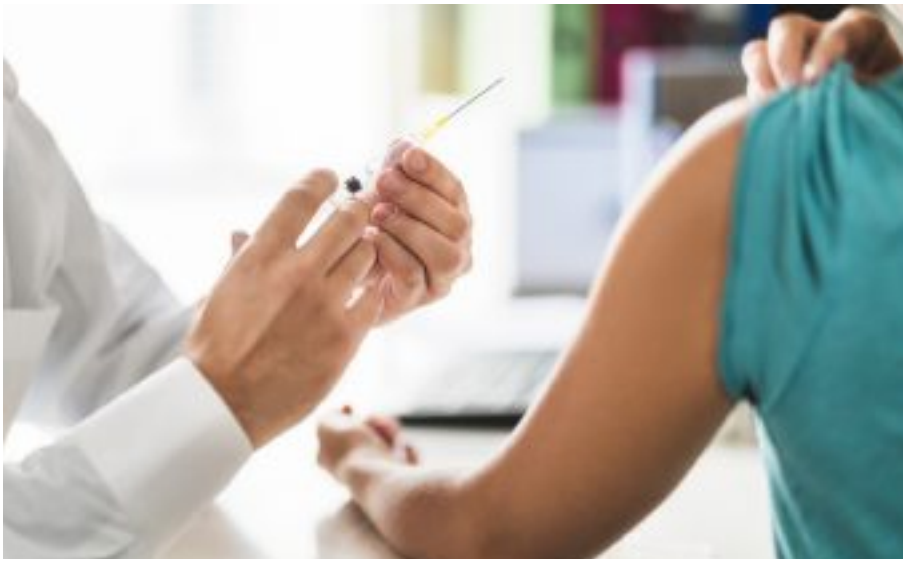


Image: © Tero Vesalainen | Dreamstime.com

tions regarding the need for vaccine boosters in vulnerable individuals. Subsequently, we used the mathematical model to simulate a subpopulation of immunocompromised subjects within a population and thus obtained the distribution of protection in the population. This analysis has highlighted the weaknesses in the current dosing schedules in causing intermittent periods of immunity-lapse in a major fraction of the population, thereby increasing the susceptibility to breakthrough infections. These observations are further amplified by the omicron variant due to the reduced efficacy of the current vaccines, suggesting greater susceptibility to breakthrough infections.

To solve the latter problem, we simulated all possible vaccination dosing protocols to identify the best dosing schedules to administer mRNA vaccines and obtain an effective and long-term protection against the omicron variant. What emerged from our study is that to obtain an effective protection at a global scale, it is necessary to use specific protocols for each immunocompromised population, at the same time also highlights need to act rapidly to update vaccines designed against newer variants in order to obtain long-lasting protection [12].

Mathematical models, as we can see, are a fundamental tool to keep up with the dynamic and intrinsically complex events. With the help of such models, it is possible conduct virtual clinical trials to choose the right dosage and dosing schedules of the vaccine for each category, to maximize protection across the population. From this point of view, the results obtained in our work will help to administer the vaccines in a more equitable and rational way and, consequently, protect against new variants.

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Vittorio Cristini, Ph.D.
Professor and Director,
Mathematics in Medicine Program
The Houston Methodist Research Institute
https://www.houstonmethodist.org/math-in-medicine/
Tel: (505) 934-1813
vcristini@houstonmethodist.org

The accessibility imperative: Sexual health education and interventions in adolescents and emerging adults with intellectual and developmental disabilities (I/DD)

Dianne Morrison-Beedy, PhD, RN, FNAP, FAANP, FAAN Chief Talent and Global Strategy Officer,
The Ohio State University College of Nursing Linsey Grove, DrPH Co-Owner Carriage House Consulting, LLC

Adolescents and emerging adults with intellectual disabilities (I/DD) have historically been unsupported in finding romantic or sexual relationships despite literature documenting that having a partner or relationship is important to many. The 1998 Human Rights Act respects the rights of every person, including those with I/DD, to form and engage in love or intimate relationships. Yet misconceptions and prejudices often disenfranchise persons with I/DD and perpetuate falsehoods that they do not have the same needs for intimate and sexual relationships. To compound this, sexuality education has, historically, been denied or limited to adolescent and emerging adults with I/DD despite their need for such services.

Of particular concern in this vulnerable population is the increased risk that adolescents and emerging adults with I/DD face for sexual assault and coercion. People with intellectual disabilities are estimated to be seven times more likely to be victims of sexual assault than their non-disabled peers[1]. Worldwide, teens disproportionately bear the burden of sexually transmitted infections (STIs) and HIV, and youth with I/DD face increased risk because of their vulnerability and limited access to sexual health education and programming. Despite some misconceptions of asexuality or hypersexuality among this population, they develop sexually at the same rate as their non-disabled peers[2]. Unfortunately, stigmas and misconceptions surrounding this population that their I/DD status will prevent them from learning valuable skills and concepts related to sexual health education are still pervasive.

Despite their increased vulnerability, students with I/DD are less likely to receive sexual health education in public schools[3]. This lack of access to sexual health information can leave them ill-prepared to identify unhealthy and predatory behavior as well as develop the skills needed to engage in healthy, consensual relationships. Inconsistent policy at the national, state, and local level contribute to this problem in the U.S. A lack of specific language in both sexual health education and special education policy have led school districts and legislators to inadequately address accessible and inclusive sex education implementation and developmentally-appropriate curriculum.

Specifically, U.S. regulations declare that states must implement policies that provide "full educational opportunity to all children with disabilities[4]. However, this language does not clearly specify what a "full educational opportunity" entails. While the educational team - parents, service providers, and the student – jointly develop the student's Individual Education Plan (IEP), this plan is designed to ensure that the student is educated and can participate in the general curriculum and in activities with non-disabled peers. What specific subjects are included in a "general education curriculum" for students with disabilities has not been defined. This ambiguity allows school districts to interpret what subjects should be taught to students with disabilities and this is especially pertinent regarding sex education, which is not considered a core component of a general curriculum. Sex education can differ by state in whether they chose to support abstinence-only, abstinence-plus (abstinence education with additional contraceptive information), or comprehensive education (sex education that offers all sexual choice and methods of risk prevention and instruction about social and emotional context of sex and relationships). To compound these issues, the curriculum chosen by each state can differ as to whether it needs to be medically or factually accurate. Parental consent also differs from state to state with some states allowing for "opt-out" options for parents,



or consent for specific topics only, or a simple notification that sex education will be occurring during school hours[5].

Developing evidence-based, inclusive curriculum to prevent sexual coercion and promote sexual health self-determination for this vulnerable population is long overdue. Over the past decade, available evidence-based teen pregnancy and sexual risk reduction interventions have grown, however, effective interventions and adaptations for young people with intellectual and developmental disabilities (I/DD) have been almost non-existent. In the U.S., nationally recognized, evidence-based teen pregnancy prevention programs (TPP) that have been rigorously reviewed by the U.S. Department of Health and Human Services (US DHHS) Office of Adolescent Health and the Office of Population Affairs (OPA). TPP serves as a repository for those programs to facilitate uptake and implementation in communities and schools. Many of these TPP programs were developed with a focus on high-risk audiences like urban or minority youth, the homeless or incarcerated, or groups associated with high-risk sexual behaviors. However, one vulnerable group noticeably absent in TPP programs are persons with I/DD. Given the lack of evidence-based sexual risk reduction interventions noted in TPP programming, this significant research gap for understanding and addressing sexual health disparities impacting adolescents and emerging adults with I/DD must be addressed.

Combined, the (1) gap in evidence-based sexual health curriculum specifically developed for students with I/DD, (2) the lack of inclusivity mandates in state sex education policy, and (3) ambiguity in the regulations regarding what components are included in a general education curriculum present major barriers to adequate and inclusive sexual health education for those with I/DD. When considering the many options allowed in the choice of sex education programming (e.g., abstinence-based, abstinence-plus or comprehensive) as well as whether the curriculum is medically-accurate or not, it is clear that standardized approaches to sexual health education for those persons with I/DD are problematic. To truly provide accessible and inclusive sexual health education to adolescent and emerging adults with I/DD, we will need to join forces globally to ensure best practices that increase accessibility, inclusivity and tailoring of sexual health interventions for this population.

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Dianne Morrison-Beedy, PhD, RN, FNAP, FAANP, FAAN
Chief talent & global strategy officer;
The Centennial professor of nursing
The Ohio State University College of Nursing
Morrison-Beedy.1@OSU.EDU
https://twitter.com/DMorrisonBeedy



Evidence-based interventions addressing top teen public health epidemics: HIPTeens and COPE

Doctor's Dianne Morrison-Beedy and Bernadette Melnyk reveal two evidence-based interventions that are addressing sexual risk and mental health issues, ultimately protecting and supporting teenagers where they need it most

Teenagers are faced with overwhelming sexual risks and mental health issues, and often the two can be intertwined. With support and education on the topics of sexual and mental health, young people are given the tools to reduce risk behaviours and enforce healthy coping methods.

HIPTeens, or Health Improvement Project for Teens, is a CDC and DHHS-recognised STI/HIV/teen pregnancy prevention programme, which provides services and evidence-based programming to diverse communities, healthcare, and educational organisations across the globe.

COPE, or Creating Opportunities for Personal Empowerment, is a cognitive-behavioural therapy-based programme that reduces depression and anxiety, also improving healthy behaviours.

As well as both being strictly **evidence-based** intervention (EBI) programmes, Hipteens and COPE:

- Are brief, manualised and easy to deliver programmes.
- Offer easy training for delivery by facilitators from diverse backgrounds.
- Have been delivered in healthcare and community settings, schools and teen programmes.
- Tested, across age ranges, genders, races and ethnicities.
- Both are used across the U.S. and globally.

Why use HIPTeens?

Developed and tested through rigorous longitudinal scientific studies, HIPTeens was recognised by the CDC and U.S. DHHS as an exemplary evidence-based HIV/STI and teen pregnancy prevention intervention.

HIPTeens helps to educate, empower, and improve teens health through increased knowledge of risk prevention strategies, emphasis on building motivation to change behaviours, and activities designed to identify and promote risk reduction behaviours.

HIPTeens training of facilitators provides them with the opportunity to learn and practice role-plays, activities, skill sessions using motivational interviewing techniques with manu-



alised intervention strategies and timely feedback to ensure facilitation success. It is culturally sensitive, theoretically driven, medically accurate, engaging and interactive. HIPteens has Universal Design for Learning (UDL) enhanced supplements for participants with learning and intellectual disabilities.

The programme enhances goal setting, builds resilience, positive youth development and communication skills.

HIPTeens also produces vital **results:**

- Reduced episodes of vaginal sex.
- Reduced episodes of unprotected sex.
- Reduced numbers of sexual partners.
- Reduced pregnancy rates.
- Increased sexual abstinence.

Why use COPE?

When faced with stress, depression and anxiety, everyone needs help to COPE. Approximately one in four to five children, teens, and young adults are dealing with stress, anxiety and depression, however fewer than half are getting the evidenced-based treatment they need.

COPE helps young people develop the skills necessary to stop negative thoughts and start thinking and acting in more positive ways. Based on key components of cognitive behavioural therapy, each COPE Programme leads participants through brief, easy-to-follow sessions that include education and skills-building exercises.

Despite often being unable to control events that trigger stress and anxiety, COPE can help to deal with them in healthier ways. Furthermore, children, teens and young adults learn how to:

- Reduce negative thoughts/emotions.
- Increase healthy behaviours.
- Improve communication.
- Build problem-solving skills.
- Understand and cope with stress.
- Set achievable goals.
- Enhance self-esteem and resilience.
- Feel happier, healthier, and more positive, every day.

Which COPE programme is right for you?

The COPE Programmes can be delivered by healthcare providers with reimbursement, teachers, nurses, counsellors, or social workers who have completed an on-line educational workshop. Programmes come in both online and manual versions, and can be delivered in primary care practices, schools, universities, speciality care, school-based clinics as well as mental health settings. Each session can be completed in either a brief 25 to 30 minutes, in small group format, or a 50-minute class.

The programmes are:

- **COPE Teen 7-session Manual:** Designed to be delivered by healthcare providers and educational professionals to teens ages 11 to 18.
- **COPE Child 7-session Manual:** For children ages 7 to 11.
- **COPE Young Adult 7-session Manual:** For young adults and college students ages 18 to 24.
- **COPE Teen Online:** An interactive programme that makes it easy and enjoyable for teens ages 13 to 18 to learn anywhere, anytime, at their own pace.

Results produced by COPE include:

- Decreased anxiety.
- Decreased depression.
- Decreased suicidal ideations.

When children, teens and young adults learn to COPE in positive ways, their brains lay down new pathways and grow strong connections, and this goes hand in hand with relationships to and knowledge around sexual health. COPE teaches young people how to turn negative thoughts into positive ones, so that they feel better emotionally and behave in healthier ways.

HIPTeens training, please visit our website here or get in touch: hip4change@gmail.com +1 813 230 3335.

For more information on COPE or to place an order, visit us on www.cope2thrive.com or email us on cope.melnyk@gmail.com.

SPECIAL PRICING FOR ORDERING BOTH PROGRAMS

COPE Creating Opportunities for Personal Empowerment

HIP TEENS Health Improvement Project for Teens

Dianne Morrison-Beedy
PhD, RN, FNAP, FAANP, FAAN,
hip4change@gmail.com
http://www.hip4change.com/

Bernadette Melnyk
cope.melnyk@gmail.com
www.cope2thrive.com

Understanding the effects of Long COVID on mental health

Professor Marcantonio Spada, Consultant CBT Practitioner at Onebright, helps us to understand the effects of Long COVID on mental health

Long COVID, also termed 'post COVID-19 condition', is emerging as a set of physical and psychological symptoms faced by people who have recovered from COVID-19. There continues to be uncertainty about the prevalence of Long COVID symptoms in adults and children following infection. The Office for National Statistics estimated in 2021 that around 1.2 million people in the UK (including around 77,000 children aged two to 16 and around 134,000 people between 17 and 25 years old) are experiencing self-reported Long COVID. Long COVID can be very debilitating, and some people need help with personal care months after the initial infection. Many dealing with Long COVID have reported that it has not only affected their family life and ability to care for dependents but also their ability to work and manage their personal finances.

"The Office for National Statistics estimated in 2021 that 1.2 million people in the UK are experiencing self-reported Long COVID"

How to spot the signs and symptoms of Long COVID

The World Health Organization (WHO) has confirmed that over 200 symptoms have been reported by people experiencing Long COVID. The most common are:

- Fatigue.
- Difficulties in thinking (often described as 'brain fog').
- Shortness of breath.

Additional symptoms include, anxiety or depression, difficulty speaking, chest pain and muscle aches, loss of smell and/or taste, fear of illness, and traumatic memories of ill health/isolation.

A need for better understanding about the effects of Long COVID

The unpredictability of Long COVID will impact its sufferers in many ways, for example, in preventing socialising and working, and in not knowing how long the condition will endure. This, in turn, is likely to fuel psychological distress. Research has indicated that up to a third of people may be suffering anxiety and/or mood disorders six months after their initial COVID-19 infection. As evidence mounts on the growing mental health impact that the pandemic has had on individuals, an invisible pandemic continues to spill over into the workplace; one that requires more than simply raising awareness or approving an extended holiday break for an employee. Anxiety and low mood have always been part of working life, but the COVID-19 pandemic has propelled these into the limelight.

Boosting your mental health when battling the effects of Long COVID

Whilst research and medical professionals continue to shed light on Long COVID and its association with psychological distress, there are some tips on how to boost mental health if you are suffering from Long COVID:

- **Be kind to yourself during your recovery** – Be prepared that some days will be worse than others. There may be 'windows' of improvement followed by more difficult times. These ups and downs are part of the recovery process.
- **Connect with other people** – This can help you feel happier and distract you from both physical and psychological symptoms of Long COVID. Make sure to keep in touch, regularly, with family and friends.



- **Have a daily routine** – This will also help improve mood and sense of stability.
- **Stay active** – Continuing to move will help release endorphins and take attention away from monitoring fluctuating physical and psychological symptoms. It will also help with strengthening baseline fitness to improve confidence.

How can you deal with the effects of Long Covid as an employer?

Employers should also be aware that the effects of Long COVID can come and go. On some days the person might seem well, but on others, their symptoms can be worse and they might need to be off work again or have work patterns made more flexible.

If an employee is on sick leave, they might feel isolated or need support to return to work. Employers should consider:

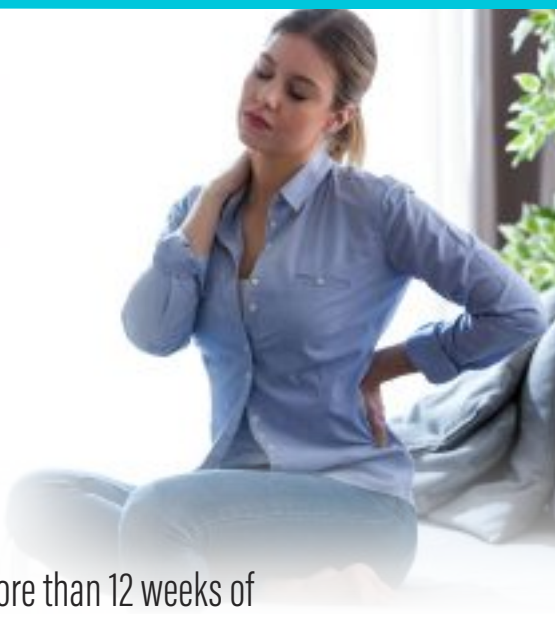
- Agreeing how and when to make contact during any absence.
- Making sure their work is covered and shared out appropriately while they are off.
- Talking about ways to support them as they return to work where and when possible.
- Determining if they can do anything to help if an employer feels the employee is not able to do their work or is taking a lot of time off. For example, a further occupational health assessment to find out if more support is needed is a viable option.


Marcantonio Spada

Living with the effects of Long COVID

A substantial number of people who suffered from COVID-19 will have persistent complaints, both physical and psychological, for several months after the onset of COVID-19–related symptoms. We need to be aware of this and support recovery which will occur for the vast majority and may take both time and patience on the part of employers.

Professor Marcantonio Spada
Consultant CBT Practitioner at Onebright
Tel: +44 (0)330 838 2000
info@onebright.com
https://onebright.com/
https://twitter.com/onebright_life_



Long COVID syndrome - think global, act local

There are now an estimated 1.4 million people in the UK experiencing more than 12 weeks of symptoms after infection with SARS-CoV-2 (COVID), also known as long COVID syndrome.

Of those suffering with long covid syndrome, 826,000 have had symptoms for at least one year and 376,000 for at least two years. At this scale, long COVID presents challenges not only to individuals but also to healthcare systems in the UK and many other countries which have been significantly affected during the pandemic. Global solutions are needed, but we also need to take account of local resources, infrastructure and issues.



Long covid syndrome trial
Amitava Banerjee

Amitava Banerjee, Professor of Clinical Data Science and Consultant Cardiologist at University College London is leading the STIMULATE-ICP team as Chief Investigator, with researchers, health professionals, patients and industry partners from over 30 organisations in the largest clinical study of long COVID syndrome to date. "Long COVID in the community, in people who have not been hospitalised, needs a coordinated response across research and clinical practice, and across the patient pathway. Otherwise, we will be too late in tackling what is likely to be the largest impact of the pandemic in the long run," said Banerjee.

The trial of investigation, treatment and rehabilitation strategies has been affected by multiple delays but is due to start this month in 6 sites around England (Hull, Derby, Leicester, Liverpool, Exeter and London). The non-trial parts of the study are underway and are already showing variations in care models and provision for long COVID around the country. There are already emerging data within our consortium and networks about mechanisms (e.g. increased tendency for clotting in some individuals), the longer term effects of COVID in different organs (e.g. whether in the heart or across organs), the impact of rehabilitation (e.g. Living with COVID Recovery) and the long term impact on healthcare utilisation, all pointing to the importance of timely recognition and action against this major threat to public health and health systems.



Long covid syndrome in the community
Mark Gabbay

Dr Mark Gabbay is a GP in Liverpool and Professor of General Practice at the University of Liverpool and Director of the NIHR Applied Research Collaboration North West Coast. He is STIMULATE-ICP work package 3 lead- focusing on equity and the transferability of the long-covid approach to other long-term conditions.

Liverpool city region faces many health challenges with significantly high proportions of the population living in areas of higher deprivation. Consequently, research and services to seek ways to decrease health inequalities remains a very high priority across the region. We developed the Health Inequalities Assessment Toolkit for researchers (www.hiat.org.uk) now embedded in the Forequity.uk website, a resource for researchers

seeking to integrate equity in their work. Hence our work in STIMULATE-ICP includes, within work package 3, a programme exploring variabilities in access to diagnosis and treatment for long COVID, linked to a variety of protected characteristics such as socio-economic inequities, migration, ethnicity, language and rural location. We are also identifying elements of the long COVID management approach within STIMULATE-ICP that could usefully improve care pathways and experiences for other long-term conditions, including a series of linked Delphi surveys. Across all these elements, co-production with Public Advisors and professionals lies at the heart of our work.



Rehabilitation of individuals with the disease

Angela Green

Angela Green is a physiotherapist at Hull University Teaching Hospitals NHS Trust and is informing all rehabilitation aspects of STIMULATE-ICP.

Even before the pandemic, Hull represents one of the more deprived and under-resourced parts of the UK in terms of health outcomes and services respectively. During the pandemic, the high rates of infection, backlogs in care and staff shortages (compounded by Brexit and other factors) have meant that conducting clinical research is even more challenging now. However, the STIMULATE-ICP study is showing that it is possible and important to do research in all contexts so that the findings are applicable to all settings and all people.

Long COVID is a new disease which we are still defining. We are not yet sure of the trajectories of individuals or subgroups and cannot give people recovery rates in a personalised manner. Rehabilitation has been an important part of the management of long COVID since it was first recognised, but we still need to understand how it helps and who it helps.

In the trial aspect of STIMULATE-ICP, we are looking at a digitally enhanced rehabilitation platform, Living with COVID Recovery, to see if and how it helps improve fatigue and other outcomes in people with long COVID syndrome. By studying rehabilitation as part of integrated patient pathways, we hope to inform how rehabilitation is offered and delivered across long-term conditions.



Clinical support

Gail Allsopp

Gail Allsopp is co-investigator on STIMULATE- ICP, providing clinical support for one of the work packages (3b), relating to inequalities in care and how long COVID compares with other long-term conditions. Her work within the study aims to determine if the health and care system could use best practice seen within Post COVID clinics and apply it to long-term conditions such as diabetes, respiratory and neurological disorders amongst others that may benefit from a holistic, whole-person approach to care.

She helped to shape and influence the first community based, post-COVID clinic in Derbyshire. In that clinic, GPs, supported by physiotherapists, undertake biopsychosocial, holistic assessments for patients of all ages, including children, linking in very closely with the persons own GP and hospital specialists when needed, creating an integrated service for those who need it.

STIMULATE-ICP will enable us to compare community-based and hospital-based services for long COVID, which is crucial to enable us to understand the health benefits, but also preferences from users themselves. We hope then, to be able to describe how truly integrated care could be provided for all people with long term conditions, benefitting more people than only those with long COVID.

UCL Health Informatics

Amitava Banerjee
Professor Amitava Banerjee
Institute of Health Informatics
University College London
Tel: +44 (0)203 549 5449
ami.banerjee@ucl.ac.uk
https://www.ucl.ac.uk/health-informatics/people/amitava-banerjee
https://www.doctorasdatascientist.org/
https://www.stimulate-icp.org/
https://twitter.com/amibanerjee1

European innovation potential knows no bounds

Mariya Gabriel, European Commissioner for Innovation, Research, Culture, Education and Youth, calls attention to building a pan-European innovation potential ecosystem in health served with top-notch infrastructures

Europe is a recognised global scientific powerhouse, but we need to further strengthen our innovation potential to transform research outputs into marketable products. The green and digital transitions are key political priorities obliging us to be at the forefront of innovation. We need to accelerate the pace to achieve carbon neutrality and address the challenges of the digital age.

The war in Ukraine brought additional challenges, both humanitarian and economic, just when Europe was starting the post-pandemic recovery, supported by an unprecedented agreement on the Next Generation investment package. The aim is to increase our resilience, be better prepared to cope with future large-scale health crises and drive our economies and societies towards more sustainability.

The latest developments confirm that Europe needs to look at its recovery and resilience in a context of more strategic autonomy, reducing the external dependencies in strategic sectors including health but also energy, food supply and transport.

With the communications on the new European Research Area, European Education Area and the Strategy for Universities, we started to define a clear policy context, roadmaps and targets. My ambition is to build on those and go further to foster a pan European ecosystem for innovation as a framework for engaging stakeholders.

Our work to improve the European innovation potential focuses on five flagships, corresponding to well-identified challenges of the new Innovation Agenda for Europe. Namely, by incentivising private investments and improving access to capital and by allowing targeted regulatory sandboxes in specific areas to accelerate the green and digital transition. It is essential to improve our local innovation ecosystems and their governance to maximise their contribution to European cohesion through "partnerships for regional innovation." We also need a slim-governance for policymaking and monitoring to guide and promote the dialogue between European Innovation Council, Member States and Regions. Finally, we need to ensure that Europe invests in "deep tech talent" responding to the foreseeable demand in areas such as advanced materials circular manufacturing, synthetic biology, health, electronics, aerospace and sustainable energy.

"Research and innovation in health is a clear example of the need to foster synergies between national and European strategic agendas and build innovation ecosystems."

How can we make this happen?

We have the resources to make a difference. The national recovery plans contemplate a large investment in R&I. Altogether Member States devoted around €45 billion to research and innovation. The EU has Horizon Europe, the world's largest R&I programme with €95 billion served with a full set of instruments to support cutting-edge innovation projects and the public and private actors of innovation.

Research and innovation in health is a clear example of the need to foster synergies between national and European strategic agendas and build innovation ecosystems.

Bringing closer the actors of the health value chain is important to direct our investments towards a broader set of challenges, beyond the COVID-19

pandemic, including non-communicable diseases, such as cancer, neurodegenerative diseases and antimicrobial-resistance, responsible for more than 80% of deaths in Europe.

Together with Member States, we decided to launch a specific Horizon Europe partnership on resilience to optimise synergies, look at the lessons learned from the COVID-19 pandemic and reinforce the budget allocated to the Horizon Europe cluster dedicated to Health. The European Innovation Council (EIC) has the mechanisms to support companies from the lab, throughout clinical trials, to the market and an extensive portfolio of projects and companies in innovative health, biotech and medtech areas. For example, a French biotech SME – Xenothera - is developing an anti-COVID-19 treatment, (1) whereas the Finnish Faron Pharmaceuticals is working on a novel anti-cancer solution. (2)

With its Pathfinder programme, the EIC supports the exploration of radically new technologies. In 2022, two Pathfinder challenges will fund breakthrough technologies in cardiogenomics and technologies to support a radical shift from episodic to continuous healthcare.

The industrial sectors involved in health R&I (pharmaceutical, digital, IT, medical devices, diagnostics, etc.) need to improve in the setting up of pan-European collaborations to grasp new opportunities to integrate results from different sectors in a way that could really transform healthcare.

Innovation ecosystems can foster health innovations with European and local impact, requiring collaboration among different stakeholders. The health industry is crucial for translating research results into innovative products available to citizens and patients.

With that in mind, the Innovative Health Initiative (IHI) will bring together diverse health stakeholders (universities, large and small companies, etc.,) in collaborative projects that address disease areas where there is a high burden on patients and/or society.

We will also count on the support of the new European Health Emergency Preparedness and Response



Mariya Gabriel

Authority to reinforce the dialogue with industry regarding, for instance, a long-term strategy for manufacturing capacity and targeted investment, and to address supply chain bottlenecks for medical countermeasures.

I conclude by underlying the most important lesson from the COVID-19 pandemic, which was the importance of coordinating health research and innovation among European countries, and the importance of building a pan-European innovation ecosystem in health served with top-notch infrastructures.

Stronger involvement of end-users (such as patients, carers, health care professionals and providers) in the development of innovation is crucial for improved uptake of innovations. This includes ensuring that innovative products respond to the needs of end-users and are user-friendly, established on a basis of trust and awareness.

Let's continue to work on that!

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Mariya Gabriel
European Commissioner for Innovation, Research, Culture, Education and Youth
European Commission
https://ec.europa.eu/commission/commissioners/2019-2024/gabriel_en
www.twitter.com/GabrielMariya

How can we bridge the industrial-academic gap?

According to Claus Ibsen and Karl Brian Nielsen at Vestas Aircoil, closing the industrial-academic gap is the future of innovation

How do you translate scientific results into innovation?

Vestas aircoil A/S values the potential of being part of the Horizon 2020 project InDEStruct. Besides the project outcome, it has also been a possibility to reflect on how the EU funding most efficiently translates scientific results into innovation in the industry and eliminate the industrial-academic gap.

Scoping a project that does not require numerous man-years for the industry to improve the technology readiness level is not unmanageable. At the end of 2021, Karl Brian started in a R&D position at Vestas aircoil A/S. He has 20 years of experience as a professor at a Danish University and brought with him the latest scientific work, to which, he quickly introduced a new material test *(*bulge testing - *see figures)* in the company which generates new knowledge of the materials and will improve the end product.

European Commissioner for Innovation, Research, Culture, Education and Youth, Mariya Gabriel recently wrote a LinkedIn article 'Startups and science: EU businesses will increase their competitiveness by linking closely scientists and startups', where she highlighted that "With deep tech startups quickly translating scientific results into innovation, our deep societal challenges will be resolved much more quickly than in the past."



We believe that quick translation of scientific results and methods into innovation should be the goal of all projects. Here, Claus and Karl Brian will reflect on what it takes to actually do that.

When it comes to the possibility of industry working more closely with academia, what do you think of the future?

Claus: "I think it would be beneficial for the EU if we could make the industry-academia partnership work efficiently and close the industrial-academic gap. How do we collaborate and increase the technology readiness level of the project, together with academia? We are almost four years into our InDEStruct project and we do certainly see interesting results. Though for some of the project outcomes, it may require five, six, or seven years to fully exploit the present findings. That is a long way to go and for the EU to gain from this. This we believe comes down to the scoping after the project has been granted funding and is ready to start."

You want to connect academic insights to the industry. What recommendation would you make so innovation could be more easily implemented?

Karl Brian: "I think it takes a number of topics to turn out to be successful, to be fast and that technological development can be implemented in the company. The first thing that it takes is setting the context of whatever we are doing.



"Then the company needs openness in order to have the will to discuss what could be of interest, and then the company needs to have a certain level of academic skills. If it's completely without, then it's not a fast track to go that way. Mr Ibsen, who have been in Vestas aircoil for 19 years and withholds a PhD, has shown for many years this positive attitude to whatever topic that may be of interest. Finally, it takes the academic side, and there you need to find an academic person who has the research skills and understand the challenge of the business / sector.

"Also, it's important that there is a certain history. Whatever brands you move into, you need a period of a half year, one year, two years of work into this brand, to understand what the product is, and what are the technologies, but how does this make up a business for the company? Because what I'm doing should somehow improve the business of the company."

Would you suggest that scientists are trained at university, to understand the industry?

Karl Brian: "I have many colleagues from the academic world, who are leaders of the academic world, and their interpretation is that, well, we have solved all manufacturing problems, this process we have known for 100 years. So, what can be done with this? It's a question of changing your research perspective. Instead of doing something with the balance of our metals, we'll try to make a twist so that our product is performing 10% better than previous ones. Or we can be much greener in our carbon dioxide use, because then the research topic is the ability to make this change more than how to put in some more iron."

Do you see anything in the EU infrastructure that excites you about the potential of speeding up that process?

Claus: "We were recently in a consortium with research groups from all over Europe, which prepared an application for EU funding. The fund was not granted, but what we saw being in the consortium, was the many facets of research on one research topic, which can be found in Europe.

If you as an industry can identify the technology needed to do the innovation of your product, but the local University may not be an exact match, then there most probably is a European research group which has the capability.

By expanding the looking glass to the whole of Europe, you can find an optimal match for your Innovation. This we also acknowledged in our InDEStruct project, which brings together a consortium of industrial and academic partners in a bespoke doctoral training programme that is multi-disciplinary in its content. That multi-disciplinary match was University of Southampton for us.

What ambitions do you have for the future? What would you like to do with the technology?

Claus: "We have enjoyed being part of the InDEStruct project which is soon to end, and we are hoping that we can get a new project so we can continue having collaboration across the border with other universities. I think the small differences, which are between us living in Europe, are important to generate new perspectives and ideas.

The InDEStruct Project has received funding from the European Union's HORIZON 2020 research and innovation programme under the Grant Agreement no. 765636.

Vestas aircoil

Claus H. Ibsen, PhD.
Group R&D Director
Vestas aircoil A/S
ci@vestas-aircoil.com
www.vestas-aircoil.com
https://indestruct.eu/
www.linkedin.com/company/vestas-aircoil/

Smart Adhesion: anomalous damping in liquid crystalline elastomers leads to reversible adhesion

Eugene M. Terentjev, a professor of Polymer Physics at the University of Cambridge looks at smart, reusable adhesion through liquid crystalline elastomers

The University of Cambridge, through its ERC-funded APRA project, and the technology spinoff Cambridge Smart Plastics are developing a new concept using liquid crystalline elastomers which are reversibly adhesive, as simple as a hand that grips and lets go on demand.

We have made a naturally sticky rubber that a little heat will alter and allow easy detaching. On cooling, these surfaces immediately get sticky again and are ready to get to work and have a second life. The world's first in terms of a truly reusable adhesive.

Pressure-sensitive adhesion and the future of reusable tapes

Pressure-sensitive adhesion (distinct from the adhesion by gluing) is a large and expanding field of science and technology, relying on tacky and sticky surfaces. All adhesive tapes are single-use and disposable by their nature. Since over 45 billion square metres of pressure-sensitive adhesion (PSA) tapes are produced annually, the environmental impact should not be underestimated.

Even structural bonding tapes that claim to last for a product lifetime end up replaced by new when repairs or adjustments are made. There is also no realistic route to recycling such tapes given the chemicals at play, the compounded plastics or fabrics carrying them, the spoiling of surfaces and/or polymerisation of glues.

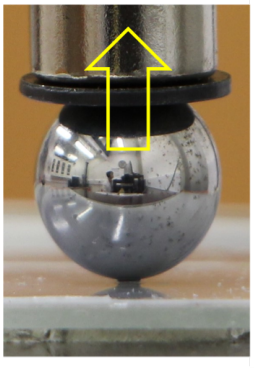
Looking at the state-of-the-art in adhesive tapes, there is no truly reusable tapes. The nearest state-of-the-art exists rely on simple concepts like "hook-and-loops" on each side to create a Velcro, or alternatively a sticky elastomer is stretched to detach, but at the cost of destroying the tape.

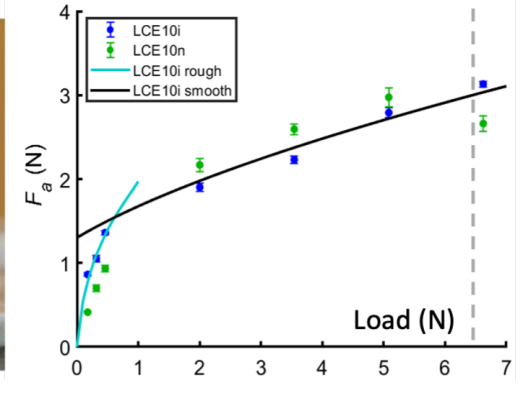
On the premium and performance end of the market, the best technologies rely on weakly crosslinked polymers. These leave no residue and are reusable until they spoil (surfaces contaminated), but delaminating them is difficult as the full strength of the adhesive must be overcome and this often leads to tearing or damage to the tape itself.

Current and future chemicals regulation affect adhesive tapes

Incoming EU bans for ADCA, DEHP, toluene, and formaldehyde (essential blowing agents for rubbers, plasticisers, and solvents), or the increasing focus of the anti-plastics lobby on how tapes have "dodged" the requirements for recycling (both incorporating and their own end-of-life). This makes the future of this field questionable, and many players are looking at possible solutions.

Liquid crystalline elastomers (LCE) represent a highly unusual and exciting 'new state of matter', first introduced in the early 1990s by the work of Finkelmann, Warner and Terentjev. By utilising the known properties of liquid crystals in a rubbery polymer network, some remarkable functionalities were obtained. The main buzz, and the focus of researchers over the last few decades has been exploring the thermal and





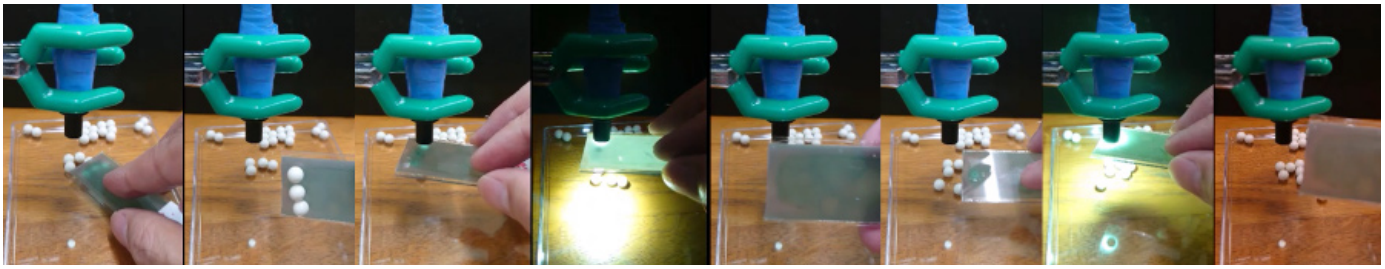


photo-actuation properties of LCE (including our own ERC APRA project).

In the liquid crystalline temperature range, the mesogens that make up the core of this material, align and stretch the polymer chains into an elongated conformation. By heating the sample, this local alignment is lost, and the polymer backbone can relax into a more favoured random-coil conformation. This leads to a macroscopic, reversible deformation called the large-stroke actuation, where all the attention was until now.

Fundamentally changing surface interaction

In our recent studies, we found a direct link between the internal viscoelastic loss in the material (*tanδ*) and the strength of pressure-sensitive adhesion. Since the anomalous damping (high *tanδ*) only exists above the glass transition of LCE, and below its nematic-isotropic transition temperature T_{NI}, the high PSA is only found in this temperature range – by heating above T_{NI}, the surface becomes non-adhesive – but on cooling back below T_{NI}, into the ambient range, the strong surface adhesion is recovered.

Such reversible PSA provides a specific and targeted application to realise immediate value from the LCE research. Our solution to reversible PSA is radically different as the introduction of heat or similar stimuli will fundamentally change the surface interaction and make delaminating easy, so that the surface releases much of what spoils regular tapes. The LCE adhesive tape will also recover its natural shape immediately as in isotropic phase the shape memory element of the more strongly crosslinked network will kick in. Spoiling risk is also reduced as the surface is no longer sticky when delaminating and can be quickly protected or re-applied to another surface. As such, it is a paradigm shift.

We envisage product repairs conducted quickly and easily with the existing tape reused, or wearable tech (e.g. medical sensors or bandages) that can be removed with warm water or washing, ready to be reapplied once cooled and dried. The reusability of a PSA will increase the useful life of products and will challenge the “replace with new” culture in manufacturing and repairs. We also forgo the need for solvents and cleaning to remove tapes and residue. The performance of LCE, as a superior bonding and damping material, will also be powerful in terms of lightweighting, given it has higher performance per volume and leads to thinner tapes, or offshoot products like mounts, washers, bushings, etc. in sectors like automotive.

Addressing UK and EU policies on plastic waste

We see this product being used not just for adhesion but as a vibration damping layer in sensitive systems like LIDAR to increase their accuracy, or in power tools to reduce their vibration effect on the operator.

There are also direct environmental benefits to the end-of-life with this technology. Our 3d-generation exchangeable xLCE systems are crosslinked by dynamic bond-exchange chemistry, which makes it recyclable and re-processable thermoset plastic (vitrimer), unlike any standard elastomeric material. That means even when the product is thrown away, there is a possibility to recover and reuse it. The covalent crosslinks are dynamic and the polymer will flow under heat & stress, and allow itself to be remoulded.

This project addresses UK and EU-wide policies on plastic waste and recycling by introducing reusability, and fits neatly to the EU and UK priorities, e.g. the "Clean Growth" Grand Challenge of the Department for BEIS and EU Green Deal. Specifically, advanced materials technology, where opportunity lies in developing small businesses like Cambridge Smart Plastics, "closely coupled to local universities". Through our collaboration and know-how transfers, we invest into human capital and skills not just in academic journals, but direct to industry across EU through our industrial partners.

CAMBRIDGE SMART PLASTICS

Eugene M. Terentjev
Professor of Polymer Physics
University of Cambridge
+44 (0)1223 337 003
Emt1000@cam.ac.uk
www.smart-plastics.co.uk

Challenges in data handling for big data in multi-omics research

Dr Gastone Castellani (biophysics) and Dr Jeanine Houwing-Duistermaat (statistics) from the University of Bologna, Italy develop methods for big multi-omics datasets

Statistical modelling

The aim of statistical analyses is to draw a conclusion for a population using data from a sample of this population. For example, we are interested in the relationship between cholesterol levels and body mass index (BMI), and we have data on these two variables in a sample. Using these data, we can compute the correlation between the two variables. Under several assumptions, our calculated correlation, the estimate, is a good guess for the correlation between cholesterol and BMI in the population. If the sample size is large, then probably our estimate is close to the unknown true value. In statistics, methods are available to quantify the uncertainty of the estimator. Further, the sample needs to represent the population. This assumption might be violated when specific groups are underrepresented. For example, working mothers might not participate in the study, because they do not have time. Sometimes we can correct for such an underrepresentation, and the obtained estimate might still represent the parameter of interest.

Data quality

Many methods for data analyses also assume that the values in our spreadsheet are equal to the true biological value. In omics research, this is, however, typically not the case. Omics data can be of several types, such as genomic, metabolomic, proteomic and metagenomic and they are measured with various high throughput technologies. Now, several sources cause a discrepancy between the true and the observed value. A lot happens between taking the sample and measuring it in the laboratory. The sample might be transported and stored. The temperature and the time passing from sampling to measurement might affect the quality of the sample. Then the technology has a measurement error, which means that if we measure the same sample twice using the same machine at the same temperature, we will not get the same value. Finally, various technologies do not directly measure the amount of a molecule in the sample but base their value on a property of the molecule such as mass, which also leads to discrepancies between the observed and true values.

> "A lot happens between taking the sample and measuring it in the laboratory. The sample might be transported and stored. The temperature and the time passing from sampling to measurement might affect the quality of the sample."

To draw conclusions using high throughput omics data from a sample for the population, it is important to treat all samples the same, minimize errors and use statistical modelling and methods which consider these errors. If the analysis method does not address the measurement error, the conclusion based on the sample for the population might be wrong and in contrast to what is often assumed the number of individuals cannot compensate for this error.



Gastone Castellani
Professor of Applied Physics and Biophysics

Privacy issues, federated learning, swarm learning and synthetic data generation

With big data measured on the same individual, privacy issues are becoming a concern. Moreover, international collaborations require building huge and shared databases across several countries. Among various methods for solving these issues, we can mention federated and swarm learning and synthetic data generation. Federated learning allows us to leave the data on local sites (for example hospitals) and to move the computational algorithms. After this step of "local learning," there is a centralized phase of learning,

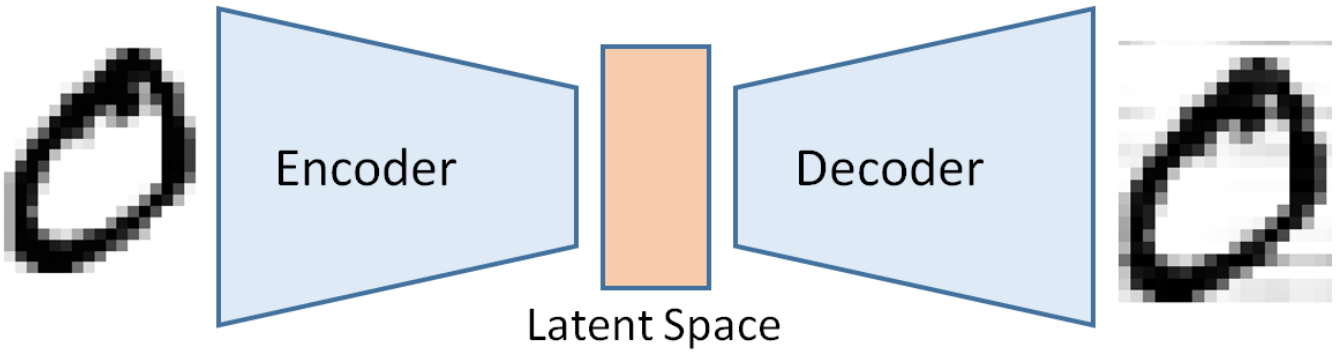


Figure. Schematic view of a variational AutoEncoder. On the left, the original image is projected, by the encoder (usually a neural network) on a low dimensional space (the latent space). On the right, the decoder (another neural network) samples from the latent space and is reconstructing an image similar to the original (with the same statistical properties) but not identical: the synthetic image.

usually by taking the average of the estimates of the model parameters. Swarm learning is a new technique that is becoming to be popular because it does not require the centralized phase of learning.

A synthetic data generation is an approach that not only leaves the data locally but also overcomes privacy issues. The basic idea of synthetic data generation is to sample in a latent space, which is constituted from variables that are not directly observable. Instead, they are transformations of the original observed variables. In mathematics, this is called embedding on a low dimensional manifold or dimensionality reduction. This technique is extremely useful when we must deal with high-dimensional data sets. An example of a simple latent space is a line, where variables in this one-dimensional latent space are obtained by projection. The clue of this approach is that after embedding, it is possible to sample from this low dimensional manifold and reconstruct data that are like the original one in the larger space but not identical. The reconstructed data have the same statistical properties as the original data. The most celebrated techniques for synthetic data generation are the so-called variational autoencoder, which is composed of an encoder (the projection on the latent space) and a decoder (the reconstruction of pseudo-original data by sampling on the latent space).

Because omics datasets vary in properties such as scale, sparsity etc, the synthetic data generation process is heavily data-dependent. For example, genomic synthetic data can be produced by using generative Bayesian methods such as generative adversarial networks (GAN) and variational autoencoder (VAE) and can generate copy number variation, and genomic and chromosomal mutations. Current methods can generate next-generation sequencing data in a platform-dependent way: Illumina, Oxford Nanopore, PacBio etc. Metabolomics can be generated through a mixed approach based on stochastic simulation and probabilistic methods. Imaging data, such as magnetic resonance and X-ray based methods and histopathological whole slide imaging can be generated by using similar approaches (GANs, VAE) and other methods based on the encoder-decoder paradigm.

Synthetic data can also be used to adjust for the underrepresentation of certain groups in our sample. For example, we can generate additional gender and age-specific data if they are not sufficiently represented in our data set.

Thus, making valid conclusions using omics data requires sufficient knowledge about the sample, the measured dataset, and the available methods for storing, sharing and analysis of the data. This is only possible using an interdisciplinary approach.

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 101017549

GENOMED4ALL

BioPhysics

Gastone Castellani
Professor of Applied Physics and Biophysics
University of Bologna
Tel: +390512094745
Gastone.Castellani@unibo.it
https://www.unibo.it/sitoweb/Gastone.Castellani/en

Natural Quasicrystals

By Professor Zbigniew M. Stadnik



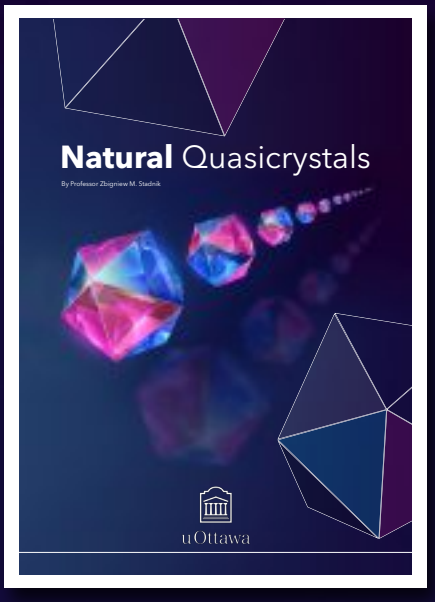
uOttawa

Until 1984, solids were either crystalline, where atoms are ordered periodically (in a repeating pattern) or amorphous, where atoms are arranged essentially randomly. Icosahedral quasicrystals (QCs), discovered in 1984 by Daniel Shechtman in the Al-Mn alloys (the 2011 Nobel Prize in Chemistry), belong to the new, third group of solids where atoms are still ordered, but the pattern is not periodic, i.e., it does not repeat (quasiperiodic order). QCs possess classically forbidden fivefold, eightfold, tenfold, and twelvefold symmetry axes.

From today's perspective, we know that the first ever human-made extant icosahedral QC of composition was formed during the first test explosion of the nuclear bomb on July 16, 1945. It was probably formed from the fusion of vaporized desert sand and copper cables.

As of 1999, all known QCs were manufactured, i.e., synthesized in the lab. They are scarce and have hitherto been found in more than a hundred binary and ternary intermetallic compounds. This number is minuscule compared to the number of known crystalline or amorphous compounds.

A theoretical physicist, Paul J. Steinhardt, was one of a few researchers who wondered whether QCs could also be found in Nature.



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Government's next big task? Avoiding the quantum computing pitfall

David Mahdi, Chief Strategy Officer and CISO Advisor at Sectigo, explores what could be the government's next big task and avoiding the quantum computing pitfall

For more than fifty years, public key infrastructure, or PKI, has been relied upon by almost all organisations to provide the cryptographic backbone which secures devices and the humans using them.

Relatively unknown outside the technology industry, PKI digital certificates provide the digital trust needed to secure critical national infrastructure - from telecommunications to energy supply, the banking sector and even life-critical technology deployed by armed forces worldwide.

Without PKI, public and private network access would not be safe, or secure. Only with PKI can we ensure the devices, people, software, and applications that make up critical national infrastructure remain in the sole control of those trusted with their security.

PKI relies mainly on two algorithms, which form the basis of current cryptography: the RSA 2048 (Rivest – Shamir – Adleman) and ECC 256 (elliptic-curve cryptography). These algorithms are the foundation of the 'digital stamps' which verify and protect human and non-human, or machine identities used to access sensitive data across government and all industries. However, change is coming.

What could be the quantum computing pitfall?

Like most things, nothing lasts, and the PKI organisations the world over have relied upon to maintain digital trust has an emerging and very real threat. We are now standing at the precipice of a new age of quantum computing; an advanced type of computation that leans on quantum physics to run multiple processes simultaneously. Quantum computing will render traditional PKI, as we know it, no longer fit for purpose.

This poses a very real threat to the information security systems we all rely on to protect our freedom and liberty. To remain secure, government agencies will have to adopt new families of quantum-resistant cryptography. Now is the time to prepare for this transition.

The step-change quantum computing will bring cannot be underestimated. The average computer trying to break a message encrypted with our common RSA and ECC algorithms would need around 300 trillion years. A quantum computer, with its ability to 'guess' keys in parallel, would need around a week.

What would happen when the first quantum computer becomes powerful enough?

The effects will be dire; when the first quantum computer becomes powerful enough, even data under the highest encryption will become easily decrypted by whoever has access to a functional quantum computer.

In fact, some adversaries are already saving encrypted content, that they will later look to break with quantum computers (and perhaps other methods). This could be anything from the control systems upholding the national electric grid, remote devices controlling the water supply, systems operated by the armed forces or secret services, even the central banking system. Scientists consider the predicted fallout of quantum computers so severe it's called the Quantum Apocalypse.

Given the gigantic steps forward in the research and development of quantum computers, with Google, Honeywell, and indeed China in the race, it is a matter of when rather than whether quantum computers will change the digital world as we know it. One thing

is certain: Governments must implement new cryptographic alternatives as soon as possible.

Quantum-resistant alternatives

Work is already underway to overcome this looming issue: The USA's National Institute of Standards and Technology (NIST) is working to find quantum-resistant alternatives to our current algorithms. Organisations across the world, from the fields of academia, technology, and the public sector, have united to collaborate in the discovery of new, quantum-safe algorithms.

> "The step-change quantum computing will bring cannot be underestimated. The average computer trying to break a message encrypted with our common RSA and ECC algorithms would need around 300 trillion years. A quantum computer, with its ability to 'guess' keys in parallel, would need around a week."

NIST coordinates their efforts, and its Post-Quantum Cryptography project is well en-route to identifying and vetting potential next-generation cryptographic schemes, which it expects to do by 2024.

Even before the NIST arrives at its final candidates, government agencies must begin the transition to quantum-safe PKI certificates to withstand the Quantum Apocalypse.

This process presents the core challenge: replacing every one of the trillions of certificates and keys in circulation in our digital systems is a gargantuan task given the variety of types, sources, issuers, lifespans, and a myriad of other factors. For every government around the world, this is mission-critical: failure to replace even one certificate could lead to breaches, data exfiltration, or operational disruption.

How do we avoid the quantum computing pitfall?

The first step is to gain a full understanding of all certificates and keys present in the public environment, and enable government IT to replace them at will, regardless of their specificities. The only way to make this shift effectively and safely is to leverage crypto-agile automation.

That is a crypto-agile approach, which anticipates frequent changes across, potentially, millions of


David Mahdi

certificates, keys and cryptography. One example, as it pertains to certificates is with Certificate Lifecycle Management. This allows organisations to manage all the certificates in the enterprise system at once, renewing, deploying and revoking them as necessary.

Deploying these CLM solutions now can ease the transition to quantum-resistant certificates. The most advanced CLM solutions can manage the transition of all certificates, independently of their particulars, including which Certificate Authority issued them originally. This makes CLM extremely effective in the transition from existing PKI certificates to quantum-resistant ones, as it ensures no stone will be left unturned.

While the cryptographic community works to standardise quantum-safe algorithms, players who have been securing the digital systems since the dawn of the internet have published free sets of resources like Quantum Labs.

Organisations and governments must arm themselves with the tools to migrate to quantum-resistant algorithms and prepare for the quantum era. In this way, they face the quantum era as a leap forward, not a jump into the void.

David Mahdi
Chief Strategy Officer
CISO Advisor at Sectigo
Tel: +1 (914) 732 8446
Sales@Sectigo.com
https://sectigo.com/
https://twitter.com/sectigohq

Verification in Quantum Computing

Quantum computing promises to change the way we tackle certain problems in the future, however, developing applications for this new and upcoming technology has proven to be quite a challenge



Many tools and conveniences we take for granted today when developing classical circuits and systems (such as simulators, compilers, verification methods, debuggers, or high-level programming languages) are barely available to quantum developers. Due to this limited tool support and lack of automation methods for the design of quantum applications, developers need to conduct many of the tedious and error-prone design steps manually. It is estimated that developers for classical circuits and systems already spend roughly 75% of their time debugging. Without proper methods and tools, this is bound to get worse in quantum computing – motivating corresponding verification approaches.

The Subtlety of Bugs in Quantum Computing

In contrast to classical computing, where errors typically manifest themselves in the form of compiler errors or program crashes, bugs in quantum programs frequently are more subtle. A quantum program might have successfully run on a quantum computer, but the obtained results may be nowhere close to what the developer expected. Making matters worse, a recent study has shown that around 40% of all bugs encountered in developing quantum computing applications stem from the tools used for their development (e.g., for compilation and optimization). This means that, when the code is not behaving as expected, there is a 4 out of 10 chance that this has nothing to do with the algorithm design itself or the programmer. Thus, days and days may be spent on debugging code without avail. It is crucial to provide quantum developers with automated methods to check that what is executed on the quantum computer still realizes the originally intended functionality.

Equivalence Checking of Quantum Circuits

Conceptually, checking the equivalence of two quantum circuits (e.g., the algorithmic description and the low-level implementation) is rather straight-forward. The functionality of each gate g in a quantum circuit G is described by a (unitary) matrix U. Consequently, the functionality of a whole quantum circuit can be constructed by subsequently multiplying all individual gate matrices. Then, checking the equivalence of two circuits reduces to the comparison of the respectively obtained matrices. However, the size of the involved matrices grows exponentially with respect to the number of qubits and, as a result, necessitates special data structures and methods for all but the most trivial cases.

Researchers at the Technical University of Munich, the Johannes Kepler University Linz, and the Software Competence Center Hagenberg are working on efficient techniques for this challenging problem. In their efforts, the computational paradigm of quantum computing and its technicalities are not seen as a burden, but rather as an opportunity. In classical computing, operations do not have to be reversible, i.e., it is not possible to compute the inputs to an operation from its outputs. For example, if the logical *AND* of a and b is 0, it is not possible to uniquely determine a and b. In contrast, every operation in quantum computing is inherently reversible.

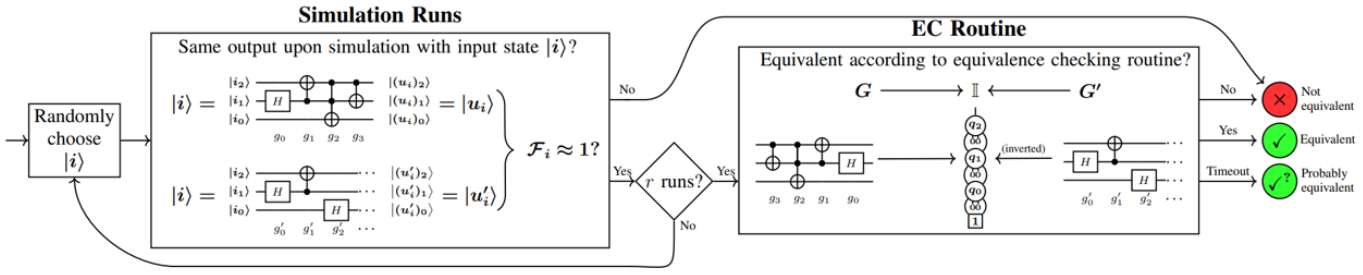


Figure 1: Equivalence Checking Flow for Quantum Circuits

Click to enlarge

This reversibility allows to invert a quantum circuit easily (by reversing the order of operations and inverting each individual operation). Combining the original circuit and the inverse of the other circuit allows to reduce the question whether two circuits are equivalent to the question whether the combined circuit realizes the identity function, i.e., the function where the output always equals the input. For many commonly used data structures, such as decision diagrams or tensor networks, the identity has a very compact representation. Thus, starting from this compact structure, an efficient way of checking whether both considered circuits are equivalent is to alternatingly apply gates from either circuit (G or G'^{-1}) with the goal of staying as close as possible to the identity. If the identity results at the end of this procedure, the circuits in question are considered equivalent.

Moreover, in classical computing, the inevitable information loss introduced by many logic gates (such as observed for the *AND* gate above) frequently makes it hard to detect errors in classical circuits and systems. Thus, sophisticated schemes for constraint-based stimuli generation or fuzzing are necessary to adequately check the functionality of such systems. Again, quantum characteristics improve the situation considerably. Due to the reversibility, even small errors frequently impact the whole functionality of a quantum circuit. This makes probing quantum circuits with randomly chosen input states a feasible (and computationally less complex) alternative to checking the complete functionality as demonstrated above.

A First Step Towards Aiding Quantum Software Engineers

These complementary observations for checking the equivalence of quantum circuits form an advanced equivalence checking flow that is illustrated in Figure 1. The corresponding methods have been published and incorporated into open-source software available to all researchers and engineers in the field (see box above). The resulting tool natively integrates with IBM's SDK Qiskit and can be used to verify that a high-level quantum circuit has been correctly compiled to a specific device using Qiskit. This provides users with the confidence that what is actually executed on the quantum computer is what was intended and that no error has been introduced through compilation.

Open-Source Software Tools

The tools described in this article are publicly available as open-source at https://github.com/cda-tum/qcec. Furthermore, a web-based graphical interface showcasing a lightweight visualization of what is going on under the hood of the verification method can be accessed at https://www.cda.cit.tum.de/app/ddvis/. More details on the sketched concepts are provided at https://www.cda.cit.tum.de/research/quantum_verification/ and the papers linked there.

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Robert Wille
Professor
Technical University of Munich and
Software Competence Center Hagenberg
Tel: +49 176 23 44 09 64
mail@rwille.de
www.rwille.de
https://twitter.com/rbrtwll

Education, science & research for Germany's future

Promoting the policy areas of education, science and research are crucial for Germany's future prosperity, according to the Federal Ministry of Education and Research (BMBF)

Promoting the policy areas of education, science and research play a vital part in securing Germany's future prosperity. [1]

Germany's current Federal Minister of Education and Research, Bettina Stark-Watzinger [2], believes education and research are both hugely important for the development of the country. It is interesting to learn more of her thoughts on this in a December 2021 interview. On education and research for the future of Germany's people, Stark-Watzinger affirms that each person can be empowered, and the means to achieve this is simply education. She develops this point and adds that research and innovation both provide a basis for future progress and to tackle grand challenges.

"Education starts at day care centres and continues at school, in vocational training and higher education and, ideally, throughout our lives. This is how we create opportunities and enable individual careers for anyone, whatever their personal background. Better education provides for advancement and self-determination as well as for growth and prosperity. Its twin is research and innovation. The two of them provide the basis for progress and are urgently required to address grand challenges such as COVID-19, digitalization and climate change."

Education & research for future prosperity

Stark-Watzinger gives fascinating insights into her key plans for the coming years, stating that more progress is desired by the coalition and that education and research play a critical role here. "Education and research will play a key role in this regard. They are the most important drivers of progress in our country," the Minister comments.



Humoldt high school building in Constance (Konstance), Germany.

COVID-19 underlines the need to give education a modernisation boost in Germany, so that's why it is vital to make the Digital Pact speed up by reducing bureaucratic obstacles, Stark-Watzinger states. The Minister also details reforming BAföG training assistance and giving extra support to children and young people with special needs. It is worth explaining first that BAföG means training is funded by the public sector, so the state provides individual trainees with the finances required to cover training fees and living expenses. [3]

"We want to reform BAföG training assistance and make it less dependent on parental income. And we want to provide additional support to children and young people who are in special need to give them a better educational start in life," Stark-Watzinger says.

Also, Stark-Watzinger sets out to do more for the multi-faceted research landscape that characterises Germany. As such, increasing government expenditure on research development is important for Stark-

Watzinger in her role as Federal Minister of Education and Research, but having said that she wants to remain curious when wearing her researcher's hat. The latter is an interesting observation if we know something of Stark-Watzinger's background, indeed, she worked in the management of two financial research institutions in Frankfurt for nearly ten years before being elected to the German Bundestag as a member responsible for the budget of the Ministry. (4)

Education: BMBF support for Ukrainian students

Returning to the theme of education, we see in late May the Federal Ministry of Education and Research (BMBF) with the German Academic Exchange Service (DAAD) expands support (worth €9 million) for students who have departed Ukraine.

Federal Education Minister Bettina Stark-Watzinger reveals more about this very valuable initiative. Students who have left Ukraine need BMBF's support, hence the expansion of existing programmes. "With the two new digital programmes, we are contributing to the continuation of teaching at Ukrainian universities for the first time. In addition, we support German universities in their efforts to offer existing courses in a virtual format to prepare refugee students for studies in Germany.

"This broad approach enables students and prospective students from Ukraine to quickly continue or start their university studies. We are thus providing for a certain degree of continuity and offering prospects for young people. I hope that the war will soon end so that they can return home." (5)

Looking ahead: A research challenge

An exciting area to close this article concerns research and innovation on green hydrogen. This supports the aforementioned aim of BMBF concerning the vital role research plays for Germany's future prosperity.

BMBF coordinated the Strategic Research and Innovation Agenda (SRIA), which in the European Research Area concerns science, industry and civil society all trying to accelerate the upscaling of the hydrogen economy. Bettina Stark-Watzinger explains that climate change is a huge challenge for humanity and that when tackling this, the focus will be placed on technology instead of lifestyle change.



Jonathan Miles

"The Strategic Research and Innovation Agenda is to serve as a nucleus on the way towards a European Hydrogen Union. The Agenda Process on Green Hydrogen is thus also a blueprint for future broad-based initiatives of the Member States in an advanced, more dynamic European Research Area. This is important because only by working together can we achieve our climate goals," the Minister stated (6). Certainly, we know that the BMBF sets out to "advance research on green hydrogen along the entire value chain". (7)

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Jonathan Miles
Managing Editor, Open Access Government
Open Access Government
editorial@openaccessgovernment.org
www.openaccessgovernment.org
https://twitter.com/OpenAccessGov

ARENA2036 – co-creating leapfrog innovations beneath one roof

Dr Clemens Ackermann at ARENA2036 discusses the leapfrog innovations taking place in a variety of disciplines and in research





About ARENA2036

Since 2013, applied research on the mobility and production of the future has been conducted in the Active Research Environment for the Next generation of Automobiles, or ARENA2036 for short, right in the middle of the university campus in Stuttgart-Vaihingen, Germany.

More than 50 organisations from sciences and industry are working hand in hand to bring forth leapfrog innovations in a variety of disciplines, such as aerospace, automotive, material sciences, production technologies, or intralogistics.

At the heart of the industrial and automotive metropolitan region of Stuttgart, the research campus forms an essential link between science and industry through leapfrog innovations. Small and medium-sized enterprises, large corporations, start-ups, universities, and research institutions all benefit from each other in more than 25 active research projects.

Their key topics range from mobility, production, and work of the future to digitalization. Within these projects, our partners benefit from state-of-the-art technologies such as 5G networks, novel approaches in intralogistics, rapid prototyping, and automated additive manufacturing.

The original focus on further developing the automobile itself has broadened considerably since ARENA2036 was founded. Today, the year 2036 no longer only symbolizes the 150th anniversary of the automobile, but above all, the goal to redefine today's concept of mobility and production by then.

Therefore, new technologies, concepts, and ways of production for the future of mobility need to be devised. Alongside the conceptual and theoretical work, the experts at ARENA2036 create environments to build, test, and improve demonstrators of the tools and products, that are needed to fulfil said objectives.

The cornerstones of the Research Campus

Four of the projects, so-called joint projects, form the strategic cornerstones of the research work at the Research Campus:

1. *FlexCAR*, a standardised vehicle platform that enables the transformation of rigid supply chains into resilient, flexible supplier networks based on its open soft- and hardware interfaces. In addition, superstructures for a wide variety of application purposes can be cyberphysically developed for the open platform. Taken together, the concept conceives an updatable and upgradable car.

2. *The Digital Fingerprint*, which forms a uniform, consistent database for Industry 4.0 production. It connects



many of the projects on site with each other and facilitates collaboration between different projects as their status progresses.

3. *Fluid Production* enables highly flexible production environments based on the cyberphysicality of all components. A variety of scenarios are being tested on site in the research factory. Thus, production machines and processes on autonomously driving robots become independent of their location due to their adaptability on a variety of scenarios.



4. The close collaboration on campus requires new approaches to cooperation. For example, concepts for joint research work on campus are developed at the *Agile Innovation Hub* and researched in their implementation. The Joint Project can thus be seen as an interface project between many other projects on site.

Short paths to leapfrog innovations

On the way to Industry 4.0, the co-creative and interdisciplinary collaboration at the Research Campus proves that short paths in research and development provide crucial advantages for innovative work environments. Technologies such as Internet of Things in 5G networks are quickly implemented into practical demonstrators and thereby provide valuable testbeds for pre-competitive developments and research. In combination with the close network of partners, companies can quickly transfer their outcomes into the industry.

ARENA2036 sees itself as the provider of a versatile platform to strengthen partnerships between organisations and push forward the development of potentially disruptive technologies. By breaking down silos inside organisations themselves as well as borders between multiple institutions, this blueprint becomes reality and thus paves a completely new way for research and development.

In the coming years, ARENA2036 will continue to be a door opener for start-ups, research, and innovation, bringing a breath of fresh air into the industry and strengthening Germany as a globally renowned technological melting pot. The future trajectory of the Research Campus puts a strong emphasis on sustainability and connectivity within the context of automotive production.

ARENA2036

Dr Clemens Ackermann
Deputy Managing Director & Research Coordinator
ARENA2036
Tel: +49 (0)1754 385 589
clemens.ackermann@arena2036.de
https://www.arena2036.de/en/
https://twitter.com/arena2036

The failed promises of the Universal Declaration of Human Rights on the right to education

Anantha Duraiappah, Director at UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP), describes the failed promises of the Universal Declaration of Human Rights on the right to education

In a historical achievement for humankind almost 75 years ago, the Universal Declaration of Human Rights clearly recognised education as a basic human right. Although a non-legally binding document, it became the first international instrument to acknowledge the importance of the right to education for individuals and societies.



Anantha Duraiappah
Director
UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP)

What are the specific clauses of Article 26?

• Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.

• Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.

• Parents have a prior right to choose the kind of education that shall be given to their children.

Today we find education a booming industry with privatisation having taken hold of the sector. This commodification of education has inevitably created an elitist system of private schools with the best funded providing the "best" education to those who can afford the fees for attending these private schools. This forms what Daniel Markovits in his book "'The Meritocracy Trap" describes as a new aristocracy in the form of heritage meritocracy. The recently launched International Science and Evidence based Education (ISEE) Assessment report by UNESCO MGIEP identifies it as a key driver to the growing inequity that spills over to the stratification of societal structures into the "haves'" and "have nots".

In addition to the commodification of the education system, the ISEE also highlights the standardisation of curricula, pedagogy, and learner assessments. The "one size fits all" has become the mainstay in education even if we have overwhelming evidence, now endorsed by the latest findings from the ISEE Assessment, that each learner learns differently. For example, we now know that one in every five to ten learners have some form of learning differences which our present "one system fits all" just does not accommodate.

Flaws of the present education system

A key policy recommendation suggested by the ISEE Assessment is to initiate periodic universal screening to identify each learner's strengths and weaknesses and then find interventions to nurture the strengths and minimise the weaknesses. The present inclusive education system is just not sufficient in its current form.

The second flaw in our education systems, and this is not a new phenomenon, is the assumption that education is all about knowledge acquisition. In other words, the focus in on the cognitive dimension of each learner. But we now know, and strongly emphasised



by the ISEE Assessment, is that learning is not just a cognitive process but an interconnected phenomenon between cognition and emotion. Simply put, learning is influenced by emotions and emotions influence our learning. But let's not make the mistake of switching from one end of the spectrum to the other - it is key to understand that learning is indeed an inter-connected process between cognition and emotion.

Acknowledging these two main fundamental insights will suggest a complete restructuring of our present curricula, pedagogies, and learner assessments. The focus will shift to ensuring that they all take this whole-brain approach, and the learner is given the agency to chart their own learning path while being evaluated against their own benchmarks. This approach will still ensure learners are meeting basic criteria for the foundational competencies of literacy, numeracy, emotion regulation, empathy, and compassion.

Restructuring the present curricula

Last but not least, what is critically missing in our present education policymaking is the use of science and evidence. To achieve this, a transdisciplinary approach involving experts from a broad range of disciplines must be made intrinsic to policymaking and the notion of consensus science must be advocated. There will always be uncertainties in our knowledge base on how learning happens and how context influences the learning process. Therefore, a process which advocates consensus among the experts is a necessary condition in any education policymaking.

Anything falling short of this shift means propagating education policymaking based on opinions and ad-hoc information held by a limited number of players in the field. Ideally, an international neutral science body which has the remit to pool this transdisciplinary network of experts from across the world should be created to ensure global assessments similar to the ISEE Assessment are done periodically to update our information base, establish a database of evidence from across the world and strengthen the science-policy nexus within the education sector. Until then, we will continue to fall short of delivering on the basic human rights declared in 1948 – most particularly, the right to education.

Anantha Duraiappah
Director
UNESCO Mahatma Gandhi Institute of Education for Peace and Sustainable Development (MGIEP)
Tel: +91 11 2307 2356 60
https://mgiep.unesco.org/
https://twitter.com/UNESCO_MGIEP

How can education help to bridge the STEM diversity gap?

Victoria Knight, Strategic Campaigns Director at BAE Systems Digital Intelligence, explores the importance of education in overcoming the STEM diversity gap

STEM careers have taken centre stage over the past few years, with the technology industry continuing to grow at an unprecedented rate. However, finding the right talent and digital skills to match this growth has become a huge challenge for many STEM employers.

Despite a significant rise in the use of technology across sectors, participation in digital skills training is declining. On top of this, starting as early as nursery school, there is a clear pattern of disadvantage for STEM students based on race, ethnicity, gender, and class. This is resulting in missed potential and failure to unlock a broad range of digital talent.

This is exemplified by recent data from PNAS, which reveals only 25% of STEM jobs were held by women in 2020. We must also look at social mobility and racial equity within these industries. For example, facial recognition technology is currently failing to identify black females. With bias present in automated facial analysis algorithms and datasets, fundamental changes within STEM fields have never been more necessary.

Steps have been taken in recent years to close the STEM diversity gap, but more needs to be done to encourage people from all backgrounds to pursue these fields. This starts with promoting inclusivity in STEM education and inspiring underrepresented groups from an early age. In turn, this will help to develop tomorrow's STEM talent, increase the likelihood of success for underrepresented minorities and bridge the growing skills divide.

So, what can be done to make STEM more diverse and inclusive in the UK?

Encouragement and inclusivity in the early years

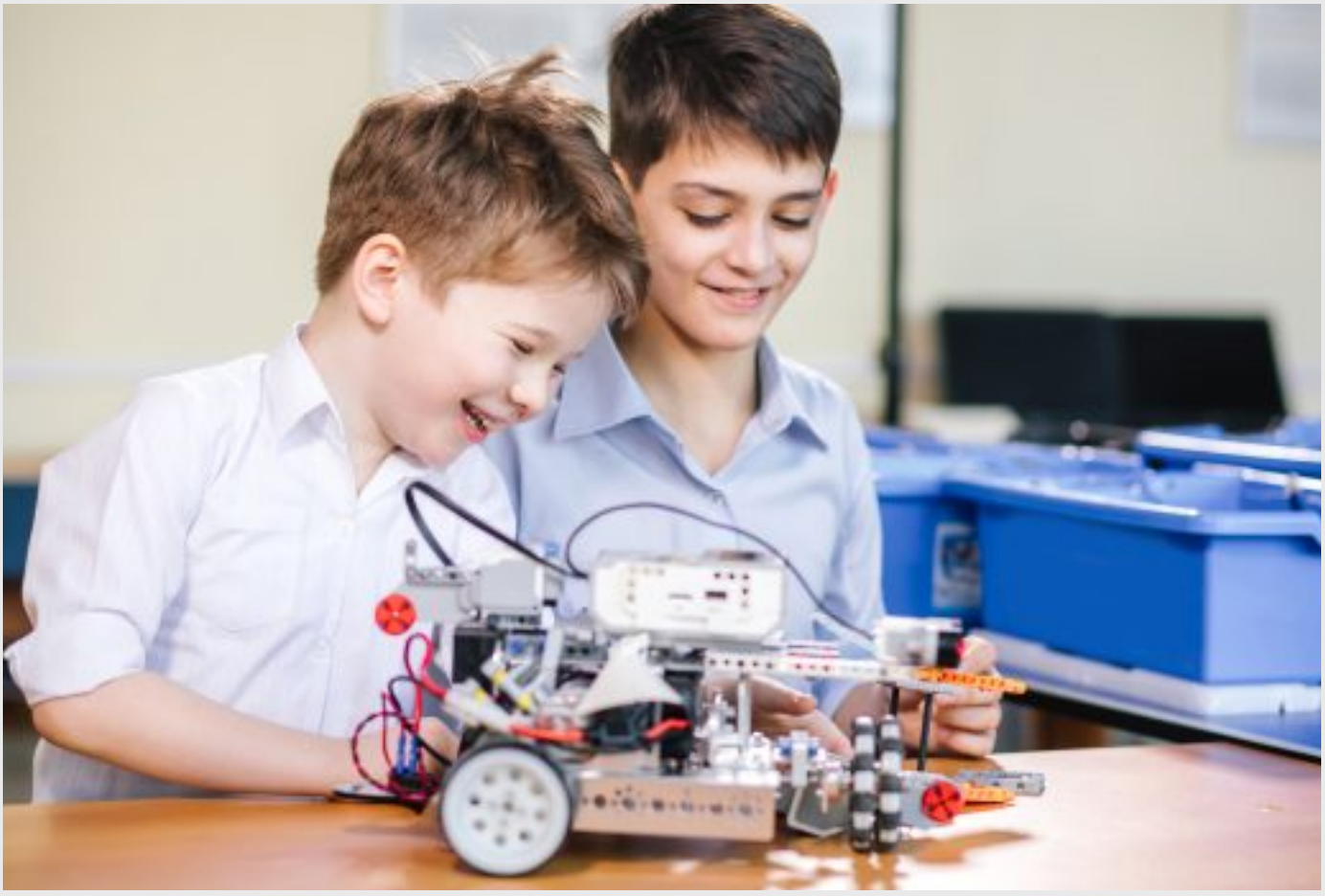


Victoria Knight

The national curriculum for STEM learning is growing, but there is still a lack of information, advice, and role models out there to encourage young people from all backgrounds to consider a career in these fields. STEM subjects are therefore still widely perceived as exclusionary, and this rings true from nursery school all the way up to the boardroom.

To combat this disparity, steps must be taken from an early age to inspire underrepresented groups to pursue STEM careers. For example, it has been found that role models for minority students will help them to develop a greater sense of belonging, by enabling people with similar backgrounds to envision themselves working in these fields. The importance of visibility is also highlighted by data from Microsoft, which found that young girls with female role models are 50% more likely to consider STEM subjects and careers.

Essentially, embracing diversity in students, recognising their differences, and adapting the curriculum to meet their unique needs is crucial to fostering a wide range of digital skills. However, changing the curriculum alone will not be enough to tackle this shortage.



Opening doors through alternative education

To help bridge the STEM skills gap, schools, universities, and organisations must also focus on promoting alternative routes into STEM careers. For example, digital training courses, bootcamps, workshops and apprenticeship programmes have proven to be effective ways of nurturing high-level talent from an early age.

To attract talent from all backgrounds, organisations and institutions must watch out for exclusionary language in advertisements. They must also reposition their marketing strategies and make learning opportunities more accessible for all. For example, when designing a training course, it is important to consider the diverse needs of a range of learners. This will include tailoring activities to various social and cultural backgrounds.

Here at BAE Systems Digital Intelligence, we host a range of seminars and events aimed at increasing diversity within STEM fields, as well as organising regular cyber courses to encourage women from different backgrounds to develop their digital skills. This includes our partnership with Code First Girls, in which we are sponsoring its CFGdegree programme to encourage greater workplace diversity.

Ultimately, we must all work together to help tackle the diversity challenge in STEM and provide greater opportunities for people from all backgrounds to enter these careers. A diverse and inclusive workforce not only contributes to greater innovation but will also enable organisations to resolve problems swiftly with a wide range of skills to draw on.

Victoria Knight
Strategic Campaigns Director
BAE Systems Digital Intelligence
STEM Ambassador and Member of Manchester's Cyber Advisory Group
www.baesystems.com/en/cybersecurity/home
https://twitter.com/baesystemsplc



Engineering solutions for ecological problems

Christine M. Cunningham, Professor at The Pennsylvania State University, discusses engineering solutions for children to help solve ecological problems

Students need to understand how engineered technologies come to be created through better engineering solutions. This includes not only engaging with engineering concepts, practices, and processes, but also reflecting upon how engineering impacts people, communities, and the environment.

Children are natural engineers – they stack blocks, construct forts from pillows and blankets, and design habitats for their dolls or pets. To nurture such problem-solving proclivities, educational spaces should provide opportunities for children to learn about the human-made, or engineered, world they inhabit. Engineering shapes the world we live in – clean water, safe food, strong buildings, instant communication, and cutting-edge medical devices are all products of engineering.

Engineering, science, and mathematics concepts intertwine. Using scientific and mathematical knowledge and tools to solve authentic engineering problems that invite original solutions can motivate students and help them learn disciplinary content. High-quality, intentionally designed, experiences and curricular materials promote such interdisciplinary learning.

Youth Engineering Solutions

Youth Engineering Solutions (YES) aims to help educate the next generation of problem solvers and engineers by developing equity-oriented, research-based engineering and STEM curricular resources for K–8 youth and their educators.

YES curricular units integrate with commonly taught life, physical, and earth science concepts and are anchored by an equity-oriented model for engineering learning. As they work collaboratively to design innovative solutions to real-world problems, students use engineering, science, and computational thinking ideas and practices. YES aims to empower all students, particularly those from populations underrepresented in STEM, to develop engineering proficiency and confidence, which build their engineering and problem-solving identities.

Engineering challenges can integrate with life science and ecology concepts. For example, in the YES *Engineering Pumpkin Pollinators* unit, as students ages 6–8 learn about life cycles of plants and pollination they are introduced to an engineering problem and asked to generate original solutions.

The next sections describe how students use socially engaged engineering and an engineering design process to address the challenge.

Socially engaged engineering

Youth need to understand how engineering connects to their lives, communities, and cultures. Socially engaged engineering design centres on real-world problems. It also helps students recognise that a range of stakeholders (including people, animals, and the environment) benefit or are harmed by engineering solutions. Through such work, students develop empathy and perspective-taking as well as more robust solutions.

In primary grades, YES uses a short, illustrated story to introduce engineering. The *Pollinators* story features two farm children, Jake and Alex. They worry that due to their declining pumpkin crop they will not have a pumpkin for the annual fall festival.

They identify a decrease in the bee population as a possible cause – flowers that are not pollinated do not bear pumpkins. Jake and Alex solve the problem by engineering a hand

pollinator that moves pollen from flower to flower. After reading the story, classroom students will also design a pumpkin pollinator.

A systematic problem-solving approach – the engineering design process

The characters also model a problem-solving approach—the engineering design process—that students also use to structure their work.

The Engineering Design Process



In the **Ask** phase, students deepen their understanding of the problem and related scientific and engineering concepts. For example, in the *Pollinators* unit, students explore how biological systems function. How do bees help plants produce fruit? Why is a decline in the number of bees problematic? Why are bees good pollinators for pumpkins?

Structured activities help students construct these critical understandings. In one lesson, students assemble a life cycle/pollinator puzzle and think about the effects if one step is missing. In a subsequent lesson, students act as bees to pollinate pumpkins. As sickness strikes their colony, they record



data to observe that fewer bees mean less pollination which results in fewer pumpkins. Finally, students consider the actions of pollinators and shape of pumpkin flowers to identify attributes of good pumpkin pollinators.

Students use this knowledge to inform the design of a hand pollinator that mimics bees' pollination strategies. They identify criteria and constraints their device must meet. For example, it must pick up and drop off pollen, preferably to multiple flowers.

They investigate the materials available for their designs – pompoms, erasers, toothpicks, straws, pipe cleaners, feathers, marbles – to determine which as best at moving pollen (modelled with baking soda). They **Imagine** a number of possible solutions to the problem. In pairs, students **Plan** a design and sketch it. Then they **Create** and **Test** it to see how well their pollinator functions to transfer pollen from flower to flower. Using the data they collect, they iteratively **Improve** their solution.

Engaging students such real-world, hands-on engineering solutions, which draw on science knowledge, results in better student learning outcomes for both engineering and science learning. As they use science and engineering to address challenges related to their lives and the environment, students also deepen their understandings of the interconnectedness of disciplines and develop problem-solving skills.

This work is funded in part by the National Science Foundation Grant #205434 and The Pennsylvania State University.

Christine M. Cunningham
Professor
Practice in Education and Engineering
The Pennsylvania State University
Tel: +1 814 865 0861
ccunningham@psu.edu
https://ed.psu.edu/directory/dr-christine-cunningham
https://yes.psu.edu
https://twitter.com/cunninghamcm
https://www.linkedin.com/in/christine-cunningham-b42684a/
https://www.linkedin.com/company/youth-engineering-solutions

EX-PED-LAB- Sustainable designs for Early Childhood Education Professional Development through workshop methodology

The project EX-PED-LAB is first and foremost a response to the call for generating scholarly knowledge about exploration as a methodology for early childhood education.

The project EX-PED-LAB is first and foremost a response to the call for generating scholarly knowledge about exploration as a methodology for delivering collaborative and responsive pedagogical program design to support early childhood education innovation in kindergartens, kindergarten teacher education and in practice-oriented research in Norway.

EX-PED-LAB is the short name for 'Exploration and Pedagogical Innovation Laboratory' and refers to how the use of workshop methodology can create change and innovation in pedagogical practice in Norwegian early years institutions and teacher education kindergartens and in universities educating staff for ECEC work life.

Our workshops bring together teachers, managers, students, and researchers – and occasionally artists, designers, children, and families – for joint exploration and co-creation. The project takes on a whole-institution approach where sustainability is embedded in all processes and operations. Staff and students will meet the topic in curriculums, frameworks, and strategic institutional documents. Tasks will respond to these as well as to participants experiences of success, tensions, and worries. These experiences are reformulated by an interdisciplinary team consisting of local authorities, kindergarten management staff and researchers.

Interdisciplinary co-creation in early childhood education

The interdisciplinary teams will negotiate and develop nudging activities which are inquiry based and include play qualities and explorative engagement. The workshop activities are designed in loops, including preparatory tasks, exploration and imagination activities, design thinking, co-creation of ideas and experiments, documentation, and evaluation. There will always be reflexivity tasks included (e.g., oral, artistic expressive, narrative writings, questionnaires or focus group dialogues). For example, the project "Kindergarten teacher as co-researcher - innovation project for testing an exploratory research design for knowledge development in the kindergarten sector", was funded by the Regional Research Fund in 2019 (RFFVEST – 305594) and served as pilot scheme in 2019-2021 (Birkeland et al., 2022; Ødegaaard et al., 2022).

The pilot scheme gave some ideas to success criteria and wicked tensions and problems (Ødegaard, in print). In bringing together interdisciplinary groups in participatory research, new thinking and the building of a sustainable future oriented educational system can be achieved in the early childhood education and in teacher education (Birkeland et al., 2020; Birkeland et al., 2021; Bærheim et al., 2022; Wals, 2014).

On this background the project for 2021-2025 concentrates on gaining a meta perspective on workshops as methodology. Aspects of sustainability will be reflected in pedagogical cultures and environment in the materials used. The project is a response to findings and recommendations in the final report from the UN Decade of Education for Sustainable Development (2005-2014): Shaping the Future We Want). The report recommended that research and assessment on local ESD policy approaches was strengthened (UN-2014).

EX-PED-LAB provides research, assessment, and a toolbox on how municipalities can engage directly with local kindergarten institutions; how teachers can work with staff development through workshop methodology; how teacher education

might provide additional leverage to meet their sustainability commitments and strengthen cultures of exploration; and inquiry-based approaches to teaching and change to achieve goals for better quality, both in pedagogical and physical environments in kindergarten and teacher education.

So, what do we do?

Some of the workshops take an academic approach to early childhood education. They involve analysis and response to work prepared by the participants, which may entail observations, drawings, stories, photographs, and films. Others will take a practical approach whereby individuals use their imagination and try out different solutions, using materials and play qualities (Guddiksen & Skovbjerg, 2020). We have been working in the landscape where a new kindergarten is planned to be built, creating imaginary scenarios with natural materials on site and discussing risk, rules, and regulation afterwards, to see what ideas to bring forward in the process of building an outdoor space designed for inclusive play and exploration for children aged one to five. By establishing a stage and a forum where preschool teachers and managers can play and explore with architects and researchers, new opportunities for sharing experiences and transcending internal professional knowledge are made possible.

The EX-PED-LAB project responds to the call for scholarly knowledge to inform the design and delivery of collaborative and responsive pedagogical programmes that support innovation in kindergartens, in kindergarten teacher education and in practice-oriented research in Norway. The EX-PED-LAB combines these into interdisciplinary research to facilitate new thinking and new knowledge that supports a future-oriented kindergarten education system. The EX-PED-LAB is a research hub within which interdisciplinary teams across the sectors of early childhood education, research, practice, administration, teacher education and design can imagine, debate, research, innovate and generate new knowledge for the development of new practices for immediate transformation of the kindergarten sector. The project addresses the UN's SDG 4 on quality education and 17 on inclusive partnerships and pursues environmental sustainability in the results.

Project facts: *Funded by the Research Council Norway 2019-2025*
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Western Norway University of Applied Sciences

Elin Eriksen Ødegaard
Director and Professor in Early Childhood Pedagogy
Western Norway University of Applied Sciences
Tel: +47 555 85 932
eeo@hvl.no
Elin Eriksen Ødegaard - Western Norway University of Applied Sciences (hvl.no)
Website center: KINDknow - Kindergarten Knowledge Centre for Systemic Research on Diversity and Sustainable Futures - Western Norway University of Applied Sciences (hvl.no)
https://twitter.com/Sereptine

A gendered view on ICT and social inclusion

Dr Sarah Mohammad-Qureshi, Equality, Diversity and Inclusion Partner at The University of Law, presents a gendered view on ICT and social inclusion

In the current age of digital advancement, it is tempting to assume widespread access to smart technology and the internet. It may seem even more inconceivable how gender could serve as a barrier to digital literacy and digital access through social inclusion.

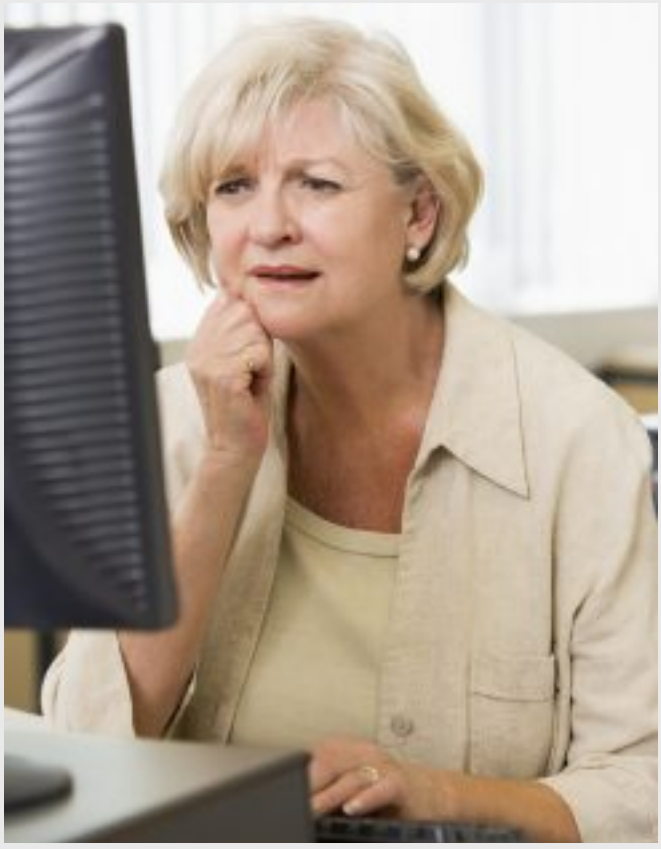
However, a gendered digital divide does exist globally and is in danger of widening with every advance made in digital technology. Digital literacy is largely reliant on access to technology and the education to use it. With women representing over half of those in extreme poverty and 65% of the world's illiterate, it is less surprising that a gendered digital divide exists.

Far from being a skill limited to professional use, information and communication technology (ICT) is encroaching on all aspects of lifestyle enhancement – further empowering those with the privilege of access and knowledge.

Equitable access to technology from a gender perspective

The digital age has closed the physical space between specialist services and their users, offered faster payment systems, expanded educational resources, developed accessibility aids and widened opportunities for those with sensory or physical impairment. As technology advances, ICT skills are powerful in supporting people fully participate in society.

Equitable access to technology from a gender perspective, has the potential to break down barriers to independence, safety, health and wellbeing experienced by many women and non-binary people. Global statistics share how girls from rural areas are the least likely to attend school, leaving them vulnerable to poverty, exploitation and violence.



Data also links the education of mothers to improved child mortality. In areas where distance to school settings has reduced, the impact on girls' education has been positive. Investing in ICT can help reduce that distance further, helping to train and resource a greater number of community educators to support more girls into realising their potential.

In both rural and urban areas, education affords women input into decision-making in society and within their own households. The progression from literacy into employment, provides financial independence which facilitates social inclusion, participation and an influence in the community.

ICT inequities are not limited to those countries or women in rural regions

However, whilst many studies on the gendered digital divide highlight disparities in low- and middle-income countries, ICT inequities are not limited to those countries or women in rural regions.

In more economically developed countries (MEDC), differential ICT skills are also prevalent. Male-dominated stereotypes, earlier access to technology during play, and greater encouragement for risk-taking, support boys in taking greater interest in developing their digital skills.

> "By upskilling and reskilling in ICT talent, women can be prepared for future-proofed employment in a variety of industries, diversifying the workforce and the range of thought and innovation this introduces."

The inequal participation in certain STEM subjects widens further into higher education, with the proportion of women and non-binary undergraduate students studying computer science in the UK recorded at 16% (2018/19).

Even outside the coding sector, this imbalance can have significant impact on society. Reports during the COVID-19 pandemic uncovered how women are overrepresented in face-to-face roles in the retail, hospitality, beauty and care-related industries.

Reskilling in ICT can further prove the capabilities of women

COVID-19 restrictions enabled the continuation of professions which adapted to a remote working or a virtual environment aided by the nature of the work involved and access to ICT. Women suffered greater job losses due to their overrepresentation in sectors unable to provide a virtual service or the precarity of their employment in junior roles.

The pandemic proved a great risk to even the marginal improvements made to gender equality in the workforce over the last few decades. This in turn highlighted the need for greater focus on supporting women to achieve fully equitable and secure access to the workplace.



Sarah Mohammad-Qureshi

There are multiple steps supporting the return of women to the workforce and offering greater equity to flexible, secure and lucrative roles, with digital inclusion recognised as particularly beneficial. By upskilling and reskilling in ICT talent, women can be prepared for future-proofed employment in a variety of industries, diversifying the workforce and the range of thought and innovation this introduces.

It is important to note how the impact of digital access has the potential to reach beyond the immediate development of women. There is a role-modelling effect on younger family members and the community, which empowers a generational shift in stereotypes and ideals about the capabilities of women.

The enhanced access to financial independence contributes to the economic benefit offered by the statistic that women reinvest 80% of their earnings back into their families and the community. Overall, there is capacity to influence and improve communities through access to education and support services, informed health advice, and access to new markets for women-led businesses and services which benefits all.

Sarah Mohammad-Qureshi PhD FHEA
Equality, Diversity and Inclusion Partner
The University of Law
Tel: +44 (0)800 289 997
study@law.ac.uk
www.law.ac.uk
https://twitter.com/universityoflaw

The role of teachers and teacher educators in addressing the gender digital divide



Gender equality is essential to develop and sustain the capacity for sustainable development although, ironically, STEM subjects and professions see the greatest gender digital divide and especially in developing economies

Economic and social development is dependent on a robust technological base. Globally, STEM (science, technology, engineering, and mathematics) education leads to the highest-paid and most prestigious jobs. Digital literacy is critical for civic engagement-political participation, community-building, access to health care; economic stability. Social inequalities are both perpetuated, and challenged, through technology.

Yet, apart from self-efficacy, attitude and access, decades of research have shown that while there are no significant differences among males and females in ability, participation and retention in STEM subjects among women fall rapidly in high school and higher education and carry over into related professions. We have explored these complex issues in previous editorials. In this article, we will look at the role of gender in the recruitment of women as teachers of STEM.

Digital literacy: tackling the gender digital divide

Digital literacy, digital or competence, is identified by European Commission as a core competence in 2022 and beyond. Digital competence for citizens goes beyond information literacy and the ability to use digital tools and includes integrating various viewpoints such as creativity, ethics, cooperation and communication as well as the need for attitudes and perspectives related to privacy, copyright compliance, and digital culture. Digital competencies are integrated with basic job performance skills such as communication, problem-solving, and collaboration skills. Several digital literacy/competence frameworks are available, including the *ISTE Standards for Educators*, and UNESCO's *ICT competency framework for teachers* and the *DigCompEdu* framework. The latter focuses on pedagogical aspects while other frameworks emphasize technical dimensions of digital competence.

Studies analyzing gender differences in digital competency found certain gender-based characteristics in pre-service teachers may affect the use of technology in the classroom, influencing gender preferences for subjects and professions that are technology-based. Male pre-service teachers show higher ability in information and data usage, digital content production, safety, and problem-

solving; had a higher ability to use computers and acquire digital media information faster, and had a higher level of awareness and understanding of technology-related variables. Men are more likely to rate their confidence and professional skills positively showed higher self-esteem in commitment to the academic goals of schooling and over-estimated their digital competency.

By contrast, female teachers have lower proficiency levels in computer and internet programming, database design, hardware and software, and multimedia production; but the level of technological pedagogical content knowledge is higher. The level of female teachers' content knowledge, pedagogical knowledge, and pedagogical content knowledge are higher; the level of knowledge and interest related to teaching methods and subject areas is higher, and females have higher knowledge and awareness of technology which is related to content knowledge and teaching methods. Finally, females show relatively low interest in the technology component itself and underestimate their competencies.

An unconscious bias in STEM?

The design of teacher education programs is fundamental to developing a gender-responsive curriculum, digitally competent teachers, and being able to integrate technology in STEM and other school subjects. With the recent pandemic surfacing the need for flexibility, resilience and creativity in teachers' pedagogical responses, the urgency of transforming pre-service teacher education, as well as continuing learning support, has become apparent. For one thing, a lack of gender responsiveness in teaching and curriculum development has been implicated in difficulties attracting and retaining women in STEM. Educators may have unconscious or even conscious gender biases or have not been educated in pedagogies that might ameliorate the situation.

There are also fewer women role models in teaching with technology during pre-service teacher education. In one study of pre-service physics teachers, male students were more competent at using various digital tools for information and data sharing, and digital content creation. Female students were better at using technology to research information and in communication and collaboration. Other studies have found that a focus on projects that resonate with women, for example, those related to environmental justice, in which technology use is socioculturally-contextualized and relevant, encourages participation and retention. This approach to curriculum rejects science as an instrumentalist, i.e. dry, non-contextualized and simply factual, divorces from the reality of how science affects social, economic and political policies and practices.

Some universities describe program innovations that have been successful in attracting women to computer science programs and specializations in teacher education. For example, Carnegie Mellon University held places designated for women, even with lower levels of experience and provided enhanced counselling support. A course for secondary school teachers in computer science explained about teaching but also presented the difficulties that female students have. Social networks and informal learning and practice opportunities helped alleviate anxiety. Other educators have opted to include social, moral, and ethical issues in computer science education.

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UNIVERSITY OF ALBERTA

Katy Campbell
Professor, Dean Emeritus
University of Alberta
Tel: +1 780 994 9745
katy.campbell@ualberta.ca
https://apps.ualberta.ca/directory/person/kc4

Education priorities and STEM skills in the US

The US Department of Education's mission is to promote student achievement and preparation for global competitiveness by fostering educational excellence, advancing STEM skills, and ensuring equal access

The department was created in 1980 by combining offices from several federal agencies to foster STEM skills, and advance education for all. Today, its 4,400 employees and $68 billion budget are focused on:

- Establishing policies on federal financial aid for education and distributing, as well as monitoring those funds.
- Collecting data on America's schools and disseminating research.
- Focusing national attention on key educational issues.
- Prohibiting discrimination and ensuring equal access to education.

Financial aid

The department distributes financial aid to eligible applicants throughout the nation for early childhood, elementary, secondary and postsecondary education programmes. Federal programmes benefit all students, and special programmes exist to serve individuals with disabilities, those who live in poverty, American Indians, immigrants and those with limited English proficiency. Federal funds for education are distributed using three methods: a set formula, competition and financial need determination.

Collecting data and disseminating research

The department oversees research on most aspects of education; collects data on trends; and gathers information to help identify best practices in education, including teaching techniques that work. Employees of the department, as well as contractors and grant recipients, carry out the research.

Research findings and statistics are disseminated to educators, policymakers, parents, researchers and the general public in the form of reports and publications - both printed and online. Recent publications have covered the latest national assessments of educational progress in a variety of subject areas, innovations in education, the condition of education in America, annual reports on a variety of federal education programmes, how to improve mathematics education and many other pertinent education topics. In a typical year, the department publishes hundreds of publications and millions of copies to meet the public's demand for information.

Education reform

The department makes recommendations for education reform. The secretary advises the president in this regard and leads the department in implementing the president's education policies in many arenas - from the preparation of legislative proposals for Congress to decisions about education research priorities. Of vital importance in formulating and implementing policies is the department's close work with a variety of advisory groups and organisations composed of citizens from all walks of life who have an interest and expertise in education and who provide significant ideas on key policies and programmes.

In addition, the secretary brings national attention to education issues by giving speeches, writing articles for publication, addressing the media and making personal appearances in schools and other education settings. The department further highlights education issues by sponsoring and participating in national conferences and other similar activities, such as the Blue Ribbon Schools and Presidential Scholars award programmes, the Teaching Ambassador Fellows Programme, the Student Art Exhibit Programme, and

special events and ceremonies to honour teachers or students.

Equal access to education

The department enforces five civil rights statutes to ensure equal educational opportunity for all students, regardless of race, colour, national origin, sex, disability or age. These laws extend to all state education agencies, elementary and secondary school systems, colleges and universities, vocational schools, proprietary schools, state vocational rehabilitation agencies, libraries and museums, and other entities that receive US Department of Education funds. Specific examples of those whose rights are protected include homeless children with disabilities, individuals with limited English proficiency, women and girls in athletic programmes, and people in need of vocational rehabilitation.

STEM skills

In an ever-changing world, it is more important than ever that children are prepared to bring knowledge and skills to solve problems, make sense of information and know how to gather and evaluate evidence to make decisions. These kind of skills are developed in science, technology, engineering and mathematics, including computer science, collectively known as STEM/CS.

The department endeavours to ensure that all children have access to STEM literacy and educational options regardless of where they live.

In 2018, the STEM Education Strategic Plan, Charting a Course for Success: America's Strategy for STEM Education was published setting out a five-year plan to ensure the US is the global leader in STEM literacy, innovation and employment.

The strategy plan focuses on three overarching goals:

- Build Strong Foundations for STEM Literacy by ensuring that every American has the opportunity to master basic STEM concepts and to become digitally literate.
- Increase Diversity, Equity and Inclusion in STEM by providing all Americans with lifelong access to high-quality STEM education, especially those historically underrepresented and underserved in STEM fields and employment.
- Prepare the STEM Workforce for the Future by creating authentic learning experiences - for both college-educated STEM practitioners and those working in skilled trades that do not require a four-year degree - that encourage and prepare learners to pursue STEM careers.

1. https://www.ed.gov/sites/default/files/documents/stem/2021-stem-progress-report.pdf
2. https://www.ed.gov/stem#stem-strategy
3. https://www2.ed.gov/about/landing.jhtml
4. https://www2.ed.gov/about/overview/focus/whattoc.html

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Addressing barriers to inclusive higher education in China

James Pitman, Managing Director UK and Europe, Study Group, addresses the barriers to inclusive higher education (HE) in China



In 2021, China's government introduced the 'double reduction' education policy as part of the 14th Five-Year Plan. The measure calls for a reduction in both the amount of homework and extracurricular tutoring that pupils receive.

Although the policy's stated purpose was intended to ease pressure on students to score highly on their end-of-school exam, the Gaokao – a move welcomed by many families struggling with escalating pressure on ambitious young people – it also reflects a wider societal pivot towards vocational training to respond to the needs of the Chinese economy.

This is not to say China and Chinese families are moving away from a focus on university degrees. Higher education remains a priority for both students and parents and in some ways, a focus on quality and the employment opportunities which follow, has only increased in recent years.

Applications from Chinese students to UK universities increased by 43%

China is home to a fifth of the world's population and the numbers of young people moving at any one time into tertiary education is breath-taking when seen from other counties. As a result, it cannot be overstated just how competitive domestic higher education is in China.

Despite achieving good Gaokao grades, many students are unable to progress into the best universities at home. This means a high volume will leave to study at top institutions abroad, an option seen by many families as preferable to enrolment at a less reputable Chinese university. Some students simply choose to go abroad anyway, keen to expand their understanding of the world (reflected in the unrelenting demand for western inclusive higher education. UCAS data shows applications from Chinese students to UK universities increased by 43% between 2019 and 2021).

However, this route has been thrown into disarray by delays to examinations at IELTS testing centres and the 'living with' approach the UK is now taking to the pandemic, which is at odds with China's 'zero Covid' policy. And away from the UK, other popular international education destinations simply closed their borders.

An inclusive higher education environment

So, what next for Chinese students looking at their university study options? Even though international education routes have reopened, there are still obvious issues to overcome. For example, it is extremely difficult for lower income Chinese families to send their children abroad due to high travel costs. In many areas of rural China, the high school enrolment rate is lower than 40% and, even when students score highly on the Gaokao, moving to a tier one city like Shanghai or Guangzhou, can be prohibitively expensive.

Also, the 'double reduction' plan only extends to vocational schools and the financial hardship faced by poorer families in third- to fifth-tier cities who wish to send their children to traditional universities continues to be a challenge for those able students and policy makers alike.

While we have no influence over domestic Chinese educational concerns and challenges (many of which are in some form increasingly familiar as we also grapple with the ballooning cost of student loans and calls for greater parity for vocational education routes), we still have an important role to play in meeting the needs and aspirations of all students in ways the Chinese government describes as 'win-win cooperation'.

Western institutions need to continue to develop blended learning and online course content to allow greater flexibility for Chinese students keen to study and minimise costs, while maintaining the quality students and regulators rightly expect.

The familiar requirement to study an entire course overseas might also be reviewed. Satellite campuses in China offering support through the initial semesters of a degree could also help students, giving them the opportunity to work towards an international degree locally, before travelling to the host country to complete their studies.



James Pitman

The hybrid and flexible approach for students

Our recent report on the region notes the 'HyFlex' – hybrid and flexible – approach is proving particularly popular. This arrangement enables students to enrol on an international degree course that is partially conducted online. It benefits those who still desire an in-person, overseas experience, but whose families may not have the means to send them abroad for three to four years. Additionally, it guarantees that students can continue learning in the event of further lockdowns, such as the one recently faced in Shanghai.

In addition to blended learning and HyFlex, higher education sectors around the world should work to address the financial obstacles faced by overseas students, especially those caused by extenuating pandemic circumstances. For example, we note that UK universities offered incentives for Chinese students to enrol, including entry requirement and financial flexibility: reduced fees for students studying remotely for a year before completing their degree in-country.

The demand for inclusive higher education amongst Chinese families remains strong, but current inequities inhibit full participation and the chance for students to fulfil their potential. A combination of domestic action, transnational education and blended learning will help develop a culture of inclusivity for all young people in the region.

James Pitman
Managing Director UK and Europe
Study Group
https://corporate.studygroup.com/contact-us
www.studygroup.com
https://twitter.com/study_group

Reform in the Chinese college admissions policies

Chinese college admissions policies affect the educational experiences and labour market outcomes for millions of students each year

In China alone, ten million high school seniors participate in the National College Entrance Exam to compete for seven million seats at various universities each year, making this system the largest centralised matching market in the world.

In China, centralised matching processes via standardised tests assigning students to universities have been in place since 1952. The National College Entrance Examination forms the foundation for the current Chinese college admissions system. Affirmative action for ethnic minorities and other special groups are implemented as a pre-announced number of points added to a student's exam score. Public universities are affordable for the majority of Chinese families, with financial aid for students from low-income families.

Matching with a wealth of field observations

Through its regional variations and its evolution over time, the Chinese system also provides matching theorists and experimentalists with a wealth of field observations to enrich our understanding of matching mechanisms. In recent years, each province implements an independent matching process from one of the two classes of mechanisms: the sequential or the parallel mechanism. The sequential mechanism, strategically equivalent to the Immediate Acceptance mechanism (IA), had been the only mechanism used in Chinese student assignments both at the high school and college level until 2000. However, this mechanism is manipulable, in the sense that students might find it in their best interest to submit a rank order list of universities which do not reflect their true preferences.

To alleviate the problem of high-scoring students not being accepted by any universities, the parallel mechanism (PA) was first implemented in Hunan Province in 2001. In the parallel mechanism, students select several "parallel" colleges within each choice-band. For example, a student's first choice-band may contain a set of three colleges, A, B, and C while her second choice-band may contain another set of three colleges, D, E, and F (in decreasing desirability within each band). Assignments for parallel colleges listed in the same band are considered temporary until all choices of that band have been considered. Thus, this mechanism lies between IA, where every choice is final, and the Deferred Acceptance mechanism (DA), where every choice is temporary until all seats are filled.

Implications of parallel mechanisms (PA)

To investigate the theoretical properties of the parallel mechanisms (PA), Chen and Kesten (2017) formulate a parametric family of application-rejection mechanisms where each member is characterised by their parallel and periodic choice-band sizes that allow the application and rejection process to continue before assignments are made permanent. As the choice-band size increases, we go from IA to PA, and from those to DA. They show that members of this family become less manipulable and more stable as the choice-band size increases. This implies that the Chinese provinces that have adopted a parallel mechanism have transitioned to a less manipulable and more stable assignment system. Furthermore, Chen and Kesten (2017) show that a parallel mechanism provides students with a certain sense of "insurance" by allowing them to list their equilibrium assignments under the IA mechanism as a safety option while listing more desirable options higher up in their preferences. This strategy leads to an outcome at least as good as that of the IA mechanism.



Yan Chen
Daniel Kahneman Collegiate Professor



To investigate behavioral responses to these mechanisms and to search for behavioral regularities where theory is silent, Chen and Kesten (2019) evaluate the sequential (IA), parallel (PA), and deferred acceptance (DA) mechanisms in the laboratory in two environments differentiated by their complexity. In the laboratory, participants are most likely to reveal their preferences truthfully under DA, followed by PA and then IA. Furthermore, while DA is significantly more stable than PA, which is more stable than IA, efficiency comparisons vary across environments. Regardless of the metrics, the performance of PA is robustly sandwiched between IA and DA.

Radical reforms in the Chinese college admissions system

By 2019, all 31 provinces and autonomous regions have abandoned the sequential in favor of various versions of the parallel mechanism, which is widely perceived to improve allocation outcomes for students. Using a unique data set from a province that implemented a partial reform between 2008 and 2009, Chen et al. (2020) find that students list more colleges in their rank-ordered lists, and more prestigious colleges as their top choices, after the province adopts the parallel mechanism in its Tier 1 college admissions process. These listing strategies in turn lead to greater stability in matching outcomes, consistent with the theoretical prediction in Chen and Kesten (2017) that the parallel mechanism is less manipulable and more stable than the sequential mechanism.

In sum, the last twenty years have witnessed radical reforms in the Chinese college admissions system, with many provinces moving from a sequential (immediate acceptance) mechanism to some version of the parallel Chinese college admissions mechanism, leading to better matching outcomes for students.

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SCHOOL OF INFORMATION
UNIVERSITY OF MICHIGAN

Yan Chen
Daniel Kahneman Collegiate Professor
School of Information
University of Michigan
Tel: +1 734 764 9488
yanchen@umich.edu



What is Astrophysics?

Daniele Malafarina, Associate Professor from Nazarbayev University, School of Sciences and Humanities, unpacks astrophysics for us in this insightful article

For most of history, looking at the cosmos was done with the naked eye, without instruments, and the main purpose of observations were to keep track of the movements of celestial bodies. Astronomy did not tell us anything about the nature of the objects being observed, namely the stars and planets.

Since the time of Galileo, Newton, Kepler, and other pioneers of the scientific revolution, we started looking at the cosmos using instruments and applying the laws of physics to make sense of what the instruments measure. This allowed us to understand what astronomical objects are, how they form and evolve, and this is the core of what astrophysics is: Using the laws of physics applied to observations of phenomena in the universe to understand their nature and evolution.



Daniele Malafarina

Astrophysics discovery

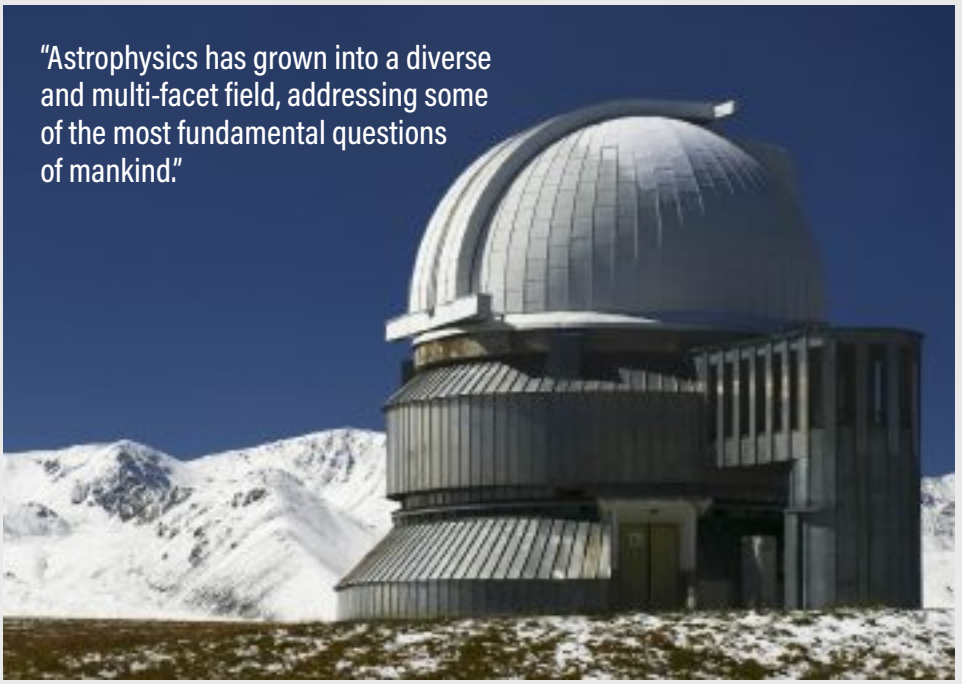
The use of tools from physics applied to the cosmos and the development of better and better telescopes and instruments has completely revolutionised our understanding of the universe and our place in it. We discovered new planets in the solar system; Uranus in 1781, and Neptune, predicted theoretically in 1845 and discovered in 1846. We discovered new objects such as comets, dwarf planets, moons and asteroids. In the process, we learned how the solar system formed and evolved.

We discovered new kinds of stars, such as white dwarfs and neutron stars, and planets orbiting other stars. In the process, we learned how stars form and evolve over time and how other planetary systems may develop the conditions suitable for the appearance of life.

We discovered that there are other galaxies besides our own and that the universe is expanding. We also learned how big the universe is and how it all started from an extremely small, hot, and dense initial state.

Expanding our view of the cosmos

In the last hundred years, astrophysics has expanded our view of the cosmos together with our tools to investigate it. At the beginning of the 20th century, astronomers could rely only on visible light to study the universe. Today, we look at phenomena through several carriers of information like gravitational waves, different electromagnetic wavelengths, such as x-rays and gamma rays, and particles, such as neutrinos and protons.



Astrophysics has grown into a diverse and multi-facet field, addressing some of the most fundamental questions of mankind including:

- How the first stars and structures in the universe formed several hundred million years after the big bang.
- How gravity behaves to produce black holes, probably the most extreme objects in the universe.
- How planetary systems form and what conditions could lead to the formation of life.

But why do we study such things? At first glance, it may seem that answering these questions has no impact on everyday life. When one thinks about astrophysics, the first impression may be that it is research done out of curiosity about the universe with no practical relevance. This is not true as astrophysics and the study of the cosmos has produced permanent changes in our society, both from the practical as well as cultural point of view.

A few practical tools that would not exist without astrophysics include CCD cameras, which are found in every smartphone but were first developed for telescopes, and the GPS system we rely upon when travelling requires the laws of General Relativity to work accurately. Also, some non-invasive methods for detecting tumours rely on sensors adapted from radio wave astronomical instruments.

This is called technology transfer and is the reason why governments and many prominent industries in the world invest in research in astronomy. Technologies developed for scientific purposes eventually find application in everyday life.

Astrophysics influences cultural changes

Astrophysics has also influenced cultural changes that have impacted our society: The discovery that the Earth is not the centre of the universe helped us realise that we are just one part of a larger system. Also, the first image of the Earth seen from space emphasised that we all live on the same small planet, drifting alone in the vastness of space and gave some people the sense of belonging to this planet rather than to a specific country.

The discovery of extrasolar planets helped us understand that there may be other inhabited worlds in the galaxy and the search for life outside Earth is helping us to understand how our own evolution happened and where some of our behavioural traits come from.

This is all part of our cultural evolution, a necessary prerequisite for a dynamic, healthy, and thriving society. Our understanding of the planetary formation, the appearance of life, and the evolution of the universe has changed the way we see ourselves as a species. That change is still ongoing, and it is part of a

More on Astrophysics: Japan's agenda

Open Access Government investigates Japan's priorities regarding space exploration and astrophysics

Alongside international cooperation, the Japan Aerospace Exploration Agency (JAXA) leads active innovative space exploration programmes that aim to expand the realm of human activities to other celestial bodies within the Solar System.

Established in October 2003, JAXA comprises five offices, one Innovation Hub and other common departments, including the Institute of Space and Astronautical Science (ISAS.)

Central issues for ISAS' future plans include "astronomy over multiple wavelengths," and "planetary exploration founded on materials," according to the Director-General, Hitoshi KUNINAKA. ISAS itself is made up of five research departments, one of which is the Department of Space Astronomy and Astrophysics. This department is particularly engaged in astrophysics research using observational instruments and technology for the next generation and the study and launch of new space missions. Observations are regularly conducted over a wide range of wavelengths, including radio submillimetre infrared, X-ray and gamma-rays. Furthermore, research is also conducted using ground-based observations.

The priorities of this department include:

- Galaxy clusters.
- Active galactic nuclei.
- Galaxies.
- Stars.
- Star-forming regions and protostars.
- Supernova remnants.
- Interstellar matter.
- Exoplanets.

International collaboration has dramatically deepened over the past decade. Previous ISAS accomplishments have garnered respect from throughout the world, garnering sufficient recognition to be invited for participation in joint international projects. As these missions become increasingly large and complex, and as they extend into ever-deeper regions of space, the strategic provision of Japanese expertise will aid in the realisation of Big Science projects that could not be accomplished through the efforts of any single country.

Research and innovation in astrophysics is vital in Japan, and it goes hand in hand with effective international collaboration.

Reference: https://global.jaxa.jp/

necessary process if we wish to depart from the constraints of our evolutionary past and become a more peaceful, self-determined, and hopefully multi-planetary species.

Human evolution as a journey

If we look at human evolution as a journey, we can expect the next steps to be uncertain, as they may lead to improvement or worsening of the living conditions for mankind. However, what is certain is that we cannot stay still and must try to move forward. A better scientific understanding of what is around us is necessary to make the best decisions for the future of mankind. This understanding cannot be limited to a short time span. We need to look further at where humanity can be in 100 or 1,000 years. While it is important that people work on developing technologies to address today's problems, it is also important to look beyond and lay the foundations for technologies, ideologies and objectives of future generations. Fundamental sciences like astrophysics serve this purpose.

Daniele Malafarina
Associate Professor
Nazarbayev University
School of Sciences and Humanities
Tel: +7 7172 69 46 61
daniele.malafarina@nu.edu.kz
https://ssh.nu.edu.kz/
https://twitter.com/NUedukz

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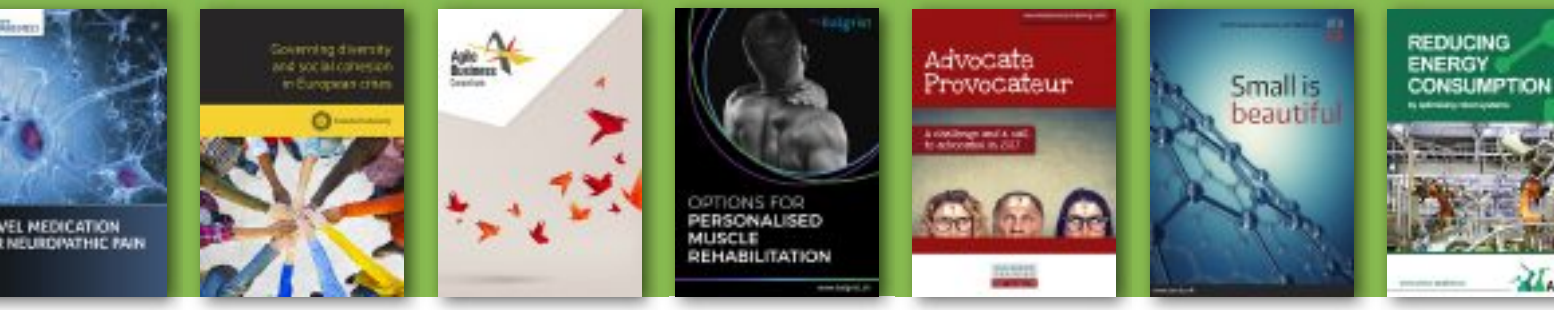
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Low-cost high-productivity space science from Japan

NAOJ Director General Saku Tsuneta provides an overview of Japan's involvement in space science

Space science has advanced rapidly over the past century. With this advancement, the required investment has increased. But Japanese institutes have found ways to deliver cutting-edge space science at low cost through a strategy of innovation and collaboration. This collaboration extends across national boarders and from ground-based facilities to space-based facilities. Ground-based observatories benefit from established infrastructure, a solid foundation for extremely large apertures, and easy access for decades of continuous upgrades. Space missions, in turn, can collect data without interference from Earth's atmosphere.



Space science in Japan

Japan has two national research institutes dedicated to space science: the National Astronomical Observatory of Japan (NAOJ) and the Japan Aerospace Exploration Agency (JAXA).

NAOJ, the national center of astronomical research in Japan, primarily develops world-leading ground-based observing facilities and promotes the open use of these facilities among researchers throughout Japan as well as encouraging international cooperation. The three great observatories of NAOJ are the Subaru Telescope, ALMA, and TMT (to be constructed). NAOJ also coordinates collaboration with a number of smaller facilities.

JAXA supports the Japanese government's overall aerospace development and utilization. JAXA, therefore, can conduct both basic research and development, and utilization. Within JAXA, the branch most involved in the study of stars and other planets is the Institute of Space and Astronautical Science (ISAS).

The missions of NAOJ and JAXA are not mutually exclusive and they have collaborated on several projects. NOAJ astronomers have played a major role in JAXA's solar physics satellite "HINODE" and more specialized roles in the asteroid explorers Hayabusa1 and 2. These collaborations have been more than just successful, entering extended missions after completing their objectives.

International collaboration for space science missions

Japanese space science programs engage in extensive international collaboration to leverage the best talent available both domestically and internationally.

Among JAXA's upcoming space-science missions the X-Ray Imaging and Spectroscopy Mission (XRISM) includes participation by the U.S. National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA); the asteroid Phaethon flyby mission Destiny+ includes

participation by the German aerospace center (Deutsches Zentrum furLuft- und Raumfahrt, DLR); and the Martian Moons Exploration (MMX) mission includes participation by NASA, ESA, DLR, and the French national centre for space studies (Centre National D'Etudes Spatiales, CNES).

Together, NAOJ and JAXA are working with international partners to develop missions like CLASP, SOLAR-C, and JASMINE. The CLASP suborbital experiments (See photo.) to observe the Sun were developed through collaboration including NASA Marshall Space Flight Center, the Institute of Astrophysics of the Canary Islands (IAC), and Institut D'Astrophysique Spatiale (IAS), and launched at the White Sands Missile Range in the U.S. SOLAR-C, the successor to HINODE, includes participation by NASA, ESA, DLR, CNES, and space agencies in the UK, Italy, and Switzerland. JASMINE is a satellite mission to measure the distances and motions of stars through infrared observations. Unlike visible light, infrared light can penetrate the interstellar clouds around the Galactic Center and show us the region around the super massive black hole at the heart of the Milky Way Galaxy. JASMINE will be complementary to ESA's Gaia Project, which observes stars over a wider area in visible light, and dialog and scientific exchange to maximize the return from both projects are ongoing.

Ground-space collaboration

One area of active collaboration between ground-based and space-based observations is survey missions, observing a wide area of the sky with multiple independent telescopes with different capabilities to build comprehensive, large-scale maps of the Universe, including information such as the dark matter distribution. NAOJ's Subaru Telescope is well suited to survey observations, with its unique construction combining a wide field-of-view with a large light-gathering area and an ever-evolving suite of cutting-edge instruments. The Subaru Telescope has committed to wide imaging surveys complementary to the upcoming ESA Euclid mission and NASA Nancy Grace Roman Space Telescope. Euclid and Roman will both be active in the mid to late 2020s observing in infrared-red (IR) wavelengths. The Subaru Telescope's visible/IR survey programs cover different wavelength ranges than the space telescopes, complementing their data.

The Subaru Telescope has also observed future targets for probe missions to other bodies in the Solar System. In December 2020, the Subaru Telescope observed the asteroid 1998 KY26, the destination of Hayabusa2's extended mission. Based on this data, JAXA was able to determine the asteroid's accurate orbital parameters, vital information for reaching the asteroid. The Subaru Telescope searched for new targets for the extended mission of NASA's New Horizons, and found over 70 previously unknown bodies, giving NASA their pick of targets.

The next step, astronomy from the Moon

Some of the faintest signals from space are completely washed out by the atmosphere and ionosphere of the Earth and the artificial radio waves produced by modern society. Observations to catch these faint signals cannot be conducted from Earth. Even near-Earth orbit is too radio-loud for some of the observations. But if we place our instruments on the Moon's far side, the Moon itself acts as a natural shield, blocking artificial radio waves and providing an ideal, quiet environment for astronomy.

The JAXA SLIM (Smart Lander for Investigating Moon) mission seeks to demonstrate the technology needed for accurate lunar landings, as a basis for further lunar exploration. Scientists have been performing a feasibility study for a future SLIM-like mission to deploy radio antennas with a moon rover in the late 2020s on the rear side of the Moon to measure ultra-low frequency radio sources and the background from space. These observations would be impossible for ground-based or orbital observatories due to the reflection by the Earth's ionosphere and artificial noise from the Earth.

Japan's ambitions to push the limits of space science on a lean budget will continue to drive JAXA and NAOJ, together with domestic and international collaborations, to pursue novel space exploration ideas.

国立天文台 NAOJ National Astronomical Observatory of Japan

Saku Tsuneta
Director General
National Astronomical Observatory of Japan
Tel: +81 422 34 3650
dg-naoj@nao.ac.jp
www.nao.ac.jp/en
https://twitter.com/prcnaoj_en

Japan: Inter-university research to generate more knowledge

Prof Dr Preethi Kesavan, Head, School of Technology at LSBF Singapore,
discusses how to promote academic and inter-university research



As people make more professional changes, lifelong learning needs, such as recurring education and multidisciplinary competency will be a vital tool to help them navigate the change in employment demands and seek fulfilment via self-development. The International Year of Fundamental Sciences for Sustainable Development has been set for 2022.

The boundaries between research and discipline between universities are fluid, and important research questions are handled with an established disciplinary interface. Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) supports the establishment of the International Research Centre Initiative (WPI) to build "globally visible" research centres.

The number of Japanese winners in the three science categories has raised to 18, second to the United States, since the beginning of the twenty-first century. To maintain the long-term success of academic and fundamental research in Japan, it is necessary to continue to provide a variety of assistance and strengthen relevant measures. Basic research lays the groundwork for high-impact applications in fields as diverse as biology and manufacturing, allowing for societal change.

Industry, government, and significant academic contributions have long been lauded for their potential to revitalise universities and advance society, and there have been calls to improve and strengthen these efforts. Universities are important sources of



Preethi Kesavan

knowledge for society, and because they generate highly specialised academics, they may help revitalise and strengthen cities, industries, and other sectors.

"Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) supports the establishment of the International Research Centre Initiative (WPI) to build "globally visible" research centres."

There has been a surge in desire for inter-university and industry, government and academic collaborations, in which institutions develop cooperative links in society to execute various initiatives, amid the big shifts occurring under the digital transformation.

The organisational environment is likely to have a substantial impact on scientists' industrial activity. Scientists are more involved in research if they perceive their university has a strong entrepreneurial aim or a favourable policy climate.

Recognising the entrepreneurial attitude and policy framework of a university's mission as crucial organisational qualities related to the university-industry connection. It is believed that being a part of an academic institution that fosters entrepreneurship will stimulate academics' interest in knowledge dissemination.

The advancement of science across Asia

As a result of the COVID-19 pandemic and climate change, scientists now discover new solutions, and remain at the forefront of scientific discoveries, helping us to better understand the universe. One of the five pioneering Asian scientists of 2021, Japanese molecular biologist, Mika Nomoto, is researching the immune systems of plants to develop chemicals that can reduce crop damage that may be able to reduce global food shortages.

Governments, researchers, and industry are collaborating in Asia to focus on research directions and grow to support sustainability and advance digital transformation. Japan has demonstrated that greener practices are deeply intertwined with digital transformation by launching the Society 5.0 in 2017. As part of its smart city program, Japan reduces nuclear energy use and integrates hydrogen energy.

In the face of global challenges, such as climate change and economic development, Asia has consistently pushed to champion valuable research and harness science and technology. Young Scientist Awards 2021 recognises Singapore's top research talent, and 2021 top honours go to three young researchers who have made significant contributions to Singapore's scientific landscape through their work in quantum computing and neuroscience.

Prof Dr Preethi Kesavan
Head, School of Technology
LSBF Singapore
Tel: +65 6580 7700
info@LSBF.edu.sg
https://www.lsbf.edu.sg/
https://twitter.com/LSBFSingapore

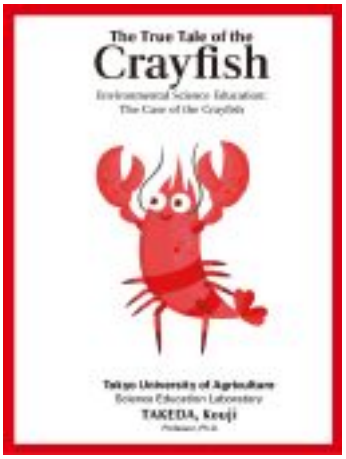
Environmental Science Education on the subject of Crayfish *(Procambarus Clarkii)*

Tokyo NODAI Research Program for Sustainable Agriculture discusses the Environmental Science Education of crayfish

In Japan, the crayfish *(Procambarus Clarkii)* is a familiar species, but it is also an active target for extermination because of its impact on ecosystems such as native aquatic insects and waterweed communities, and because it is a cause of agricultural damage such as feeding damage to rice seedlings and collapse of the rice paddy's banks. Learning more about the species through environmental science education is a necessity.

There are few cases where crayfish are actively utilized in Japan, but in Europe, the United States, and China, crayfish are used as a food (protein source). In other words, the eradication and utilization of crayfish in Japan would have to protect the local environment and other local resources, and lead to the development of new resources as sustainable agricultural resources. However, it is not easy to immediately recognize crayfish as a food source in Japan, as it has not been recognized as a common food source in the country.

Therefore, we considered educational activities using the crayfish as a resource through environmental science education, in which students learn about "Environment, Invasive species, Life of creatures, Resources, and Food." In addition, we decided to make use of our expertise in the environment and food, which is the mainstay of Tokyo University of Agriculture, and to work on the utilization of crayfish for food and agricultural materials as a useful resource in order to reduce the environmental burden for future food problems.



In this process, the crayfish will be cultivated in aquaponics, which combines crayfish and leafy vegetables in a hygienic environment through the circulation of clean water. Furthermore, crayfish will be studied from a nutritional perspective and their safety will be evaluated so that they can be used as food for humans and animals. Then, the shells are used as food additives and the inedible parts as fertilizers, aiming to utilize crayfish as a sustainable agricultural resource.

This article describes the environmental science education practices that form the core of the project, as well as the booklet prepared as a guide of our project and the aquaponics-based crayfish breeding system.

Teaching Practice of Environmental Science Education

We conducted environmental education to raise interest in familiar organisms through ecological surveys triggered by crayfish as a form of social education in the community and conducted environmental conservation activities through extermination. The exterminated crayfish were also used for observation and scientific experiments on body colour change as part of public lectures for elementary, junior high, and high school students and extracurricular classes at schools. Then, educational practices on "Environment, Invasive species, Life of creatures, Resources, and Food" were conducted in elementary schools and public lectures to explain the concept of crayfish as a food and agricultural resource, as well as its significance as a sustainable agricultural resource.

Through the class practice, it became clear from the students' written comments that the crayfish provided an opportunity to rethink environmental conservation and the lives of living creatures, as well as a chance to view crayfish as a resource. In addition, a booklet was prepared for students and parents on the seven points covered in this class (Habitat of crayfish, Characteristics, History of introduction, Habitat range in Japan, Alien species problem, Colourful crawfish, and Resource).



Photo 1

The True Tale of the Crayfish in Japan

This booklet is a guide to "Environmental Science Education" and focuses on the crayfish, which can be found all around you. The top part of each page is a story for children, and the bottom part is the Japanese translation so that parents and teachers can read the story to their children.

Crayfish are common invasive species in the world. What is often overlooked when considering the problem of invasive species is that “once the natural environment has been touched by humans, it needs to be continuously maintained and managed by humans.” In addition, managing nature includes not only preserving the landscape, but also managing the living organisms that are connected to maintaining the ecological balance. However, few people seem to understand this point.

That is because, when it comes time to clean up ponds and swamps, there is a tendency to think that the invasive species that ultimately survive are to blame. This is despite the fact that the lack of continuous maintenance and management by humans is responsible for the situation. Here, we raise the question of why the crayfish is a problem and look at the issue from both the human’s and the crayfish's perspectives.

We hope that the crayfish will be an opportunity for people to think about how humans and the environment, as well as the creatures that inhabit it, can coexist. We hope that parents will read the booklet to their children in the lower grades of elementary school and think about it with them.

Crayfish Breeding Equipment in Aquaponics

In a conventional aquaponics tank, plants are grown in the upper part of the tank and crayfish are kept in the lower part of the tank. However, in this breeding system, when pumping water from the lower tank to the upper plants, possible problems such as crayfish escaping through the hose, accumulation of dirt in the lower tank with crayfish, cannibalism due to keeping many crayfish in a limited space, and food damage to crops were considered. To solve these problems, we attempted to improve the rearing equipment as shown in **Photo 1.**

In contrast to conventional aquaponics equipment, the crayfish rearing area was placed at the top, and plants were grown in the bottom area. This made it possible to prevent accumulated dirt (leftover food and faeces) from accumulating in the tank, to increase the number of tanks, to prevent mass rearing and escape, and to prevent food damage to crops. In addition, since materials other than pumps can be procured inexpensively, it has become possible to create breeding equipment that is less expensive than conventional aquariums for future use as teaching materials. We are also currently working on a large-scale closed aquaculture system using groundwater for crayfish rearing.

In the future, the nutritional value and safety of the crayfish cultured by these devices will be verified, and future utilization of crawfish resources in Japan will be promoted based on environmental science education.

Authors: *Takeda K., Higuchi S., Ono H., Asai T. Kato T., Suzuki T., Takahashi N., Miyajima K., Kurosawa A., Komatsu K. and Okazawa H.*

Funding: *Tokyo NODAI Research Program for Sustainable Agriculture*

Acknowledgement: *We would like to thank Dr. Junichi Nakagawa for advice and suggestions for the article.*

Tokyo University of Agriculture
Science Education Laboratory (SEL)

Kouji Takeda
Professor
Tokyo University of Agriculture
Graduate School of Agriculture,
Department of Ecological Symbiotic Science.
Graduate School of Agro-Environmental Science,
Department of Regional Regeneration Science.
Science Education Laboratory of Teacher Education Course.
Tel: +81 3 5477 2517
k2takeda@nodai.ac.jp
http://dbs.nodai.ac.jp/html/100000700_en.html

The effects of nanoparticles and the disruption of neural development

Associate Professor Ken Tachibana explores how the effects of nanoparticles on the environment and human body, particularly that of a developing brain, have been left largely unexamined

The biological development of a human is an extremely complex and delicate process. It starts from fertilisation and continues until long after birth. The creation and development of the brain is particularly complicated and susceptible to disruptions to its progression. The primary cells responsible for the development of the brain are the neural stem cells. These are a broad class of cells that can differentiate into the wide range of cell types that form the adult brain. To achieve this complex process, different cells need to undergo a range of gene expression changes at the right time. This is delicate and its disturbance is a key cause of pathology in a wide range of diseases.

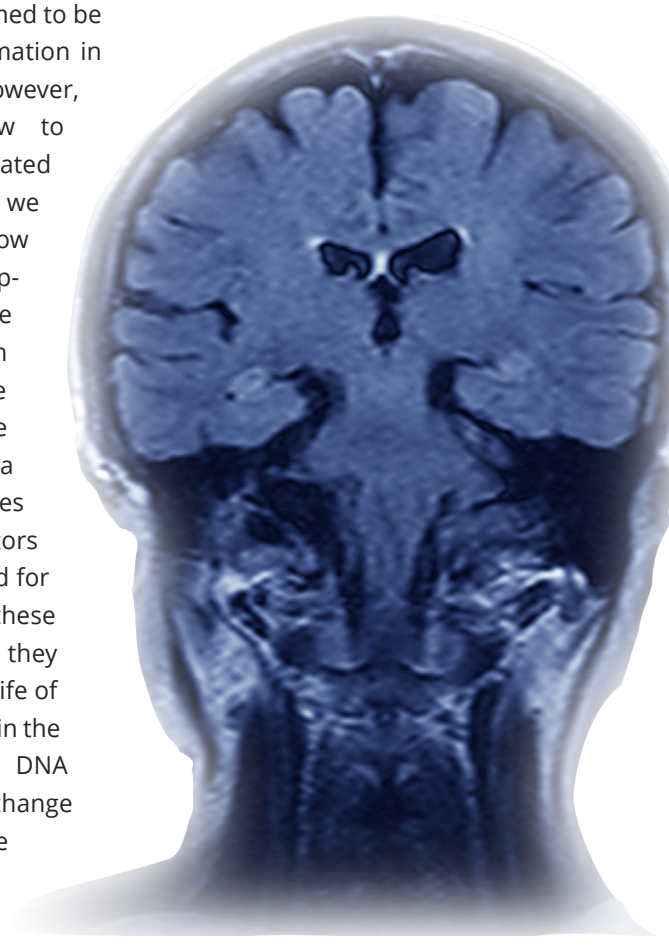
> "There are many external factors that are known to disrupt neural development however, there are several common chemicals whose effects remain largely unknown."

There are many external factors that are known to disrupt neural development however, there are several common chemicals whose effects remain largely unknown. One such group are broadly described as nanoparticles. These are small particles that are being increasingly used by many industries as they can help in the creation of products with better properties. However, their effect on the environment and the human body, particularly that of a developing brain, have been largely unexamined.

The effects of nanoparticles on neural development

We delving further into the effects of nanoparticles on neural development. The starting point for this work was discovery of our laboratory that mothers exposed to nanoparticles were more likely to have children with altered brain morphology and related pathologies. This effect seemed to be mediate by chronic inflammation in parts of the foetal brain. However, to truly understand how to prevent the danger associated with these nanoparticles, we needed to understand how they affect neural development. We theorised that the effects of nanoparticles on gene expression could be derived from epigenetic gene regulation. Epigenetics is a branch of the genetic sciences that concerns heritable factors that are not directly encoded for in DNA sequences. Whilst these phenomena are heritable, they can also change during the life of a person and play a key role in the development of a human. DNA methylation is one such change whereby the bases cytosine can be methylated. Methylation in promoters can result in repressing gene transcription, which is the first step towards the production of proteins that affect the cell physically.

Our project will explore the methylation state of neural stem cells at various different points of development when exposed to a variety of nanoparticles. The methylation state of DNA changes heavily during devel-



opment, however the wrong changes at the wrong time can lead to the wrong genes being expressed. This, in turn, would result in abnormal development and associated pathologies. At the same time, chronic inflammation has been associated with DNA methylation in other contexts. Chronic inflammation, of course, is one of the results of nanoparticle exposure as shown by several groups previously. Our project has been highlighting whether there are any significant changes to DNA methylation following exposure to nanoparticles and the subsequent inflammation.

"We can find definitive answers as to the nature of the developmental changes the cells undergo and therefore, how they may be prevented to make nanoparticles safer."

Changes in gene expression

Whilst the DNA methylation state will be examined, it is also essential to show the link between this methylation and changes in gene expression that are related to abnormal neural development. Therefore, in our parallel branch of the project, we monitoring gene expression changes. This will highlight which genes are being impacted and at which stage of the development process. This data will be combined with the DNA methylation data as well as with that attained from histology and microscopy conducted on tested neural stem cells.

There are multiple techniques that our team will employ to answer the key biological questions of the project. The first step will be exposing pregnant mice to nanoparticles via inhalation. The developing mouse brains will be extracted and analysed using a few different methods. DNA will be extracted, and methylated DNA selected using proteins that bind exclusively to such DNA. These DNA fragments can then be sequenced on massive scale. Next, genes that show a difference will be targeted for gene expression analysis. This will be done by extracting the RNA and conducting microarray analysis and reverse-transcription PCR. This will show whether methylation changes are always leading to gene expression changes. After this work is conducted, the project seeks to understand the interaction between chronic inflammation and abnormal DNA methylation in the context of neural stem cells by conducting cell line work. Finally, these two branches will be linked together in the final steps of the project where we will look to hone in on the most relevant neural stem cell types and brain regions where changes are seen in mice.

The project will gather a multitude of data, particularly concerning gene expression and DNA methylation state. These vast datasets will contain rich information concerning how the cells are responding to the presence of the nanoparticles. If properly exploited, we can find definitive answers as to the nature of the developmental changes the cells undergo and therefore, how they may be prevented to make nanoparticles safer. However, it takes expertise to fully unlock the potential within such datasets. We are expecting to have to conduct complex bioinformatic analyses to understand how phenotype might be affected by nanoparticle exposure. Therefore, we have obtained the support of researchers who have significant bioinformatic analysis experience.

Encouraging the understanding of brain development

Our research would have many important outcomes. Firstly, it will contribute to our understanding of brain development and how that can be modified by different chemicals present in our environment. This will be key to understand various pathologies and creating methods to prevent or handle them. In addition, it will also inform how we evaluate the safety of novel products and of our environment in general. It will help in the development of new tests and standards for the presence and use of nanoparticles. The impact of this isn't just limited to humans. If nanoparticles affect the brains of mice and humans, they can likely affect the development of many different animals. This means that the results that our team uncover can even help protect the environment in the future.

Sanyo-Onoda City University

Ken Tachibana
Associate Professor
Division of Toxicology and Health Science,
Faculty of Pharmaceutical Sciences,
Sanyo-Onoda City University
Tel: +81 836 39 6892
k_tachibana@rs.socu.ac.jp
https://researchmap.jp/read0084052?lang=en

(Research database of Japanese researcher)

How to predict the remaining lifecycle of mechanical products

Researchers are working on a non-destructive method to measure strains, that can estimate the remaining lifecycle of mechanical products

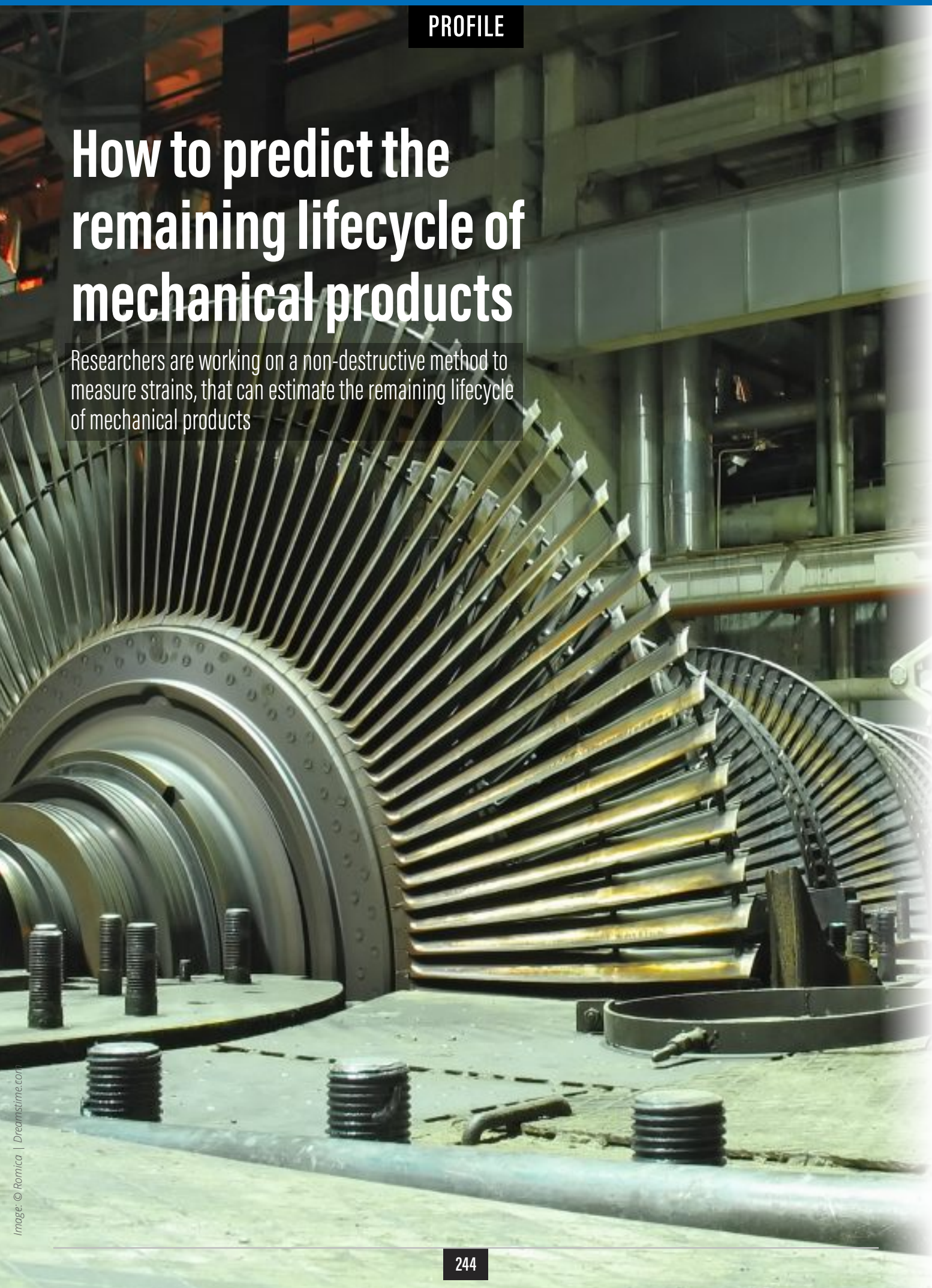


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Non-destructive inspections for cracks in turbine blades are periodically conducted in power generation plants. However, if the time between crack initiation and fracture is shorter than the inspection interval, there is a need to establish a non-destructive method to predict the remaining useful life even in absence of cracks.

Existing estimation methods aren't accurate enough

Current methods for predicting remaining life include numerical analysis and measuring microscopic cracks and the surface hardness of turbines. However, many parameters are difficult to determine, such as the temperature distribution required for numerical analysis, and the estimation accuracy is relatively low. In addition, non-destructive methods can only measure a limited number of parts. Therefore, there is a need to establish a method for non-destructively evaluating the three-dimensional creep strain distribution.

After a relatively large earthquake, it is necessary to assess the damage quickly to decide whether the power plant can be restarted. Evaluation of plastic strain distribution is important in areas where there is a high possibility of damage. However, currently, only the surface of the components can be examined by hardness testing. Another problem is that the hardness tests are not non-destructive since they leave indentations. A relatively simple non-destructive evaluation of the plastic strain inside a piping system can quickly determine whether the plant can be restarted.

Three-dimensional creep strains and plastic strains could be the answer

Our research group is working on a technique to estimate three-dimensional creep strains and plastic strains using surface deformation and strains measured non-destructively. Since deformation is caused by inelastic strains, inelastic strains can be regarded as the cause and deformation as the result. Therefore, the process of determining inelastic strain from deformation in this study is an inverse problem.

Revelations about the lifecycle of mechanical products

Two important results have been obtained from this research. First, in the case of turbine rotor blades, patterns applied to the surface disappear at high temperatures. Therefore, the deformation obtained is limited to certain points, such as corners. Second, the relationship between inelastic strain and deformation is non-linear.

The solution of these problems is expected to enable an approach to determine the internal inelastic strain from the surface deformation for all types of components. The method can be applied if the dimensions and material (Young's modulus and Poisson's ratio) of the component are known, even though the complex process of inelastic strain generation does not need to be known.

KOGAKUIN UNIVERSITY

Masaru Ogawa
Associate Professor
Kogakuin University
Tel: +81 3 3340 2595
ogawa-masaru@cc.kogakuin.ac.jp
https://lab-dr-ogawa.com/en-home/

Reducing medical costs of patients with thyroid cancer by centralising medical functions

Professor Hiroki Konno at Nihon University explores proposals for reducing medical costs for patients with thyroid cancer in Japan

In Japan, the urgent issue is to reduce medical costs in response to the increase in national medical expenditures (43.4 trillion yen in the fiscal year 2019), particularly for patients with thyroid cancer. The government is promoting the centralisation of acute care functions as one of its policies to reduce medical costs.

The law first stipulated this policy in the Medical Care Act of 1998. In 2014, the Medical Care Act made it mandatory for prefectures to consolidate medical functions and adjust the supply and demand of hospital beds in each region. In 2019, the government's working group required hospitals with inadequate regional performance to reorganise their medical functions.

However, the effects of the policy have not been fully apparent, and there have been delays obviously in some regions. This paper examines and explains the reasons for this trend and proposes a solution for the care of patients with thyroid cancer.

Postoperative care of patients undergoing thyroid tumor resection in Japan

Patients with thyroid cancer who undergo thyroid tumor resection have a satisfactory prognosis. The average length of hospital stay (LOS) in FY2019 was 8.9±2.21 days for resection (thyroidectomy), including endoscopic resection. Hypothyroidism and hypocalcemia that patients occur postoperatively are commonly treated with thyroid hormones, calcium agents, and vitamin D administration.

> "Patients whose postoperative status has stabilised should be moved to a subacute care bed and, if possible, should continue treatment in an outpatient setting."

However, patients with hypothyroidism experience symptoms of lethargy, fatigue, swelling, coldness, weight gain, slowness of movement, poor memory, and constipation, while patients with hypocalcemia experience muscle spasms with severe symptoms of pain, confusion, and depression. For this reason, postoperatively, patients are often treated continuously in acute care beds.

Issues hindering reductions in medical costs for inpatients

One of the effects of promoting the centralising medical functions is to reduce medical costs for inpatients by shortening the LOS. However, the following three problems hinder this effect:


Hiroki Konno

1) Patients may be treated for hypothyroidism and hypocalcemia in acute care beds for safe postoperative management.

2) General hospitals may still have a philosophy of comprehensive care from admission to discharge.

3) Elderly patients, in particular, may seek care in a hospital with a high care system because of anxiety about postoperative exacerbations and depression associated with general malaise.

The solution for patients with thyroid cancer

To reduce medical costs for inpatients with thyroid cancer, first, Patients whose postoperative status has stabilised should be moved to a subacute care bed and, if possible, should continue treatment in an outpatient setting. Postoperative complications of thyroidectomy may include a variety of symptoms; however, hypothyroidism and hypocalcemia do not always require treatment in an acute care bed. Continuous care in acute care beds facilitates postoperative care management; however, it prolongs LOS in acute care beds. This way of care should be revised, assuming that acute care functions of hospitals will be centralised in each region.

In addition, the government must consider eliminating incentives for acute care hospitals to admit patients to reduce the number of empty beds. This is because the early discharge of patients from acute care beds can increase the number of empty beds in hospitals and create an induced demand. This could be resolved by strongly requiring hospitals with low inpatient volumes to reorganise their medical functions in the Medical Care Act.

Second, the system under which additional rewards are given should be revised as long as the LOS does not exceed the national LOS. In Japan, the payment system of acute care has a mechanism in which the per-diem payment gradually decreases as the LOS increases, and this system gives acute care hospitals an incentive to discharge patients early. Additional rewards should be given only to acute care hospitals in the first quartile of LOS to be more effective.

> "The average age of patients with thyroid cancer is younger than those with other diseases."

In Japan, general hospitals have historically had a culture of providing comprehensive care to patients in acute care beds from admission to discharge. This is due to the origin of hospitals in Japan. Hospitals were established due to the growth of large clinics providing care in the neighborhood. Therefore, medical staff has historically had the mission to provide care responsibly until the patient is discharged from the hospital. Twenty years after payment reform in 2003, hospitals' culture of care delivery is certainly changing; however, it will take more time for the effects of government policy to change the culture.

Third, clinics and home physicians in the region should cooperate with the hospital where the surgery was performed and take steps to dispel patient anxiety and ensure patient safety. The average age of patients with thyroid cancer is younger than those with other diseases. However, in general, Japanese patients tend to trust hospital care strongly. This view indicates deep-seated anxiety about treatment in clinics and at home.

Although the government is currently promoting the enhancement of regional medical care, it has yet to establish a system that can respond to the diversity of medical needs, such as chronic diseases, rare diseases, cancer, palliative care, dementia, pediatric diseases, and disabilities. Although it will take time to change the culture regarding the public's use of medical care, it can be expected to change as reform of the delivery system of medical care in regions.

To streamline medical costs for thyroid cancer

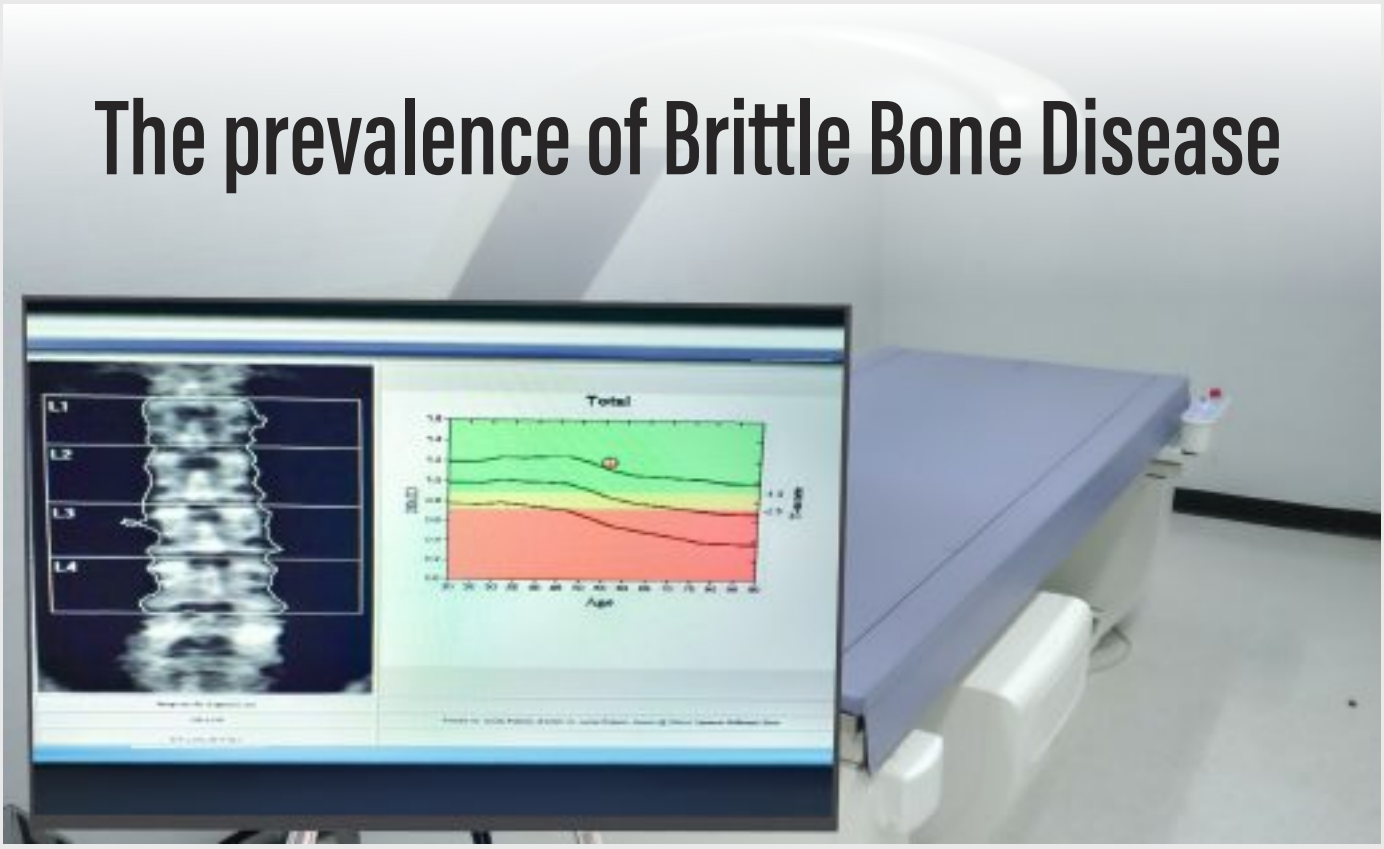
The centralisation of acute care is essential to reducing inpatient medical costs. Thyroid cancer treatment is more easily differentiated between acute and subacute care because of the standardisation of treatment methods. Patients whose condition has stabilised after surgery should be moved to subacute care beds, and reimbursement for hospitals with average LOS should be further reduced. At the same time, clinics and home physicians in the region could function as a complement to hospital care, thereby eliminating the concerns of patients discharged early.



Nihon University
College of Economics

Hiroki Konno
Professor
College of Economics, Nihon University
Tel: +81 3 3219 3301
konno.hiroki@nihon-u.ac.jp
https://kenkyu-web.cin.nihon-u.ac.jp/Profiles/128/0012718/profile.html?lang=en

The prevalence of Brittle Bone Disease



Dr Roger J. Young, Professor at Saba University School of Medicine, walks us through Brittle Bone Disease, otherwise known as Osteogenesis Imperfecta Type I

Brittle Bone Disease, otherwise known as Osteogenesis Imperfecta Type I, is a manifestation of a range of pathologies originating from the malfunction or malformation of the protein collagen. As devastating as this disease can be, it is one of the milder pathologies associated with the malfunction of this protein, with variants ranging from asymptomatic to incompatibility with life.

Brittle Bone Disease has a prevalence in the UK of about one in fifteen thousand with similar frequencies being reported in other locations and individuals with this disease display increased susceptibility to bone fractures along with decreased bone density. Diagnoses may frequently be post-natal with multiple bone fractures occurring during delivery of the affected individual. Other symptoms include blue sclera of the eyes where the reduction in collagen allows the sclera tissue to be translucent, deafness due to the malformation of the middle ear bones, and dental abnormalities. Bone density scans in older children are useful in diagnosis as well as X-rays to visualise fractures that have previously occurred.

Collagen exists as several subtypes and is the most abundant protein in mammalian systems with Type I collagen being the most prevalent form in the body where it performs many roles as the main protein in the extracellular membrane in skin, bones, tendons, heart and other organs. Given its near ubiquitous nature, it is no wonder that an error in collagen function can have far reaching effects throughout the body.

Collagen synthesis in fibroblast cells

To understand the disease, it helps to summarise the process of collagen synthesis in fibroblast cells found in connective tissue. Transcription of the COL1A1 and COL1A2 genes and subsequent translation of their mRNA products creates a polypeptide repeat of glycine, hydroxylysine & hydroxyproline which assumes a helical structure. While still in the cytosol, three of these polypeptide chains (two from the COL1A1 gene, and one from the COL1A2 gene) are intertwined as a triple helix and then secreted into the extracellular space. Here, the ends of the triple helix are trimmed, and the remaining structure crosslinked

to other triple helices of collagen. In a manner analogous to forming a strong thick rope from a large number of intertwined and twisted thin fibers, the structurally functional collagen protein is then able to perform its many molecular roles. Any alteration in this enzymatically and spatially complex process will alter the end product such that it has different and maybe deficient properties compared to the unaltered product. While the most commonly mutated genes involved in collagen synthesis are the alleles mentioned above, given the complexity of the synthesis process there are more than a dozen other genes that when mutated are also implicated in Brittle Bone Disease.

The systemic distribution of collagen and its essential role in many different organs is a major challenge in the treatment of Brittle Bone Disease. While relatively new molecular techniques such as CRISPR can target individual nucleotide mutations within a cell and the use of assorted viral vectors can target specific tissues, the specific alteration of a genetic mutation possibly unique to that individual, throughout the majority of cells in the body provides a remarkable goal.

Noninvasive prenatal testing

The practice of noninvasive prenatal testing is well established. Obtaining fetal cells via a simple blood draw provides minimal risk to the mother and enables a full genome screen of the fetus to determine the presence of mutations in alleles involved in collagen synthesis. Knowledge of the risk to the fetus of Brittle Bone Disease can allow the parents to prepare for such an eventuality and enable physicians to choose safer options for delivery to minimise bone fractures. Brittle Bone Disease is a dominantly inherited trait, and most cases have a familial history, therefore education of prospective parents combined with prenatal testing will provide early information and allow parents to choose their course of action.

Treatment and research for Brittle Bone Disease

While Brittle Bone Disease can be treated with bisphosphonate to reduce bone loss along with prophylactic vitamin D, it has also been shown that all-trans retinoic acid (from Vitamin A) can stimulate collagen production in aged and photodamaged skin, therefore diet modification could be a pre-emptive step into reducing the effects of this disease.



Dr Roger J. Young

While research into curing Brittle Bone Disease alone possesses many challenges, doing so also improves our understanding of collagen synthesis and function in many of the other roles that it plays in our tissues. With an increasing global percentage of elderly individuals, collagen deficient age-related maladies are on the increase as octogenarians not only produce less collagen than their younger peers, but also fail to successfully crosslink collagen fibers leading to a variety of collagen molecular modifications. These age-related maladaptations may be manifested as a variety of pathologies including chronic obstructive pulmonary disease and idiopathic pulmonary fibrosis.

The malformation of collagen then, may result in a variety of pathologies that present in a multi-system manner, and as such a direct targeted approach to curing Brittle Bone Disease will be challenging with behavioral and dietary modifications providing the most immediate benefit. Rapid advances in genetic testing techniques however now provide parents and researchers alike the opportunities to study individual genetic changes and prepare in vitro or in utero treatments as appropriate. With collagen modifications affecting multiple pathologies from lung and heart disease to cancer, continued research into Brittle Bone Disease will also yield advances in these areas and provide benefits to others who suffer from collagen related ailments.

Dr Roger J. Young
Professor
Saba University School of Medicine
Tel: +1 (978) 862 9600
admissions@saba.edu
www.saba.edu
https://twitter.com/SabaUniv

Improving the quality of life for people with brittle bone disease: Osteogenesis Imperfecta

Pascale V Guillot, at the University College London, looks toward improving the quality of life for those with Osteogenesis imperfecta, a chronic health condition called brittle bone disease

Osteogenesis imperfecta is a rare genetic disease that starts to manifest in the womb by bone fractures and deformities of the skeleton. The severity of the disease ranges from mild (people can almost live a normal life) to severe (using a wheelchair as being unable to move), with the most severe cases not surviving the neonatal period and dying before birth or shortly after. This is because there are over a thousand different mutations in the DNA coding for type I collagen gene, which result in either insufficient amounts of type I collagen or an abnormal type I collagen molecule.

Type I collage is a protein which is the main component of bones and skin, but also other organs including kidneys, heart, and teeth. Therefore, any modifications of the structure or amount of type I collagen not only affects the bones by making them weaker and more fragile, but also affect the cardiac and renal function.

This contributes to decrease the quality of life of people with brittle bone disease, as people suffer from bone fractures, smaller stature, bowing of the bones and skeletal deformities, but also from other pathologies which may include fragile teeth, bleeding and easy bruising, blue colour in the eyes, breathing problems that can be very severe in relation to malformation of the rib cage, extreme tiredness, hearing loss, painful skin, loose joints, muscle weakness, serious cardiac problems and chronic renal failure.

> "As the disease starts to manifest before birth, babies and infants are already affected and may have experienced multiple fractures before they are able to talk."

The quality of life for people with brittle bone disease

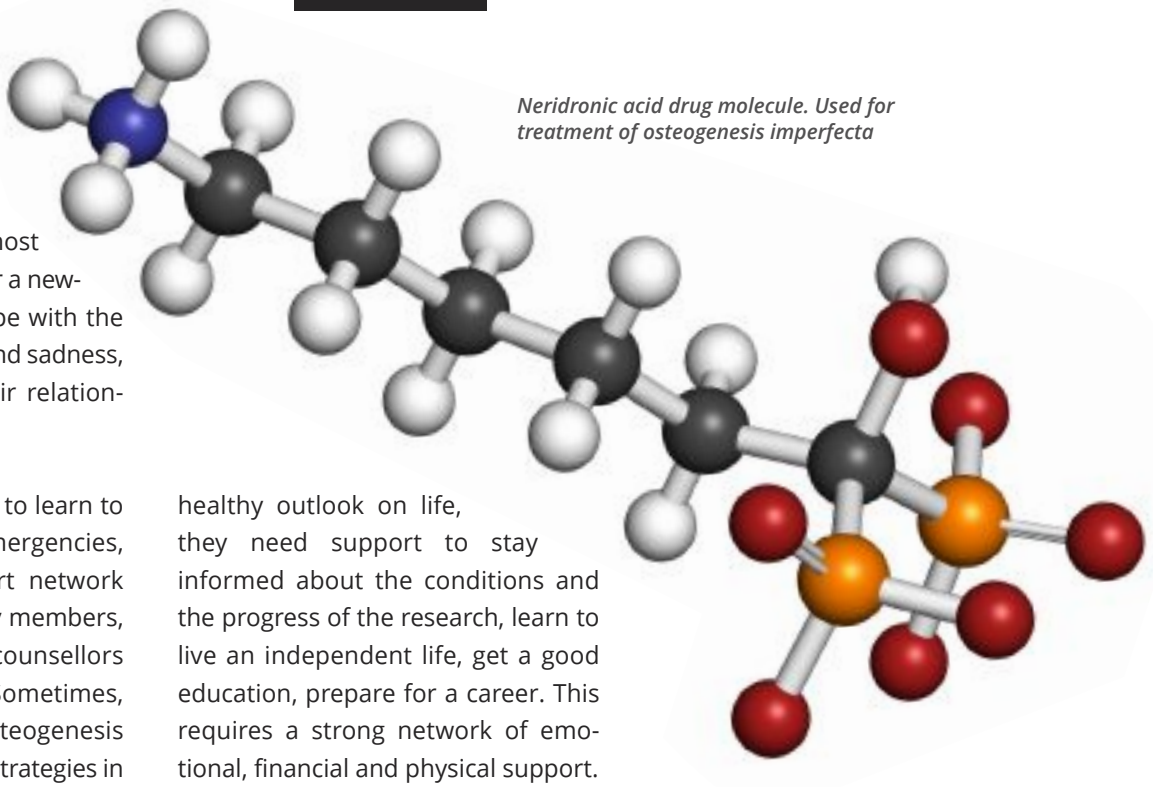
The quality of life for people with brittle bone disease is impaired from an early age in relation to their health condition. This includes the impact of multiple hospital admissions and severe pain on mental health, not only for children affect but for those who care for them. Whilst some treatments are offered, there is currently no cure for the disease, which may add to low self-esteem and anxiety, depression, feeling of being isolated and fear of an early death.

Therefore considering the mental health and wellbeing of people with osteogenesis imperfecta needs to be considered and assistance provided to help them and their families to cope with both the physical and emotional aspects of the disease. Therapies include how to develop skills for coping with the stress and anxiety inherent with living with life-long chronic health issues.

The daily life of people with brittle bone disease

The life of people born with osteogenesis imperfecta is stressful as children, and then adults, deal with recurrent fractures, reduced mobility, tiredness and general pain. The prospect of fracturing a bone whilst sneezing certainly puts a toll on daily life. Several osteogenesis imperfecta foundations are raising awareness for their "unbreakable spirit" but the social and emotional issues associated with the disease need to be addressed. For the parents, the diagnosis of osteogenesis imperfecta for an unborn child or an infant raises immediate anxiety as well as challenges, such as locating doctors and other health care providers. Sometimes, child abuse allegations are made before the diagnostic, which also contributes to the emotional distress of the parents.

Therefore, strategies need to be put in place to help the parents cope with the stress of caring for a child with a life-long medical condition, which will affect their everyday life. knowing that



Neridronic acid drug molecule. Used for treatment of osteogenesis imperfecta

pain and fractures are almost inevitable. Whilst caring for a newborn, parents need to cope with the additional fatigue, stress and sadness, which can also affect their relationship.

Strategies include therapy to learn to cope with medical emergencies, creating a strong support network which include other family members, nurses, doctors, genetic counsellors and social workers. Sometimes, parents also have osteogenesis imperfecta and may have strategies in place to deal with such situations.

Siblings who are not affected by osteogenesis imperfecta my feel left out or jealous of the time their parents are spending with the affected child, or may experience anger, guilt, or worry. Therefore, family therapies can be put in place to address these feelings and help children understand the situation and feel reassured.

What about children with osteogenesis imperfecta?

As the disease starts to manifest before birth, babies and infants are already affected and may have experienced multiple fractures before they are able to talk. Parents and doctors need to communicate in an age-appropriate way as well as include the child in the family activities and projects.

Later in life, the disease affects relationships and career choices. Life with a chronic condition can affect their mental health as well as they physical wellbeing. However, they are capable of developing close relationships and successful careers. To develop a healthy outlook on life, they need support to stay informed about the conditions and the progress of the research, learn to live an independent life, get a good education, prepare for a career. This requires a strong network of emotional, financial and physical support.

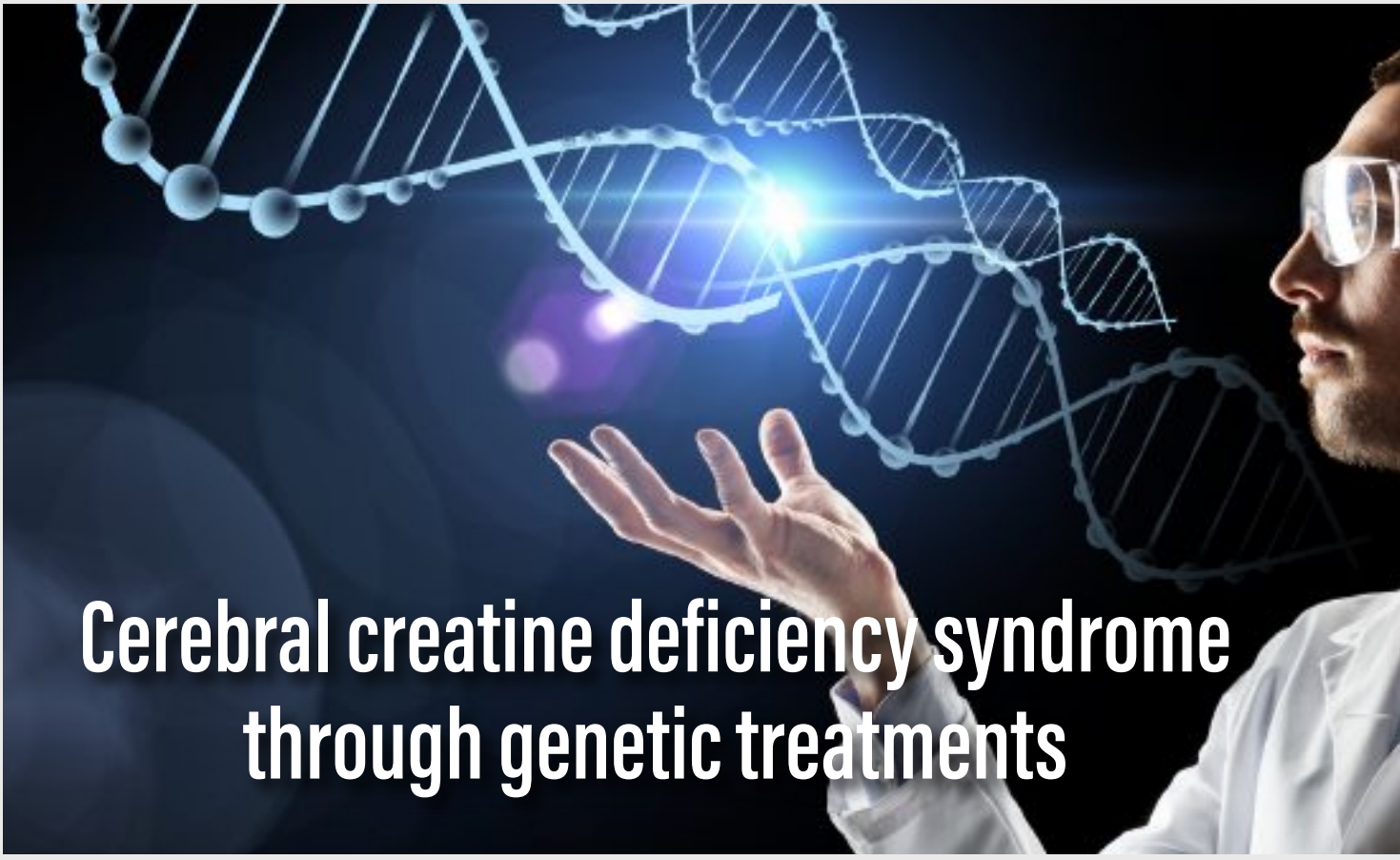
Being a teen with osteogenesis imperfecta

Teenage years are challenging for most of us. But a pre-teen or teen with osteogenesis imperfecta is facing additional challenges that add to the emotional as well as physical burden of the disease. First, the skeleton is growing rapidly, which increases the risks of fractures and hospitalization, with the knockon effects of missing school and impacting social life. As most teens may struggle with changes in physical appearance, self-esteem and self-confidence, teens with osteogenesis imperfecta face the additional burden of dentogenesis imperfecta (with fragile teeth), height issues, deformities, which can impact their social life as they are unable to participate to certain sports or social activities.

Children, teens and adults with osteogenesis imperfecta as well as their families and friends rely on a strong network of emotional, financial and physical support to face these challenges in order to experience a meaningful life. Whilst scientific research focus on developing new therapies to counteract bone fragility using stem cells, exosomes and other drugs, osteogenesis imperfecta community awareness is fundamental to ensure the best quality of life possible for people with osteogenesis imperfecta.

EGA INSTITUTE FOR WOMEN'S HEALTH UCL

Pascale V Guillot
Associate Professor
University College London, Elizabeth Garrett Anderson Institute for Women's Health (UCL EGA IfWH)
Tel: +44 (0)203 987 2056
p.guillot@ucl.ac.uk
https://www.ucl.ac.uk/womens-health/research/maternal-and-fetal-medicine/cellular-reprogramming-and-perinatal-therapy



Cerebral creatine deficiency syndrome through genetic treatments

Cecilia Van Cauwenberghe from Frost & Sullivan's TechCasting Group, addresses cerebral creatine deficiency syndrome through genetic treatments

Inborn errors of metabolism (IEMs) are a wide scoping set of disorders induced by the disruption of a metabolic pathway (Salazar, 2020). A specific inborn error of metabolism of interest in this work is cerebral creatine deficiency syndrome (CCDS), caused by an inherited defect of creatine metabolism in the brain. CCDS represents a group of rare genetic disorders primarily characterised by intellectual and speech disability, behaviour disorder, autism spectrum, movement anomaly and chronic cerebral seizures.

Although the whole molecular base genetics mostly triggering these disorders is complex, SLC6A8, GAMT, and GATM have been identified as genes responsible for CCDS (Shen et al., 2022). Loss of function (LOF) mutations in the SLC6A8 creatine transporter (CT1), for instance, results in CCDS. Therefore, CCDS are subdivided into groups: creatine transporter defect (CTD); guanidinoacetate methyltransferase deficiency (GAMT); arginine: glycine amidinotransferase deficiency (AGAT).

According to the U.S. National Institute of Health (NIH), CTD is estimated to account for 1-2% of all genetic intellectual disabilities, whereas GAMT deficiency represents one out of 2,640,000 to one out of 550,000 patients being diagnosed. The prevalence of AGAT is not known because a lack of studies.

Therapeutics aspects & precision medicine frameworks

In the clinic, Cerebral creatine deficiency syndrome has been well characterised; therefore, it is well-known that mutations within these three key genes are the primary drivers of the disease. From a molecular standpoint, the underlying cause of CCDS is related to deficiencies in cellular energy homeostasis and an inability to maintain cellular energy sources at the right levels to enable the cells to support numerous critical metabolic pathways per function (Patel et al., 2018).

The development of effective long-term treatment schemes for CTD patients poses a major challenge to



the scientific community. Traditional therapeutic avenues are related to creatine substitutes. Recent investigations have focused on gene therapy and the use of allosteric modulators as potential treatments for CTD. Allosteric modulators acting on monoamine neurotransmitter transporters also hold the potential to become effective potentiator molecules that can be designed to restore creatine transport in the loss-of-function CRT1 variants linked to CTD (Farr et al., 2020).

"Allosteric modulators acting on monoamine neurotransmitter transporters also hold the potential to become effective potentiator molecules that can be designed to restore creatine transport in the loss-of-function CRT1 variants linked to CTD (Farr et al., 2020)."

Pharmacochaperoning is another putative treatment strategy for handling CTD. Pharmacological chaperones are specific ligands (i.e., substrates or inhibitors) which bind to and stabilise the target proteins. The creation of a pharmacochaperoning platform focused on the identification of lead molecules to develop more efficient pharmacochaperone analogs capable of binding to different protein conformations and hence, correct additional misfolded mutants constitutes one of the main goals of many researchers (Farr et al., 2020).

Indeed, pharmacochaperoning can work through different mechanisms, including binding to and stabilisation of the native state; folding intermediates; suppressing aggregate formation; or dissolving aggregates (Marinko et al., 2019). According to these researchers, the clear association between membrane protein misfolding and human diseases allows examining pharmacochaperoning opportunities for the development of therapeutics and precision medicine.

Acknowledgements

I want to thank all contributors from the industry involved with developing and delivering this article from Frost & Sullivan.

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Cecilia E. Van Cauwenberghe, PhD, MSc, BS Eng, BA, MBA
Principal Consultant
Senior SciTech Advisor & Associate Fellow
TechVision Group, Frost & Sullivan
cecilia.vancauwenberghe@frost.com
www.frost.com
www.twitter.com/Frost_Sullivan



The challenge of treating genetic diseases: The example of creatine transporter deficiency

The vast majority of genetic diseases remains beyond possibilities of treatment with research continuing to be able to offer therapies to the affected patients

Treating genetic diseases is a challenge. A restricted number of these diseases can be treated through specific diet, medics, chaperone molecules or enzyme replacement therapies, while some rare recent advances brought gene therapy to the panel of treatments.

Treatable and so far untreatable genetic diseases

Creatine deficiency syndromes (CDS) are perfect examples of this difference between treatable and so far untreatable genetic diseases. CDS are caused by mutations in the genes coding for arginine:glycine amidinotransferase (AGAT) and guanidinoacetate methyltransferase (GAMT) (creatine synthetic pathway), as well as for the creatine transporter (SLC6A8). These three diseases show a lack or very strong decrease of creatine (Cr) in the brain, measured by proton magnetic resonance spectroscopy (1H-MRS), and develop severe neurological symptoms. CDS account for 1-2% of all mental retardations, Cr transporter deficiency (CTD) being the most frequent (1% of all mental retardations in boys, as the SLC6A8 gene is located on the X chromosome).

Since a very long time, Cr is known for its role in ATP regeneration and cell storage of high energy phosphates under its phosphorylated form phosphocreatine (PCr) (through the Cr / PCr / creatine kinase system). More recently, Cr was also recognized as one of the main osmolytically active molecules of the brain, and may also act as neuromodulator or even true neurotransmitter.

AGAT and GAMT deficiencies can be treated by Cr supplementation. In contrast, despite more than 20 years of research since its discovery, CTD (SLC6A8 deficiency) is so far remaining refractory to any efficient treatment. Cr supplementation was tried without any success to replenish brain Cr. The reason for this is that SLC6A8 is the sole way for Cr to enter the brain from periphery at blood-brain barrier (BBB). Cr precursors, arginine and glycine, as well as Cr derivatives being transported independently from SLC6A8 (but keeping Cr capacity to regenerate ATP) have also been tried but without any success either.

CTD is the archetype of a genetic disease extremely challenging to treat. CTD essentially affects the brain, and the only way to treat it signifies being able to restore sufficient levels of Cr (or Cr derivatives playing the same roles as Cr) within the brain tissue. The difficulty resides in the way a molecule can enter the brain from periphery. To reach neurons or oligodendrocytes (the cells making myelin sheath in the white matter), a molecule transported from the blood has 1st) to cross microcapillary endothelial cells at BBB (one uptake and one efflux mechanisms), 2nd) to cross astrocytes surrounding BBB (another uptake and another efflux mechanisms), to finally reach the target cell (neuron or oligodendrocyte) through a third uptake mechanism, having thus in total five membranes to cross.

AAV-transduced gene therapy

Whatever these difficulties, hopes for treating SLC6A8 deficiency are arising nowadays in particular through new gene therapy technologies. Recently, the use of adeno-associated viruses (AAV) as attenuated viral vectors to treat genetic diseases by gene therapy has gained considerable attention, with successes already obtained for genetic diseases affecting both peripheral tissues and nervous system. As the brain remains challenging to treat, we and others are developing optimized AAV vectors able to efficiently transduce the brain tissue, with the aim of re-establishing the expression of a functional Cr transporter within the brain of CTD patients. We test different delivery routes of our AAV vectors to CNS, through intravenous (to reach brain through BBB) or intrathecal (direct intracerebral delivery) injections. We are in the first pre-clinical phase of this development, using a new in vivo rat model of CTD, the Slc6a8Y389C/y knock-in rat, to demonstrate the proof of concept of our AAV strategy to treat CTD. We have already demonstrated that our AAV vectors efficiently transduce the desired brain cells after intravenous and intrathecal injections. We have also performed our first injections of AAV vectors transducing the functional SLC6A8, with the hope to demonstrate in the following months that we can correct CTD.

> "An important amount of work is still ahead to optimize our AAV treatment protocol."

Our first results are promising as we could demonstrate partial prevention of CTD phenotype in the Slc6a8Y389C/y knock-in rat. However an important amount of work is still ahead to optimize our AAV treatment protocol. In particular, the optimal AAV doses have to be determined for each delivery route. The long term expression of the AAV-transduced gene has also to be evaluated.

The validation of our approach by AAV-transduced gene therapy consists in the analysis of the expected correction of the CTD phenotype. 1H-MRS is performed in central nervous system to demonstrate the expected replenishment of brain Cr. The weight gain of AAV-SLC6A8-transduced animals is also followed up: indeed, Slc6a8Y389C/y knock-in male rats, as male human patients, show a progressive attenuation of their weight gain in comparison of wild type littermates. Different behavioural tests are being performed, for which Slc6a8Y389C/y knock-in rats demonstrated altered results in comparison to wild type animals. A correction of the performances of these tests is expected.

While AAV viruses are known to elicit no or very low immunogenicity, this aspect of AAV gene therapy is also being carefully analysed within our Slc6a8Y389C/y knock-in rat model transduced by AAV-SLC6A8. Apart of potential elicitation of anti-AAV antibodies in transduced animals, other potentially AAV-driven toxic mechanisms are carefully evaluated, both in peripheral tissues and in central nervous system (cell death, alterations of cell morphology, tumorigenicity). We are also analyzing another aspect of potential toxicity of our treatment: the eventual AAV-transduced (over) expression of SLC6A8 at ectopic localization.

Promising results for the future of gene therapy and genetic diseases

In conclusion, while still ahead of a validated pre-clinical protocol to treat CTD by AAV-driven gene therapy, our promising results, and the panel of tests described above aiming to refine treatment efficiency and safety, make us confident to develop a long-awaited way to treat this so far untreatable metabolic disease affecting brain development.

UNIL | Université de Lausanne

Professor Olivier Braissant, PhD,
Associate Professor
Service of Clinical Chemistry
Lausanne University Hospital and
University of Lausanne
Rue du Bugnon 46,
1011 - Lausanne, Switzerland
Tel: +41 79 556 72 07
Olivier.Braissant@chuv.ch



Microbial electrosynthesis: Achieving a sustainable economy

Aarthi JanakiRaman, Research Director, Chemicals and Advanced Materials at TechVision, argues that microbial electrosynthesis is a way to achieve a sustainable economy

Overcoming the effects of carbon dioxide emissions is critical in the transition to a viable green economy and combat the issues of climate change. Carbon capture, utilisation and storage (CCUS) is one of the methods that can help in mitigating the challenges associated with climate change. CCUS technologies help in selective removal of carbon dioxide (CO_2) from emissions, be it from point sources such as power plants and industries, or direct air, its compression into a supercritical condition, and its transport and permanent or temporary storage to be valorised for production of chemicals or fuels to name the important ones.

Despite the huge role for CO_2 emissions reduction plays in achieving a sustainable economy and even with several financial incentives and collaborative programmes worldwide, CCS (carbon capture and storage) remains an expensive venture, thereby, impacting its large-scale deployment in many industries.

Major technological change can be difficult

While it's important that the generation of CO_2 which ends up as waste to be reduced wherever possible, it is also well known that infrastructure of large-scale units across industries such as power plants or manufacturing sites is not always amenable to major technological change. Governmental efforts to encourage a reduction in energy consumption as well as recycling and re-use will have a significant contribution in reducing emissions, but often is not enough to reduce CO_2 generation sufficiently to halt or eventually reverse the increase in atmospheric CO_2 levels. Hence, the rising importance of CCU as it offers a realistic approach to reduce CO_2 emissions from existing generation sites.

> "The use of MES for carbon dioxide emission capture and conversion involves the use of microbes at the cathode with electricity as an energy source in a microbial bioreactor."

Various processes are being deployed at various commercialisation scale for CCU, one of the foremost being electrochemical technologies using chemical catalysts. While it is viable commercially, its associated with challenges such as cost of the catalysts used, sustainability issues and lack of robustness and its limitation towards only 1C and 2C products. To overcome these issues, bio-electrochemical systems (BES), a combination approach using both biological and electrochemical methods with varied microbes as catalysts have been researched. Microbial electrosynthesis (MES) is an electricity-driven production process of value-added chemicals from waste and emissions that use microorganisms as biocatalysts. The use of MES for carbon dioxide emission capture and conversion involves the use of

microbes at the cathode with electricity as an energy source in a microbial bioreactor.

"While the advantages of MES are well established by various researchers, its commercial application is still in very early stages."

The advantages of microbial electrosynthesis

MES offers significant advantages over chemical approaches, a key one being microbial cultures can help in catalysing reactions at various temperature conditions, helping to reduce energy costs. It can be used to produce various value-added products that can be released directly to the fermentation medium, facilitating a comparatively easier recovery, and with continued application-driven research, its potential for the manufacture of C2-C6 chemicals can be established. Another advantage is that it is modular in approach and doesn't require huge land for setup. A notable feature is that MES can be integrated with renewable energy for its operations, making it more sustainable compared to use of fossil-fuel driven electricity for its operations.

An advantage of using MES as biorefineries is that some of the value-added chemicals (organic acids) obtained can be used as alternate energy sources where excess energy can be stored in the C-C bonds during off-peak hours and can be used on demand.

While the advantages of MES are well established by various researchers, its commercial application is still in very early stages. Its integration into industrial setups poses challenges in terms of scaling up the microbial bioreactors and cost. Additionally, inability to control the yield and achieve the desired purity continuously also affects its commercial prospects; operational parameters, use of pure microbial culture that requires sterile conditions, can increase cost, leading to delay in commercial use. An integrated technological approach with an aim to obtain the desired output quality is required. Focus towards determining the choice of microbial culture (mixed culture/ pure culture/ GMO etc.) to the size and design of the bioreactor to energy source is needed to make it at field-scale level. As separation and processing steps also play a critical role in ensuring product yield, quality and selectivity, a thorough analysis of all the steps that can hinder rate of reaction and yield is required right from designing the most optimum genetic toolbox to deciding the type of reactor (standalone vs. stackable) and steps to effectively separate concomitants and even valorise them.

How to get to a green, sustainable economy by 2050

Significant inroads are being deployed to transition Europe and UK to a low a carbon economy, however, the region is still heavily dependent on fossil fuels for its energy and industrial activities. CCU can be used as a viable approach to reduce dependence and with continued funding and industrial support, MES can help in effective valorisation of CO_2 to obtain chemical products and intermediates including organic acids, alcohols and polymers to name a select few. It can facilitate a closed loop system which makes use of MES as biorefineries that can be integrated into chemical plants and point source emission points to make the entire value chain more sustainable and circular in nature.

Overcoming technology challenges such as optimising the conversion rate, increase yield and purity of the chemical output can help in achieving economies of scale. Continued efforts towards industrial scale up will also help increased commercial use and provide an added value towards achieving a carbon neutral economy by 2050.

Aarthi JanakiRaman
Research Director, Chemicals and Advanced Materials
TechVision, Frost & Sullivan
Tel: +91 44 6681 4102
aarthij@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan



A piece of the puzzle into climate research: freshwater wetlands microbes

Emily Davenport and Arpita Bose discuss the case for freshwater wetlands as vital pieces of the solution for climate change and sustainable energy synthesis

Arpita Bose, Associate Professor at Washington University in St. Louis, understands the connection between environmental science, energy generation, and climate change – now, she looks towards freshwater wetlands and their carbon sequestration.

The Bose group studies extracellular electron uptake (EEU), the ability to use insoluble, solid-phase conductive substances as an electron source in non-oxygen evolving (anoxic), phototrophic bacteria (pEEU). In a laboratory setting, these electroactive microbes can grow via poised electrodes running a current. Some of these microbes can perform microbial electrosynthesis (MES) of products such as bioplastics and biofuels in a sustainable manner using sunlight and carbon dioxide (CO_2).

The Bose group has searched for undiscovered electroactive microbes within soils and sediments and found this metabolism may be more common than previously thought. In nature, these pEEU-capable microbes impact global geochemical cycles, including the emission and sequestration of greenhouse gases like CO_2.

Global ecosystems are vulnerable to climate change

Climate change has led to increased temperatures, droughts, and changes in rainfall patterns. These consequences are especially troubling for vulnerable but critical environments. Oceans and Great Lakes are warming and experiencing acidification, which can disrupt food chains. Rising temperatures in permafrost ecosystems can lead to active seasonal thawing in certain soil strata, releasing ancient carbon stores and creating conditions for microbes to accelerate that release. And in freshwater wetlands, the Bose lab group aims to understand how microbial metabolisms may impact and respond to climate change.

The impact of freshwater wetlands

The main characteristic of a wetland is its state of water saturation at, near, or above surface level, seasonally or year-round. Because they are defined by water level, wetlands can be found on every continent excluding Antarctica. They are categorised based on geographic location (coastal, inland), climate (tropical, temperate).What remains the same regardless of locale is the ecological significance of wetlands due to the ecosystem services they offer as well as habitat, provisioning, and cultural services.

Freshwater wetlands are typically found in low-lying areas, catching excess runoff of water, sediments, and nutrients. Wetlands can harbour many species adapted to land and aquatic environments, as well as promote the growth of unique species such as hydrophytes (water-adapted plants). The increased vegetation allows for reduced soil erosion and flood waters abatement. As the soils allow for saturation and create entrapments for the runoff to settle, this creates cleaner, nutrient-dense ecosystems for fish and birds to thrive during migration and/or breeding. Wetlands can also purify waters. Excessive nutrients within runoff or



sewage drainage can be trapped within the sediments or transformed, creating a buffer to prevent downstream eutrophication (nutrient overloads). Provisioning services by wetlands include material resources, such as the farming of crops, fishing, and gathering of plant fibre resources. Cultural services are the non-material resources including spiritual, educational value, and recreational use.

Wetlands, carbon storage, and climate change

Despite covering less than 8% of the Earth's surface, wetlands harbour nearly 30% of soil carbon. Because wetlands are waterlogged, they can easily become anoxic (oxygen-limited/starved) environments. The anoxic conditions allow decomposition (which releases CO_2 /greenhouse gases) to occur slower than primary production (which sequesters CO_2 /greenhouse gases), thereby creating a sink for atmospheric CO_2, highlighting their undervalued significance in global carbon sequestration.

Increasing global temperatures due to climate change may have dire yet unknown effects on wetland ecosystems. Rising temperatures can mean changes in seasonal precipitation patterns needed to sustain these environments. Loss of water could lead to oxygen-rich environments for longer periods of time. This in turn would allow for decomposition to occur more quickly and shift microbial metabolisms in the sediments to aerobic respiration, both of which releases sequestered carbon.

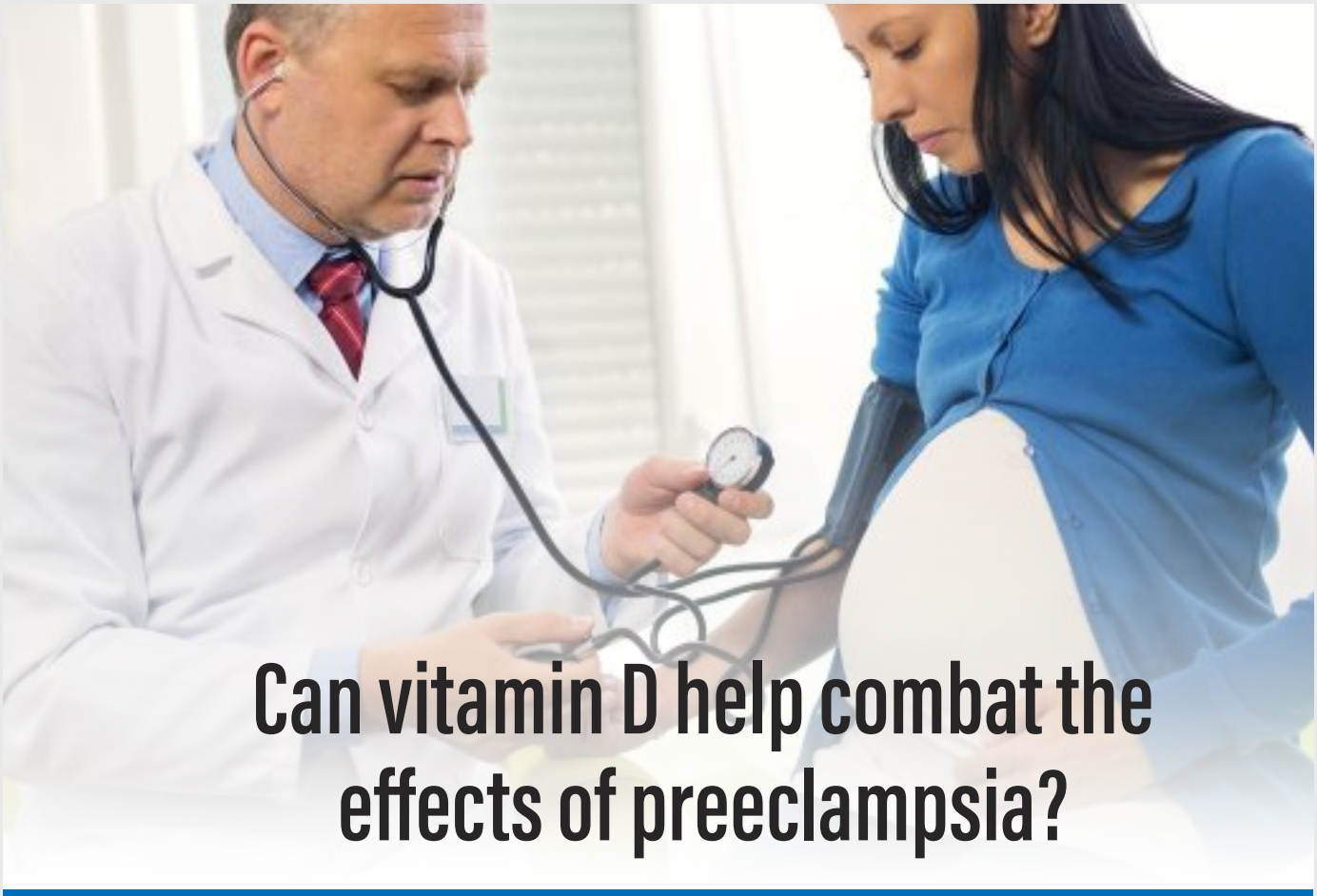
Wetland carbon sequestration at the microscopic level

Generally, the primary producers considered for carbon sequestration are the land plants such as trees, grasses, etc. But bacteria in wetlands can also perform CO_2 fixation, nitrogen fixation, denitrification, and methanogenesis, all of which directly influence atmospheric carbon and nitrogen cycles. The actual rates of nutrient transformation, as well as microbial community composition dynamics, in response to the transient environmental conditions within wetlands remains to be determined. Without this knowledge we cannot create an accurate understanding of microbial impact on atmospheric carbon concentrations. Therefore, we also lack an understanding of how these dynamic ecosystems and their processes will behave with the varying temperature and precipitation patterns associated with climate change. More studies focusing on microbial processes within wetlands, including viral processes, are needed to accurately describe wetland response to climate change. These studies will also aid conservation efforts of these vital ecosystems, and lead to new discoveries of electroactive organisms needed for a sustainable future.

We thank Eric Conners, graduate student in the Bose lab for reviewing this article.

Washington University in St.Louis

Emily Davenport
PhD Candidate
Washington University in St Louis
demily@wustl.edu



Can vitamin D help combat the effects of preeclampsia?

Shona Wilkinson at Nutrigums explains how vitamin D could be the secret weapon to combating the effects of preeclampsia

During pregnancy, women can be plagued with all types of problems. Morning sickness, backache, and changes to the skin are all complications that can be faced during the nine months. But one problem that is lesser-known but still prevalent is that of preeclampsia. Preeclampsia is a pregnancy complication characterised by high blood pressure and signs of damage to organ systems, most often the liver and kidneys, usually occurring after about 20 weeks of pregnancy.

"Vitamin D supplementation therapy in pregnancy could help in reducing the incidence of gestational hypertension - better known as preeclampsia"

Of all of the pregnancy complications, preeclampsia can often be one of the most frightening and confusing, with many people wondering about the best way of combating it or avoiding it all together. One hypothesis is that vitamin D can have a profoundly positive effect on pregnant women who are trying to avoid it. Here, I explain how vitamin D could be the secret weapon to combating the effects of preeclampsia.



Shona Wilkinson

What factors contribute to preeclampsia?

Doctors remain uncertain as to what causes preeclampsia, but some risk factors are:

- Genetics.
- Blood vessel problems.
- Autoimmune disorders.
- Having twins.
- Being over 40 years old.
- Previous cases of preeclampsia.
- Obesity.
- Previous high blood pressure.

What are the effects of vitamin D supplements on the prevention of recurrence of preeclampsia in pregnant women with a history of preeclampsia?

According to current research on the subject by The National Library of Medicine, there is a possible link between vitamin D deficiency during pregnancy and preeclampsia. Low vitamin D levels have been consistently described during the course of pregnancy of women who later developed preeclampsia and research has shown that vitamin D has a protective effect against recurrent preeclampsia.

We tend to be deficient in vitamin D generally anyway, but there is an increased need for vitamin D during pregnancy. Vitamin D supplementation therapy in pregnancy could help in reducing the incidence of gestational hypertension - better known as preeclampsia.

Why is vitamin D especially important during pregnancy?

Vitamin D is needed to help with a baby's bone growth but is a vital vitamin to ensure they can grow in the correct way. This is because vitamin D is a key component in the regulation of calcium and phosphate.

Vitamin D deficiency and how to avoid it

Vitamin D deficiency is a huge problem for many people and if left untreated can lead to a loss of bone density, which can contribute to osteoporosis and fractures (broken bones). It can also lead to disease and in children can cause rickets, which is something parents will be keen for their children to avoid.

You are more likely to be vitamin D deficient if:

- You spend little time outside (spending more time on computers).
- You are pregnant or breastfeeding.
- You are over 65 years.
- You have darker skin.
- You cover most of your skin when.
- You live in northern climates.
- You are housebound, a night-shift worker, or work in an office.
- You are significantly overweight.



How to naturally improve vitamin D intake

There are many ways to naturally improve your vitamin D intake. Vitamin D is often referred to as "the sunshine vitamin" because the sun is one of the easiest and best way of sourcing this valuable nutrient.

It's also important to consider your diet. Consuming oily fish, seafood, egg yolks, and fortified foods such as cereal, dairy products and canned goods have all been noted to make a noticeable difference to the levels of vitamin D in your body.

Shona Wilkinson
Consultant Registered Nutritionist
Nutrigums
contact@nutrigums.co.uk
https://nutrigums.co.uk/
https://www.instagram.com/nutrigums

Digital transformation in the future of local government

Digital transformation will play a key role in the future of local government. David Bemrose, Head of Account Strategy for Local Government at Crown Commercial Service (CCS), introduces a new digital transformation guide

At Crown Commercial Service (CCS), we recognise that technology buying decisions have the power to improve citizens' lives, and that better innovation in the delivery of digital services will support improvements in customer experience.

But against a backdrop of squeezed budgets and economic uncertainty, many public sector organisations are struggling to achieve their digital transformation goals, while reducing costs and creating efficiencies.

Opportunities & challenges of digital transformation for local government

Digital transformation presents many opportunities for the future of local government. Firstly, it offers your customers more flexible access to services around the clock. It can also help you to meet your carbon net-zero targets with less need for residents and service users to travel to customer service centres. The flexibility offered by new technology also supports the Government's levelling up agenda by opening up access to jobs in local authorities located anywhere in the UK. But there are many challenges to digital transformation for local government, including existing incumbent technology and employee skill gaps.

You will need to make many key decisions as part of your strategic approach to digital transformation to overcome these challenges.

CCS has produced a digital transformation guide - drawing from the Government's Technology Code of Practice. This guide aims to help you build a digital transformation strategy that meets your customers' needs - helping us all to build back better, level-up across the UK and reach that all-important carbon net-zero target by 2050. Here are five key steps taken from the new guide.

Defining customer needs

The first step is to have a clear understanding of your customers and their behaviour. Your residents and service users all have differing needs. Some may contact you in a crisis - when they are homeless, in financial difficulty or need to access social care, whereas others may just want help with regular services. New technology must meet all your customers' needs and reflect how they want to access your services.

Collaboration – working smartly

Effective collaboration with other local authorities can be extremely cost-effective. It can prevent duplication of effort - allowing you to re-use technology, data and services; share best practice and work on common challenges. You will also be able to save money by aggregating your digital procurement. Lincoln Council and the London Borough of Southwark worked together to transform the management of housing repairs, using our digital marketplace for their procurement. They were able to save on resources - avoiding duplication of effort. Open Source software makes this sort of collaboration possible - providing transparency, flexibility and accountability.

Fit for the present and the future of local government

For customer-facing services, any new technology must work well in the present and in the future. Again, the choice of software is crucial. Your new software should complement existing back-office processes and systems, with the scope to adapt if needed.

Continuity of service is vital. No system user — internal or external —should ever be adversely affected by digital transformation. It is quite possible to future-proof your technology using open standards. Open standards software will allow you to communicate with other technology and systems – sharing data, where

CCS: Supporting the UK public sector

There are several reasons for the UK public sector to purchase with the help of Crown Commercial Service (CCS), one is that they have a wide range of commercial agreements. To enhance competition and value, CCS trade agreements use competition among suppliers.

[1] For example, the latest Digital Outcomes and Specialists 5 (DOS 5) agreement can be used by all public sector organisations to find suppliers who can design, build, and deliver made-to-order digital services using an agile approach.

Three of the major advantages are:

- Provides customised services through suppliers with the right capabilities to meet the needs of the client.
- No restriction on the value of an individual call-off contract (the framework has an overall OJEU value of £2 billion).
- Most of their vendors are small and medium-sized businesses that use an agile approach to design customers' digital services. [2]

Likewise, the Technology Services [3] agreement provides access to technology services ranging from strategy and design to operational deployment. It also provides support for large projects, including top-secret classification, and a variety of other technology services such as provision and management of IT service desk, end-user device support, and network support.

CCS is the biggest public procurement organisation in the UK. It helps thousands of public and third sector buyers in the UK with billions of pounds of spending each year.

References

https://www.crowncommercial.gov.uk/about-ccs/

https://www.crowncommercial.gov.uk/agreements/RM6100

https://www.crowncommercial.gov.uk/agreements/RM1043.7

appropriate. You will be able to upgrade and expand your technology as needed.

Protecting customer data

You are also responsible for the security and privacy of your customers' personal information. Some data will belong to vulnerable individuals, including children in care, and victims of domestic violence. As set out in the General Data Protection Regulations (GDPR), all data must be protected.

Any breach could result in a significant fine and/or system failure and could place your residents and service users at risk. Again, software is available to meet this challenge. You might consider using public cloud solutions. This will typically provide your customers with a more secure, reliable, higher quality and cost-effective service.

A strategic approach

Digital transformation presents many opportunities for the future of local government, but if you want to maximise the benefits and minimise the risks, your approach must also include a purchasing strategy. A clear purchasing strategy will help you understand what components, resources, support and delivery mechanisms are needed and how to achieve the best social value for money.

You can download our digital transformation guide for more information. If you would like advice from category experts or help to access our commercial solutions please complete the online form.

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David Bemrose
Head of Account Strategy for Local Government
Crown Commercial Service (CCS)
info@crowncommercial.gov.uk
www.crowncommercial.gov.uk
www.twitter.com/gov_procurement

Is Drupal right for public sector digital transformation?

Drupal is perfect for large and small organisations. More than 60 local government sites are already live, demonstrating its growing popularity with this sector. Drupal is favoured by councils for the following reasons.

There are no boundaries when it comes to publishing in Drupal

It is becoming increasingly important for local government websites to serve not only as publishing platforms but also as authoritative repositories of guidance and information for their constituents. There must be a way for several members of staff to rapidly and easily upload fresh content to local government websites.

Users looking for information and services will find the navigation and layouts to be intuitive. The back end of the website is very simple to access for staff editing material and pages thanks to Drupal.

Strength in numbers

A large number of local governments already utilise Drupal, so they have an advantage in building joint products and sharing resources. Once a set of features has been developed, they can be shared with the rest of the Drupal community because Drupal is open source. This gives enormous chances for local governments to cooperate together and prevents each one from doing the same thing.

Ensured safety and security

A large amount of sensitive data, including personally identifiable information and financial data is processed and protected by local authorities. Local governments must be able to put their faith in the technology supporting their websites to avoid becoming the next victim of cyber-crime.

"The back end of the website is very simple to access for staff editing material and pages."

The Drupal security team is always working on new patches and upgrades, which is why Drupal has such a good track record when it comes to security.

Drupal migrations are simple

It doesn't matter what CMS they've been using in the past, most local governments find Drupal a far easier platform to migrate to than others. Even while some knowledge of PHP and SQL is normally required for migrations to go smoothly, they're rarely difficult.

Independency and adaptability

Finally, and maybe most importantly, Drupal is an open-source platform, which means that anyone can utilise the original source code. The result is a vast array of plug-ins that can do a wide range of tasks, all of which have been built by many Drupal developers.

When it comes to developing new services, Drupal has modules that can help local governments achieve their goals over the next few months and years. This is especially critical in a sector with tight budgets and the potential for policy changes to shift the goals.

LocalGov Drupal - Built for councils, by councils

LocalGov Drupal is a public sector-specific Drupal version that has been pre-configured to meet the requirements of most, if not all local council websites in the UK.

Save time and money

Up to 80% of the cost of a new council website can be saved by using LocalGov Drupal. In comparison to a licenced, proprietary website, the cost of a LocalGov Drupal website is a fraction of what it would be with no licence costs and open source. LocalGov Drupal frees up money to be spent on other services (e.g. for the homeless, health care and education) as a result.

Tried and tested features

Before any new features are launched, LocalGov Drupal is thoroughly tested by a variety of councils and development organisations. In addition, you can rest easy knowing that each feature is backed up by an automated test suite created by some of the greatest Drupal developers across the globe.

Meet accessibility standards by default

The LocalGov Drupal platform is designed to be accessible to all users. A variety of accessibility criteria, including WCAG 2.1 AA, are applied to each feature before it is released.



"There are no boundaries when it comes to publishing in Drupal ... users looking for information and services will find the navigation and layouts to be intuitive. The back end of the website is very simple to access for staff editing material and pages."

Get your new site quicker than ever

The development turnaround time for your council website is substantially faster because the functionality you require is already established and ready to go. A new municipal website can take up to a year to develop. It is customary to launch a LocalGov Drupal website within 8 to 12 weeks.

Don't be tied to an agency

As an open-source solution, LocalGov Drupal is free of vendor lock-in and licencing. If you wish to outsource the creation of your website to a different company, you can do so. The code-base is yours to keep. The only thing you'll need is a second Drupal expert.

We're going one step ahead of that and offering a LocalGov Drupal trial on AWS free for 30 days, with the option to extend to three months at a low cost.

LocalGov Drupal on AWS with Code Enigma

We're Code Enigma; an ISO certified agency of Drupal experts. We make modern, usable, mobile-first websites.

Our client list includes a raft of development, hosting and support services for public sector websites and web applications. We are also specialists in implementing complex integrations.

We know organisations in the public sector face particular challenges in completing their tasks because of their limited financial resources. We'll assist you in your efforts to coordinate actions, manage communications, safeguard constituents, and preserve sensitive data.

Because AWS is user-friendly, adaptable, secure, cost-effective, stable, scalable, and highly performant, we decided to host a LocalGov Drupal trial on AWS. And we're offering that to all public sector organisations.

Try LocalGov Drupal for 30 days on AWS, for free!

codeenigma

Maygen Jacques
Head of marketing
Code Enigma
maygen.jacques@codeenigma.com
www.codeenigma.com
https://twitter.com/codeenigma/

Electronic document & records management system to manage records like money

Richard O'Brien, Director at GilbyIM, looks at an electronic document & records management system for efficient information management

Imagine walking into a bank and being told you can see your balance, but not your withdrawal history. Or that the money you deposit may not be valid when you decide to withdraw it. Sounds farfetched? Not in the world of Information Management. The answer is to use the right tool for the job - an Electronic Document & Records Management System, which manages documents and records with precision and control, just like banks manage money.



Documents are created and received by everyone. They vary in importance, and some have more value than others. Given that so much reliance is placed on documents and records, why is it that document repositories only tell you what you hold and not what you've deleted? And, with so many different content types, combined with multiple formats and technologies spanning so many years, how can you guarantee you can access the records when you need to in years to come?

The benefits of an Electronic Document & Records Management System (EDRMS)

An EDRMS is purpose-built to manage records to the highest standards. It can manage electronic and paper records, archives, libraries, image collections and back-scanned projects. It allows the application of strict rules and in-built controls to ensure that what is placed in the system is properly managed throughout its lifecycle.

Is there a need for an EDRMS?

Yes. Every organisation has the need to manage some records, but not everything has to be managed as a record. There are internal projects, works in progress - transient and ephemeral documents - which can be stored in file shares and collaboration platforms; and then there are long-term records like HR, finance, contracts, health & safety and board meetings which demand an EDRMS.

Typical EDRMS deployments

Traditional deployments involve large upfront investment in software and hardware. Project implementation teams followed by ongoing support and maintenance by a central team can be costly. Deployments can be time-consuming when the system is configured separately for each team.

Due to these cost barriers, only large organisations have been able to afford to roll out an EDRMS. This approach has met varying degrees of success. From a user perspective, some have welcomed the structure, compliance and functionality. Others have resisted due to system complexity,

fear of change and disruption to processes, as well as not seeing the benefits the system brings to the organisation.

Where do collaboration platforms fit?

Collaboration platforms such as O365, Google Workspace and Dropbox are useful tools. They allow a great deal of flexibility for users to access, create and collaborate on content. However, if they are configured to act like an EDRMS, they lose much of the functionality that make them such great platforms to work with. Rights need to be removed from users and complex processes need to be created and documented. And what is more, all these actions need to be managed by a central team.

Where does that leave us?

As we know, all organisations create records but, depending on the industry, the need to place records in an EDRMS as opposed to a collaboration platform can differ greatly.

Collaboration platforms are used for most of the day-to-day work of many organisations, where there is a need to share access and collaborate.

Long-term records should be stored in systems designed for records: where full audit trails on every action are recorded and kept for the life of the record; where complex access controls are carefully thought through and effectively managed; where retention schedules are formally agreed and implemented, which can prove that a record has not been amended or deleted and, when something has been deleted, by who and when.

Why is GilbyIM so different?

Gilby IM is a fully managed service and opens out the benefits of an EDRMS to all organisations, from large to small. It allows the management of specific record sets without the need for expensive organisation-wide projects or support teams.

Unlike traditional EDRMS deployments, GilbyIM is offered as Software-as-a-Service (SaaS) and can be deployed within a few days. Organisations have the option to adopt a templated solution or have the platform configured to their specification.

As a fully managed service, GilbyIM gives organisations the freedom to deploy quickly an EDRMS just for the information assets that need managing without the need for a full deployment. This dramatically reduces costs. Whether it be electronic records covering HR, contracts or finance, paper files or back scanning a whole file range ready for an office move, GilbyIM solves this problem and solves it quickly.

Trusted technology

The GilbyIM platform gives you access to a system that provides assurance from the start. The technology that underpins GilbyIM manages records for over 2,500 government organisations worldwide. It conforms to ISO 15489 (the international standard for records management) and is approved by the National Archives.

Simplicity, fast deployment & agile working

The whole look and feel has been designed around the user. It is intuitive, uncluttered and requires zero training.

Our combination of a SaaS model and templated solutions means that organisations can reduce a records transformation project to days, minimise reliance on paper records and bring unstructured data under control once and for all. Not only that, it can be accessed from anywhere.

Value for money

Simplicity has been designed into GilbyIM from the outset, which enables high levels of user adoption which remains high and guarantees you project success. And because you only pay for what you use, it can be scaled to meet any organisation's needs. From small primary schools to large councils, GilbyIM provides an excellent solution and great value for money. The GilbyIM team sets up everything and provides expert advice throughout the project. Users are fully supported and software is regularly upgraded all as part of the SaaS subscription cost.

How to find out more

To find out more about GilbyIM, book a demo or enquire about how to manage your records, contact our friendly team at Contact@GilbyIM.com or visit us at www.GilbyIM.com.

GILBYIM

Richard O'Brien
Director
GilbyIM
Tel: +44 (0)7767 871 653
Richard@gilbyim.com
GilbyIM.com
https://twitter.com/RT_GilbyIM



Pivotal Solutions' strategy for providing high quality software and support

Software Consultant Paul Wallace, explains how Pivotal Solutions Limited have cultivated 20 years of success through high quality software and forming good relationships with customers

Since its inception, Pivotal Solutions' main ambition has been to provide mission critical software to large organisations in need of storage for documents and associated meta data. By working closely with its clients and their staff, Pivotal Solutions endeavour to design a tailored solution for any requirement. Pivotal Solutions has all the capabilities to produce effective solutions, that stem from the tools and skills harnessed by its experienced expert team to meet even the most complex or changing needs of its clients'.

Pivotal Solutions places the utmost importance on taking time to gain a full scope of its clients' needs to understand the requirements of all potential users and uses of the software. One of the main focuses for the company is to foresee future requirements, to create software with the agility to be flexible enough to easily cater for changes that occur over time. Having a good working relationship with stakeholders and users of all levels allows us to fully understand how the software we write will fit into their environment and workflow.

Alongside its software development, the company also ensures it provides and maintains an efficient, friendly and outstanding level of customer service. This service is an integral part of Pivotal Solutions' operations, to guarantee the user's experience is positive and continuous, for years to come.

Intuitive and customisable high quality software

Software is a tool and as such can be an aide or hinderance depending on how familiar the user is with it. High quality software software will guide the user and make it easy for them to use it and learn how to perform more advanced tasks as their familiarity with it grows. As with most things, one bad experience is all it takes to put people off using an application.

Problems with software are sometimes unavoidable but it is how they are resolved that can make the difference. Pivotal Solutions prides itself on providing an exceptional level of customer service and support that helps user feel they are being listened to and have control over the tools they are using. So even if there are problems, users will still retain their confidence in the tool.

Ensuring user confidence is paramount in ensuring the vision for the software is met and retained. If users lose confidence they may start using the dreaded spreadsheet or other data islands to do their work rather than use the tool that if used correctly will provide the business with the information and data it needs to work.

We have found that keeping each piece of functionality in our software simple helps users understand how the application works and increases buy-in. Each function of the application should be explainable in one or two sentences so that users can see how it works and how they can best use it. That isn't to say our software doesn't do some complicated tasks, we just try not to do too much unfathomable magic so the user isn't sure what will happen when they click the button. We have found that when users have a good understanding of the application that they will use it in ways we hadn't thought of.

When software is used by large organisations it must be flexible enough to cater for the different way each person or department works. Software that is intuitive and customisable reduces the cost of ownership as there is less training required, less help desk activity and more adherence to the 'proper' way of doing things.

Providing valuable and responsive support

Even the most meticulously planned application will contain 'problems', it's just the nature of the beast. These 'problems' can arise from, changes in user requirements, misunderstanding of requirements, errors in implementation. It doesn't really matter what they are, but it does matter how they're dealt with. We pride ourselves on our responsive and timely help desk service. If users are unable to do their work then the business is losing money. We will work with users to achieve a solution as quickly as possible, the most important things is the resolution of the issue.

> "We specialise in information and document management to provide software that allows users to store and search complex data and use it within automated and manual workflows."

Most of our applications rely on integration with other systems, providing and using external functionality. We have found that users will report issues with our software but the issue actually lies elsewhere. Having good relationships with people across our customers organisations allows us to determine where the issues are and either resolve them ourselves or let the appropriate team know of the issue. This expedites the resolution and lets our users get on with their jobs.

Close consultation with our customers

Alongside offering high quality software and support, we specialise in information and document management to provide software that allows users to store and search complex data and use it within automated and manual workflows. The main benefit we offer over competitors is that all our software is written in close consultation with our customers exact requirements, and we also ensure that it is adaptable for their future needs.

We have decades of experience in writing software to manage large repositories of files and associated data. This includes the indexing of binary documents to allow for forensic and casual searching with context sensitive criteria. Over the top of the processing of complex data we have created interfaces and workflow mechanisms to allow the data to be available and processable across various organisations.

Pivotal Solutions is a small agile company that can provide you with the high quality software you need. We can provide the functionality using desktop applications. Web applications or mobile. We will work with you to deliver the software application you need and provide backup and support to make it a worthwhile investment.

PIVOTAL SOLUTIONS

Paul Wallace
Software Consultant
Pivotal Solutions Limited
Tel: +44 (0)7771 993 089
pwallace@pivotal-solutions.co.uk
www.pivotal-solutions.co.uk



Migrating datacentres can be simpler with the right plan and partner

Sam Newman, director of OGEL IT, explains how migrating datacentres to the cloud can boost business efficiency

When making the decision of migrating datacentres, choosing the right migration strategy is key to getting the best out of the cloud. The smartest approach will accelerate innovation, give you a competitive advantage and boost efficiency within your organisation.

For many businesses that were not born in the cloud, designing your datacentre from the ground up is a crucial step, and getting it right means analysing your business needs and your current SLAs and how that fits into your plan for migrating data-centres.

The economics behind the promise of cloud technologies is that, as a principal, cloud services are able to deliver more than the on-premises equivalent and can grow and expand to accommodate future growth and load on demand. Another benefit of cloud services is that many organisations can offload their internal SLAs on to their Managed Service Provider or Cloud Service Provider.

There are a lot of cloud expectations that are mismanaged and have caused a lot of fear, doubt and uncertainty, as well as unrealistic expectations of how to get your datacentre successfully into the cloud. With a lot of promise within the vendor landscape in terms of what cloud technologies can do for a business, many are still asking the question, "But how do we get to cloud?"

Microsoft recognises OGEL IT as a Microsoft Gold Cloud Partner with expertise and capability in delivering its cloud services to multiple customers. We have extensive experience in the migration of organisations to Office 365 and Azure-hosted services, we have migrated and built 100s of servers in Azure and migrated thousands of users to Office 365. As a Microsoft

Gold Cloud Platform partner, our credentials are recognised by Microsoft, enabling us to escalate issues directly and engage collaboratively on customer presentations and technical demonstrations. We are also able to sell Microsoft's cloud offerings via the Microsoft Cloud Service Provider platform.

Meeting our customers' needs with Microsoft 365

Staying connected

With many businesses enabling staff to work from home three days per week after Covid-19 restrictions were lifted, it's important to ensure our customers have the capabilities to maintain their employee productivity. Supporting our customers with the delivery of Microsoft 365 services allows for a continuation of business as usual from the office, home or remotely on the go with the following functionality:

- Call, chat and host meetings.
- Share documents in the cloud.
- Collaborate using Office apps.
- Connect via email and calendar.
- Easily store and access individual and shared work files with OneDrive.

Security breaches during migrations

With 43% of all security breaches happening online through web apps and 37% of breaches involving lost or stolen data and credentials, affecting organisations' bottom line and reputations, Microsoft's security features are designed to safeguard your business. With all your information stored in the cloud, you can avoid downtime due to breaches, information loss or hardware failure. Ensuring you continue your daily activities as normal and isolating your company files safely within the cloud with the following built in security features:

- Defence against cyberthreats.
- Securing your data and devices.
- Managing your users and devices.

As businesses adjust to an uncertain economy and marketplace in a post-Covid-19 world, it is essential we provide managed services to our customers that offer them the ability to work more efficiently and without adding to their expenses with complicated technologies. At OGEL IT, we like to keep IT simple and believe that organisations need solutions that can expand and adjust with them as their business changes and grows, and at the best price for their operation.

> "When making the decision of migrating datacentres, choosing the right migration strategy is key to getting the best out of the cloud."

We can streamline your IT setup and management to improve on your staff efficiency while consolidating your expenses and saving cost with our managed service offerings. For those customers who have internal support capability, we deliver complementary services and workshops to explain the solutions and services we have delivered and work closely with them to establish their ongoing support and maintenance processes.

We are a Quest partner, certified in the design, deployment and operation of Quest (inc. Binary Tree) migration tools, enabling us to simplify large and complex transitions from on-premises or cloud to cloud transformations for both Azure and Office 365 workloads.

For a more detailed and comprehensive guide to our Service Catalogue, please get in touch and find out how we can help you migrate your datacentre to the cloud.

Crown Commercial Service Supplier

ogel Building IT with you

Sam Newman
Managing Director
OGEL IT LTD
Tel: +44 (0)1438 300 335
info@ogelit.com
www.ogelit.com
https://twitter.com/ogel_it

New support for public sector bodies struggling to embed the PPN06/20 Social Value Model

Neil Macdonald, CEO at Thrive, explains how using the Impact Evaluation Standard to report on social value in government contracts can actually lead to far better outcomes for communities and for suppliers



The rise of Social Value weightings in central government contracts through PPN 06/20 has been a welcome evolution in the way modern society can protect and support our people, our environment and our local economies. It also significantly supports the Levelling Up agenda.

What we observed after the publication of PPN06/20 in late 2020 was that while it was a significant step forward towards having a national definition of Social Value and a clear set of common reporting metrics, many contracting authorities and suppliers were unsure how to successfully execute this new rule – even with the help of the supporting documents like the Social Value Model.

Bid assessors and suppliers needs to know what they are trying to achieve, how they are expected to deliver it and how they can consistently report social value in public contracts.

So how can they get a better handle on this?

An exciting new development in the landscape of social value and procurement was the introduction of the Impact Evaluation Standard (IES) - a social value reporting framework that is completely aligned to the government's Social Value Model. This has made the process considerably easier and more transparent for both private and public sector organisations who need to qualitatively and quantitatively asses their social value.

How can the Impact Evaluation Standard support social value in public sector procurement?

One criticism we often hear from contracting authorities trying to apply the Social Value Model is that it is a challenge to know which themes and reporting metrics from the model are applicable for different types of contracts. The IES provides a suite of

metrics and proxy values which allow the impact of social value interventions to be easily determined. This means they can more clearly understand what exactly they need to ask of suppliers at procurement stage, to get the social value outcome they desire.

The fact that the IES is mapped to the government's model means contracting authorities can be consistent in their reporting against the PPN06/20 Social Value Model Themes and more clearly understand their contribution to the Levelling Up agenda.

Further to that, it also gives them a central place to consistently monitor and appraise the performance of suppliers in a more standardised format, thus making selection and re-engagement easier and more transparent.

And how does the Impact Evaluation Standard help suppliers?

Because all reporting metrics included within the Social Value Model are incorporated into the IES, suppliers can be very specific in responding to the social value requirements in tenders. They can easily see which areas of social value they can deliver and how it may impact their 'score'.

Thus, using the IES allows supplier responses to be clearer, more consistent and more accurate and it allows them to benchmark against their peers. Feedback has shown that this genuinely creates more successful bids and is an easier way to address the reporting commitments once a bid has been won.

For those wanting to be more innovative or stand out amongst their competitors, the IES provides a suite of additional metrics and proxy values, going deeper into the social value impacts which can be created from wellbeing, economic and environmental activities.

The IES provides a welcome 'common language' for social value reporting, ensuring the delivery of social value in a contract remains consistent and transparent from the beginning, and throughout the supply chain.

How can using the Impact Evaluation Standard create better outcomes for both community and supplier?

'Best practice' social value reporting requires more than just consistency of language – it requires accurate data backed up by evidence, as well as the qualitative narrative that supports this. To look only to the metrics or proxies is to risk losing the real stories and impacts behind the numbers. Social value is maximised – and indeed greatly increased – when these stories can be captured and harnessed. It has been proven that organisations who are acknowledged for the social value work they create, will continue to do more.

To do this consistently at scale requires a software system. The software needs to be twofold – both a central place for procurement and contract management for contracting authorities, as well as something suppliers can easily access and use. It needs to drive engagement and good reporting behaviours from suppliers for PPN 06/20 to really deliver its impact.

That is why, to support the correct application of the IES social value metrics, it is embedded within the Thrive software platform. This is done to make social value procurement and contract management straightforward for both Contracting Authorities and their Suppliers.

Emma Ward, is Head of Sustainability and Inclusion at Volker Wessels UK. She uses the Thrive software to report on Social Value outcomes to government clients.

"Our organisation is fundamentally committed to the delivery of social value. We regularly collaborate with our public sector clients to determine the correct deliverables and reporting metrics, but we could not report these with confidence and ease without the adoption of the combined strengths of Thrive's software and the Impact Evaluation Standard"

With the advancement of modern software tools and forward-thinking frameworks like the IES now more widespread, the adoption of social value in procurement can only accelerate. Ultimately this improves the delivery of economic, social and environmental goals in our society which is what we are all striving for – and what the point of PPN 06/20 was in the first place.

To learn about the IES, visit:
www.impactevaluationstandard.org

Or for more information on using the IES's official software platform Thrive, please visit www.thrive-platform.com

thrive

Neil Macdonald
CEO
Thrive
Tel: + 44 (0)20 3488 5061
neilm@thrive-platform.com
www.thrive-platform.com

Towards a zero trust security model for higher education

Martin Roots, Managing Director of Expede Group Limited, charts the pathway to a zero trust security model for higher education

Every university has:

High-Value Data

- Student Records
- Staff Records
- Financial Records
- Commercial Data
- Research Data
- Know How

Mission-Critical Infrastructure

- Identity Management
- Networks
- Datacentres
- On-premise services (Applications, Databases, Systems, Storage & Platforms)
- Cloud-based services
- Endpoints

Data and infrastructure are open to attack through many vectors, and a mismanaged breach can have a grave financial, legal and/or reputational impact on the university, in addition to the very real and direct impact on affected individuals.

Click for diagram.

Protection of these assets has until very recently focused on protecting the perimeter, but as corporate service **use cases blur** (think of the many user types that a university has – students, staff, researchers, partners, contractors) **and boundaries disappear** (think hybrid working, remote teaching and learning, and the push of core services to the cloud), and although it is important to have an arsenal of controls in place supported by good operational security hygiene in line with best practice, it is no longer an all-encompassing approach.

Modern security means ensuring the ***right*** **people** have the ***right*** **level of access**, to the ***right*** **resources**, in the ***right*** **context**, and that **access is assessed *continuously*** – without adding friction for the user – a security concept known as Zero Trust.

But as every organisation will be at a different level of maturity, how do we get started, whilst maintaining our current (and perhaps 'legacy') cyber security capability/investment?

Developing and implementing an overarching Zero Trust security strategy needs to take into consideration security, IT and business initiatives currently 'in flight' and planned. It also needs to consider existing security controls, as well as operational 'hygiene' capability and capacity.

With finite university resources, key investment decisions should be taken as soon as possible as to where funds and resources should be invested – whether new money and/or additional resources are required or if the current investment (and resource allocation) could be 'shifted' to deliver a better outcome.

In an ideal world:

- Anything new should be delivered according to the new strategy, architecture, design principles and operating model;
- Anything 'in flight' but not implemented should be assessed and refocused, wheresoever possible, and adapted to fit the new direction of travel and;
- Anything not currently being addressed (e.g., the stable 'legacy') should be assessed for security vulnerabilities and exposure and remediated according to asset criticality/sensitivity/value.

As this is a journey that will take us through several levels of information security maturity over many years, the business case is often broken down into stages.

STAGE 1 of the journey involves many phases:

1) The development of a University Information Security Strategy, Architecture, Design Principles and Operational Model in line with the Zero Trust Maturity Model.
2) The consolidation/delivery of inflight initiatives, and towards the end of the business case period,
3) A full business case for the programme to support the strategy implementation over subsequent stages/years.

These phases are explained a little further below.

Phase 1: Design the target architecture and operating model according to the following Zero Trust Principles:

1. ***Never Trust, Always Verify*** - secure corporate resources by eliminating persistent trust in everything: Identities, Devices, Workloads (Apps + Infrastructure), Networks & Data.

2. ***Assume Breach*** - operate on the assumption that our environment has already been breached. Architect to minimise the effects of a breach with controls to prevent lateral movement and reduce damage.

3. ***Verify Explicitly*** – where multiple modes of verification, both dynamic (RBAC, user & entity behaviour analytics, context) and static (passwords, biometrics, security tokens), must be produced to give access to resources.
   Click for diagram.

Phase 2: Assess the current information security landscape.

To get to where we want to be, we first must assess where we are. This could potentially involve returning to basics:

1. ***Assigning Information Asset Ownership (IAO)*** for each information asset category at a team/department level (if not already assigned);

2. ***The IAOs should then create an inventory of their data….***
   Click for diagram.

3. ***Map repositories, volume x sensitivity***
   By mapping repositories onto a 2x2 matrix with sensitivity along one side against the volume of data held along the other, we get an approximation of priority level when you eventually get to define the plan to protect the highest value data…
   Note: The output of this and the previous step directly feeds back into the 'data considerations' of the architecture/design phase (phase one) and, therefore, discovery and design work iteratively together.
   Click for diagram.

4. ***Analyse the effectiveness of our current controls associated with each of the identified repositories.***
   This can be achieved in workshops using a tool, such as the one pictured below to quickly capture the existing controls associated with the repository and assess the extent of their deployment concerning each repository…
   Click for diagram.

   And these controls can be further analysed to understand how effective they are currently at mitigating risks over each stage of the data lifecycle….
   Click for diagram.

Phase 3: Build the implementation roadmap and prioritise activity (the Full Business Case).

The previous phase gave us two specific ways of looking for areas of improvement. The first (the assessment of countermeasures currently deployed in respect to each repository) gives us a 'heatmap' of where effort could be applied according to a priority group.

Click for diagram.

And the second is from the analysis of how effective more detailed controls are at mitigating risks across the entire data lifecycle from creation through to destruction.

Using this analysis, potential options for mitigation initiatives can then be identified, assessed, grouped, sized and divided into execution 'waves' to produce a costed, prioritised, roadmap.

Click for diagram.

Ta-da!

STAGE 2 implementing the programme, really depends on the output of stage 1 and so it depends, but it always starts with building the target architecture and operating model as anything new needs to align with that. Moving the legacy towards that target is the tricky bit and could be the topic of another article!

If you'd like to discuss how Expede can help you to develop your information security strategy and approach, why not book a no-obligation appointment with one of our consultants today?

EXPEDE GROUP

Martin Roots
Managing Director
Expede Group
Tel: +44 (0)845 139 1039
martin.roots@expede.group
www.expede.consulting

Identity central to public sector digital transformation

Ian Lowe, Head of Industry Solutions – EMEA at Okta, argues that identity is at the heart of public sector digital transformation

Online experiences begin with verifying our identity. And, for government services, citizens need to interact with and gain access to multiple online accounts in a simple yet secure way.

To get the most from digital transformation, and empower citizens with seamless online experiences, identity is emerging as an increasingly strategic investment. Indeed, the UK government recently published its response to a public consultation on digital identities with new legislation to make digital identities more trustworthy and secure.

While we're all aware of the pressure to digitise public services, there are three common areas that the government must navigate to get it right: modernisation, security and experience. These are critical to providing a next-generation digital identity strategy.

Modernisation in stages for public sector digital transformation

As businesses embrace digital transformation and look to modernise their technology stack, there is often tension between legacy and newer systems with data and applications continue migrating to the cloud. Approximately half of the government's annual IT spend goes on maintenance and managing the data and cybersecurity of obsolete legacy systems.

A technical debt is racking up, hindering onward efforts to improve operations. Rather than rip and replace, the public sector must actively retain what it has, while also investing in the future. This is a delicate balancing act, which means modernisation must happen in stages. Identity solutions gradually free the government from legacy systems while ensuring cybersecurity is guaranteed throughout modernisation.

There is at least a 90% reduction in the ratio of threats to authentications when an organisation denies access using legacy authentication in access policies, according to Okta's Business @ Work report. Updating legacy systems is, therefore, vital to remaining secure.

Security in the public sector

The UK government is a prime target for bad actors and cyberattacks. Depending on which area of the government is involved, a successful breach can expose different sets of extremely sensitive information which can be disastrous for citizens.

Highlighting this risk, the National Cyber Security Centre (NCSC) recently published a report recognising ransomware as the biggest cyber threat facing the UK today. Multi-factor authentication (MFA) is just one immediate step that organisations can take to protect themselves against cyberattack. However, adoption of this technology remains low, with a likely reason being additional friction to user experience.

Identity strategy has a key role to play in addressing this issue, with smarter identity solutions available to balance seamlessness and security. For example, password-less and biometric security, which although ubiquitous in multi-factor authentication (MFA), are key antidotes to the shortcomings of traditional passwords.

Experience is one of the challenges

The third and final challenge is experience. Broadly speaking, we now expect the same seamless experiences from government services as we get from our consumer-facing applications.

For user experiences in identity, experiences can vary widely, often to the detriment of access to a service.



Government Digital Service (GDS)

The Government Digital Service (GDS) was launched in 2011 as part of the Cabinet Office to build platforms, products and services to help create a joined-up and personalised experience of government for all

It is responsible for the One Login for Government initiative, which aims to replace the need for users to register their information over and over again to access different government services with a single sign-on and identity checking system.

Research carried out by GDS found that 61% of users are comfortable sharing their information with government departments – and with those departments sharing that data between them. Indeed, most already assume that they have an online "government" account that holds their data and that services are joined-up.

Many see the value of a reusable proof of identify to save them time when engaging with government services and this will be a key element of the GDS service.

However, a number of barriers currently prevent users from being able to prove their identity online, including poor internet access, low digital confidence and a wariness of sharing personal information.

Users' expectations of services are also shifting. Around 70% of overall traffic to Gov.uk comes via mobile are citizens increasingly expect faster, simpler ways to do what they need to do.

To do that, GDS aims to provide a superhighway for users who can and want to use their mobile to apply for government services, so it is building an identity checking app.

This will allow smartphone users who have a photo ID the choice to prove their identity to a high level in around 10 minutes. It will do this by making use of Near Field Communication readers and smartphone cameras. Use of the app will be optional and the GDS is looking at alternative routes and how both online and offline channels need to come together to make sure everyone can use its system.

The next step is to create the first user journey combining the authentication and identity components and, by April 2023, users will be able to request a basic DBS check through a Gov.uk account by entering their passport information and answering some questions that only they should know the answer to in order to prove their identity.

Handling personal data like passport information requires the highest levels of security and resilience. The GDS is working with the National Cyber Security Centre to invest in its security architecture capability, drawing on the expertise of the Cabinet Office's Cyber Security team.

To realise the vision of One Login for Government, the number of Gov.uk services accessible must quickly go from one and two to the tens and then the 100s. The GDS is therefore working with other departments, directorates, agencies and individual services to build a clear, joined-up and shared roadmap that will enable services to understand their required functionality, as well as providing clear milestones and timelines for migration.

1. https://gds.blog.gov.uk/
2. https://gds.blog.gov.uk/2021/12/08/gds-is-10-were-ready-for-our-next-chapter/
3. https://gds.blog.gov.uk/2021/12/01/one-login-for-government-december-2021-update/?utm_medium=referral&utm_source=gdshomepage&utm_campaign=digiid

Continued on page 279 ➔



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← *Continued from page 277*



Ian Lowe
Head of Industry Solutions - EMEA at Okta

For example, not only is friction added when citizens must create and remember complex passwords, but experience deteriorates when you have to login separately to multiple government services. Good experiences are those in which the public can login once, using only a name and biometric – instead of a password – to every government service.

MFA solutions, although safer than traditional logins, are sometimes perceived to inhibit user experience, as the process can be time-consuming. The government can encourage seamless and safe access to its services through digital identity strategies such as adopting adaptive MFA, which triggers additional layers of authentication only when unusual login activity is detected.

Key issues when it comes to digital skills

In addition to these three core challenges, Auth0's recent report dissected the specific issues that governments face when it comes to identity and, through polling 200 UK public sector IT professionals, highlighted the most prominent concerns in the UK, including:

- **Overcoming the digital skills gap:** There are never enough developers, never mind the added difficulty of recruiting public sector developers from private sector jobs. Not having enough resources to manage IAM (identity and access management) internally is the second biggest pain point for respondents in the report (82%).

- **Preventing account takeover and breaches:** Stolen credentials are responsible for the majority of web application breaches, but username and password is still the most frequently used authentication method by citizens (86%).

- **Migration from legacy systems:** Many public sector organisations are looking to expand their digital services in the next two years (75%). Identity can help bridge the gap between modern and legacy systems, allowing for adaptation of solutions in stages, with no negative impact on citizens' experience of critical services.

Identity is crucial to solving these challenges. We're at a key moment in time where strategies can meet the concerns of the UK public sector by employing seamless solutions that ensure security while enhancing digital transformation. For the public sector, utilising third-party identity solutions from the private sector has become fundamental to addressing these challenges. Not only will this deliver direct access to specialists in identity – thereby freeing overworked government IT teams and managing the digital skills gap – but also, their expertise in the field is unparalleled in ensuring a good balance of security and user experience.

Furthermore, third-party solutions remove the burden on the government to keep up with the constantly evolving standards and tech innovations.

Fortunately, a new generation of risk-based, adaptive authentication processes can deliver both security and a frictionless customer journey. They introduce roadblocks only where needed – if a login is overtly suspicious or breaks behavioural norms – and without reducing user experience.

With more people accessing online UK government services than ever before, providing simple and secure login and sign-up experiences is the only way forward. A strategic approach to identity must become a priority as the public sector seeks to deliver the full benefits of digital transformation to the public.

Ian Lowe
Head of Industry Solutions - EMEA at Okta
Okta
www.okta.com/uk
https://twitter.com/okta

Public sector customer service and the adoption of cloud technology

Rob Irons, Senior Manager at Hinduja Global Solutions, discusses whether public sector customer service has improved with the adoption of cloud technology

Has cloud (and a Pandemic) enabled us to finally punch above our weight?

The advancement of public sector customer service has undoubtedly been due to the adoption of cloud technology, which opens new ways of working, saves delivery costs and supports the social value agenda.

When I think about how things have changed, I have to cast my mind back to 2005 when as a Civil Servant, I co-authored 'Better Practice Guidelines for Government Contact Centres. This was written to support the outcomes of the Varney review - 'Service Transformation: A better service for citizens and businesses, a better deal for the taxpayer'.

At the time, this whitepaper was ground-breaking. Remember this was before Netflix, Spotify and even the iPhone! The paper set the blueprint at the time for how the public sector should be delivering customer services and focused on quality to the citizen, the creation of flexible solutions, and creating an environment for staff that supported the delivery of excellent service.

These elements combined created a catalyst for government service transformation at the time and encouraged departments to consider the way citizens wanted to engage and the adoption of multichannel services which would meet the varied demand requirements.

Success in technology changes leadership

Today, whilst many of the core principles we wrote about remain true, with successful services being a balanced blend of People, Processes and Technology, changes in Government leadership and strategy, a recession, and a Pandemic have all changed the way public services must now operate.

In parallel, the expectations of citizens are set by the experiences they have as consumers across a variety of brands including the likes of Amazon, Uber and Apple, who deliver increased accessibility (multiple channels), availability (24x7), speed and functionality (self-serve) whilst reducing cost, effort and time.

When these expectations are not met, there are now faster and more public ways to show dissatisfaction through social platforms such as Facebook and Twitter.

Where Public Sector Customer Service is now

Historically, the Public Sector has been one step behind in digital innovation and modern customer service experience, however the impact of the pandemic has accelerated the ways in which public sector organisations have had to/been able to deliver services.

The UK Institute of Customer Service Survey released in January 2022, shows that customer satisfaction within Public Sector organisations has continued to increase, and for the first time is starting to outperform sectors including Utilities and Telco.

So, what did the pandemic do to the industry?

The pandemic forced organisations to take a leap of faith, making decisions they never thought they would consider.

1. Shift to cloud technology

a. Opening up new ways of working, no longer determined by physical location enabling work at home, in office or hybrid. This allows skilled catchments to be targeted increasing the quality of candidates recruited, all underpinned by unlimited capacity, scalability, and high levels of security
b. Removing reliance on legacy systems, which handcuffed departments into a BAU only state, preventing digital solution adaptation, and the ability to launch more cost-effective channels (webchat, self-service etc)
c. Reducing delivery costs through

the removal of fixed costs such as real estate and long-term licence contracts.

d. Supporting the Social Value agenda removing barriers for Levelling Up, creating more flexible working opportunities, a better and more engaging employee environment and enabling reinvestment of funds into pay all contributing to increased agent satisfaction, higher quality service and the retention of staff.

2. Increased partnerships between public sector and outsourcers have shown services can be set up at speed, whilst improving quality and optimising costs delivering greater value for the taxpayer.

What have we seen happen since the pandemic?

At the start of the pandemic, we moved 1,000 employees from the office to work at home within a 3-week period. Since then, we have created over 2,000 sustainable new roles primarily through work at home with the option of hybrid working across our 6 UK based engagement centres.

There has also been a growth in blending technology across services we deliver implementing more opportunities for customers to self-serve allowing easier and faster access to information. These changes have not been to the detriment of the service we provide, in fact the opposite.

Key Performance Indicators (KPIs) are consistently green, employee satisfaction has increased by 10 points over the last year with an increase in client satisfaction by 33% during the same period.

In the recent UKCSI survey, our partnership with Disclosure and Barring Service (DBS) was named the highest-rated public sector organisation. Together, we have worked hard over the past 2 years to transform the way in which they deliver services to customers.

We have introduced cloud technology via AWS solutions and increased channel options for users. Working collaborativly with DBS has enabled us to analyse and enhance customer journeys and identify the right measures of success creating what is now a leading customer service experience within Public Sector.

Eric Robinson, CEO of DBS, said: *"We are incredibly proud that DBS has been recognised as the highest-rated public sector organisation for customer satisfaction in the UK.*

The result demonstrates the organisation's strong commitment to providing high-quality services and the dedication and hard work of DBS staff, I also want to acknowledge the efforts of staff in HGS, who support our frontline customer services."

UKCSI added: *"DBS' strong showing in the UKCSI is encouraging and shows that public sector organisations – much like those in the private sector – who build trust and deliver on their promises will be rewarded with customer loyalty."*

So, to the question, is public sector customer service now punching above its weight? The answer is Yes!

As this year's Customer Service Index proved, the landscape has changed and there are no more excuses why Public Sector customer service should not be leading the way.

Who are HGS?

HGS have provided services to the UK public for over 20 years. As a Crown Commercial Services Supplier on the RM6181 framework and a G-Cloud 12 framework provider for digital workforce/automation, our overriding principles ensure we deliver value for money, protect the citizen (particularly the vulnerable), ensure accessibility, and operate within defined and robust accredited standards.

Our proven ability to deliver seamless services across multiple channels, 24×7, is intrinsic within our public sector service offering. We provide information (FAQ and complex), guidance, customer support, signposting, registration, and advice services.

HGS continues to invest in public sector expertise, delivery capability, and infrastructure with a unique ability to compete and in many cases outperform key competitors in the UK public sector space. To find out more about HGS within the UK Public Sector market, visit:

https://hgs.cx/industries/public-sector.

Rob Irons
Senior Manager
Hinduja Global Solutions
Tel +44 (0)7827 940 800
Rob.Irons@teamhgs.com
https://hgs.cx/industries/public-sector
https://twitter.com/LifeAtHGS
https://www.linkedin.com/company/hinduja-global-solutions-inc--/

There is a lot more to the ISDN / PSTN switch off than meets the eye. Losing your phone lines is just the tip of the iceberg

You know it's going to happen, but have you considered what exposure or risks the ISDN / PSTN switch off poses to your organisation?

Proactive planning now, will address any potential issues and help you minimise disruption



"Switch On to the Switch Off" survey

According to the "Switch On to the Switch Off" survey March 2021, 83% of organisations indicated they had no visibility of when their services would be switched off and 46% have no idea that their existing analogue phone and ISDN services will be switched off completely by December 2025.

ISDN (Integrated Services Digital Network) is a telephone network that allows both voice and data services to be delivered over digital lines simultaneously, while PSTN (Public Switched Telephone Network) is the older analogue telephone network. These aging infrastructures use underground copper telephone lines and old signalling methods which are planned to be completely switched off nationally by 2025.

The wide-reaching effects of the isdn / pstn switch off

Due to the number of telephone exchanges this involves in the UK, this will be an ongoing programme affecting all main carriers, not just BT, with a significant number of the

changes happening from 2022 onwards. 77% of organisations surveyed said they have not prepared for any disruption the switch off of these services may cause.

This change will not just affect voice calls, but security, well-being and any equipment reliant on these services and the longer actions are delayed, the more problematic the situation may become, accentuated by several factors which could intensify the complexity of the switch off, for example:

- The number and location of sites involved
- The number of suppliers involved
- Availability and accuracy of records kept
- Resource, expertise and legacy knowledge available in-house
- Variation in applications, which may result in more bespoke solutions being needed
- Long contract durations restricting options
- Electrification for any new solutions needed and / or the availability of network coverage
- Space / storage requirements
- Budget planning to cover the cost of any changes needed

We can guide you through all aspects of this change, identifying what the risks are to your organisation, how to mitigate these risks, what you need to do and when you need to do it by.

Planning ahead will limit risk and ensure:

- You control suppliers, they don't control you
- You receive independent guidance enabling you to see the whole picture
- You gain clarity, control and potential cost savings
- You future-proof your organisation
- A panic free transition

Segmentation Group can guide you in choosing the perfect solution for your organisation during a digital transformation, whether this be, providing insight, help and guidance in understanding your estate, helping you unravel, determine, interpret and manage complex areas of your telecoms, or bringing all strands of your network, equipment, costs and communication patterns together.

Segmentation Group can:

- Enable you to make quicker informed business decisions
- Enable you to make the best use of limited budgets and resources
- Make recommendations to help you achieve the best solution for you, based on what equipment and services you currently have on site
- Help you minimise the impact of the ISDN / PSTN switch off on your organisation
- Help you support your staff through the switch off with training, by getting them involved and excited about the future plans for telecoms in your organisation
- Help you make the right decisions by showing you how you are currently performing with your existing telecoms estate and helping you make informed decisions without causing further confusion
- Show you how upgrading to new digital services can be an opportunity for change and maybe even cost reduction
- Make preparations now for your digital journey to avoid pitfalls and making the transition as smooth as possible

Now more than ever before, your telecoms and how your organisation communicates should be at the forefront of your mind.

Understanding where you are and knowing where you need to be are crucial in the evolution of your telecoms.

We see things that others don't

We are specialists in guiding and future proofing medium to large public and private sector organisations in all aspects of voice, data and mobile communications.

Through the knowledge gained in these areas, we have become the authority on the ISDN / PSTN switch off, with our ability to translate this complex topic into simple terms.

Our experts will be your guide, taking you step by step on a journey of discovery from dinosaur to astronaut, designed to equip you with a holistic view of your entire telecoms estate.

segmentation group

Tel: +44 (0)3300 240 480
info@segmentationgroup.com
www.segmentationgroup.com



6 steps for a successful transformation of your network infrastructure

The public and private sectors are now facing a common issue: how do you maintain legacy technology while embracing new opportunities? Simona Mazza, Head of Digital Advisory, UBDS discusses six steps to transforming your network infrastructure

Transitioning to a simpler, more flexible, and easily scalable network infrastructure will provide increased visibility and enhanced control, but it is not an overnight switch and requires the right strategy to be ironed out, followed by a sound implementation plan and governance support.

Here are six important steps that we at UBDS always consider when starting a network technology overhaul:

1. Get senior leadership involved at the start

It is crucial to get the right people involved from the very beginning. Consult with people across the business to ensure alignment and confirm that the new network infrastructure and design would meet the organisation's needs. At UBDS, we help our clients to build a compelling case for change based on deep market insights, expert discovery, and analysis of pain points and ambitions.

2. Plan for your network transformation

Effective, detailed planning upfront will save vast amounts of time, effort, and cost. Make sure to consult widely, taking feedback from as wide a range of stakeholders as possible. Time spent planning upfront is always time well spent.

3. Work with a trusted partner with technical expertise

Migrating to the cloud can be complex and can involve significant investment and risk. Work with a trusted partner who will understand your needs and provide expert advice whilst keeping it simple. UBDS is the first and only organisation globally with a Master Services Competency for VMware SD-WAN (Software Defined Wide Area Network). Our delivery and technical expertise enable measurable and sustainable digital transformation.

4. Build in flexibility and focus on outcomes

Make your delivery plans flexible to ensure outcomes are delivered, rather than adhering to rigid requirements which may become obsolete during the project lifecycle. This is especially important for large, complex programmes. At UBDS, we help clients deliver agile digital transformations,



accelerating change, moving fast, and always focusing on outcomes and impact.

5. Engage, engage, and engage

Along with detailed planning, two major factors in any successful technology implementation delivery programme are engagement and communication. The more transparent you are, the smoother the journey will be.

When setting up your governance, include a Programme Governance Board with attendance of the Senior Responsible Owner (SRO), representation from the business/operations, commercial, finance, and service operations. Meet regularly to discuss



Simona Mazza
Head of Digital Advisory

impact on staff, finances, budget, and internal processes, to ensure all stakeholders are fully informed and subsequently create high levels of trust.

You might also want to consider setting up a Business Engagement Forum with the objective of taking people through the journey and providing a safe space for feedback and suggestions.

6. Have an airtight handover process

When handing over to the business, ensure roles and responsibilities of each team member are clearly defined and captured to drive alignment. It is important to set time aside for regular and open communication to address any potential fears concerning the transition across the organisation. At UBDS, we deliver end-to-end solutions underpinned by an agile and robust service model with roles, skills, processes, and tools clearly defined and documented. This is crucial to enabling a smooth and seamless handover to the business towards the end of each project.

Find out more about how the UBDS team led the procurement, design, and deployment of one of the largest SD-WAN network transformations for central government, helping the organisation to migrate to one of the most advanced 'data centric' networks in the world across more than 900 sites. This was completed over a shortened timeframe and accelerated the organisation's transformation plans by 2-3 years.

It is not easy to overhaul your network infrastructure, especially with so many performance and process details to consider. But with the right digital strategy, business case, sound implementation plan and delivery partner, you will have the foundation you need for innovation and growth.

If your organisation is looking to achieve a quality transformation at pace, it needs a trusted digital transformation partner. Get in touch with our specialists today to get started on your transformation journey.

UBDS

Simona Mazza
Head of Digital Advisory
UBDS
hello@ubds.com
www.ubds.com



Recognising the human side of data fabric

Mike Ellis, Managing Director of Finworks, explains what data fabric is and what are its benefits to public organisations and data professionals.

Data can be said to be an organisation's most valuable asset. Organisations are finding more interesting and innovative things to do with data. A data fabric brings all this data together, catalogues it, subjects it to rules and policies and makes sure that data is accessible where and when it's needed. Public sector organisations are planning or have implemented a data fabric architecture to power strategic, data-driven services critical to their organisation's digital transformation mission. Success is often due to recognising the human side of creating a data fabric as it teaches people new ways to think about, analyse, and use data.

Getting trusted data

Data Discovery functionality allows the ingestion and organisation of structured and unstructured data including complex and qualitative information that is often difficult to reduce into database records. When data gets onboarded and incorporated into a data fabric, it gains value by consolidating all that data under a single data catalogue. This value is a critical reason to implement a data fabric. The idea is to enrich, activate, and govern data to drive and improve business outcomes. Data discovery accelerates the delivery of new data for analytics efforts, improves data quality, and increases trust in data.

A data fabric handles the work of assembling and assuring data, so when applications consume it, it's been subjected to a standard set of checks and tools for data quality. Data validation is a standard set of checks and tools for data quality. Enrichment is primarily about analysing data to add or update meaning to the content in a data fabric. As data is ingested it is cleaned, validated and enriched and ready for consumption by services and applications but most importantly by data professionals to subject the data to ad hoc queries, or use it in big data models and analytics.

Data compliance and governance

Effective use of data fabric automation makes data more accessible and available to data users. Some of the most important metadata created during enrichment deals with compliance and governance. Metadata means "data about data" and addresses the relationships between and among data items. The overarching nature of a data fabric makes it ideal for incorporating, accommodating, and enforcing policy and governance on the organisation's data. This means that data professionals can incorporate compliance and governance requirements into data fabric policy.

Data governance is an important part of getting the right data to the right people. Data should be available to those who need it and are authorised to see it. Governance allows the right access to the data fabric catalogue, analytics tools, and data holdings, so self-service users can find data, create queries and run their analytics.

Self-service an emerging trend

Self-service is an emerging trend in organisations where a data fabric is available. Self-service users understand the data they're using, and a data fabric allows them to find new and valuable ways to put data to work by themselves. The data fabric solution allows the democratisation of data and self-service users find an astonishing number of ways to use data. Instead of waiting for IT, data analysts and professionals in other departments turn to the data fabric's catalogue to explore data items of interest. Using efficient metadata-based search capabilities, they can quickly and easily assemble a collection of data items they wish to explore, investigate, and analyse.

The benefits of data transformation

Data transformation is the process of consolidating and aggregating existing fragmented and siloed approaches to managing, storing, and situating data, to be governed and consumed as a single data fabric. Transformation is made less nebulous and more real by addressing the question "what's in it for me?" Focusing on the benefits of increased business volume, improved customer satisfaction and relationships, and new business opportunities and value-adds allow the buy-in from stakeholders, users and developers for a data transformation project. Applications come with stakeholders, users, and developers, all of whom must understand and buy into that fabric. They must understand how to move data, where to store it, how to protect it, and how to make it accessible to authorised users.

Data fabric benefits

Data fabric brings worthwhile change and numerous benefits to those who buy into the vision including:

- Using a data fabric, organisations can find, access, and combine data from all available sources and all data types
- The data fabric can provide the agility, speed, scale, and reliability needed for enterprise-grade data systems
- A data fabric can process and provision data at all velocities from streaming data in real-time to scheduled batch jobs
- The data fabric provides a consistent, coherent view of, metadata for, and controls over data to meet organisational security, privacy, and compliance needs

The move to using a data fabric also allows change and transformation to organisational culture, processes, and operations metrics. The data and database professionals want to make sure data is properly tagged and labelled, accessible to the right users, and in line with compliance and governance policies and requirements. Stakeholders want to get the best and most value from their data, as well as the applications and services that consume them. Through collaboration, all groups help each other meet goals and objectives.

Data fabric use case

Finworks currently model a universe of 650 million financial instruments for a major public European institution. The solution includes daily processes to update 2 million dynamic data sets and perform associated complex calculations. The system detects and reports on anomalies across 12 months of data history, comprising 780 million entries.

The implementation achieved a substantial improvement in both volume and quality of outputs that are produced close to real-time. The solution eliminated duplication of work across affiliates and departments. Reference instruments data is disseminated to all national banks, Market Operations, other applications and self-service users.

Conclusion

A modern data fabric offers a single, coherent view of data repositories and resources wherever they reside. By eliminating duplication, offering clean, enriched data sources, and optimising access, organisations benefit from more and better insights and require less human resources to achieve it. For human data consumers, a data fabric provides a consistent, coherent and governed view of the data needed thus ensuring efficiency and maintaining stakeholder trust and confidence.

finworks

Mike Ellis
Managing Director
Finworks
Tel: +44 (0)20 7397 0620
mike.ellis@fincore.com
https://www.finworks.com/
https://www.linkedin.com/in/mike-ellis-91bb5413/
https://www.linkedin.com/company/fincore-finworks



Do you have the agility and data visibility you need to properly plan for your organization's future?

After a decade of financial instability, the COVID-19 pandemic, and a period of rising demand for services, robust financial planning and data visibility is more important to the public sector than ever

A strategic approach to your finances will help your organization build resilience for the long term. But creating this approach will require you to begin planning for a different world from last year – and possibly for a different world next year, too.

But this won't be an easy process for many. Achieving the kind of new financial planning approach your organization now requires will necessitate a wholesale change in the structure of your reporting cycles. And it will also mean kicking many of the habits of survival learned over a decade of austerity.

Can you plan to meet changing priorities?

58% of top-tier organizations and 86% of lower-tier organizations report good financial resilience and improving service delivery (including across digital channels.) However, there remains a high degree of uncertainty over national level policies (such as funding and social care reform), which are impacting local authorities' ability to create plans that are both coherent enough to provide guidance, and flexible enough to permit pivots to accommodate any changes required in the future.

In this environment, robust financial planning and analysis are required. Including the ability to model for multiple scenarios, report quickly on current fiscal realities, and create forecasting and budgeting frameworks that are more sophisticated and flexible than the simple 12-month cycle.

Short term thinking is only getting shorter

Evidence from recent UK Public Sector research suggests that in the last 2 years, the average length of medium-term financial plans has dropped. Shorter-term planning further restricts the ability of the public sector to create strategic long-term horizons. But more importantly, it also suggests a fundamental lack of confidence among local authorities, in their ability to predict either demand for services, or their income, over a period as brief as just 3 years.

And that's far from all. According to respondents, the majority of financial plans are now becoming increasingly focused on just one year. Medium-term planning is increasingly less robust, limited to broad-strokes ideas

and what-if thinking. With the tools currently available, local authorities do not feel that they have the capability to make any concrete decisions about their future beyond the end of their desk calendar – much less the end of the decade.

This shortening of planning horizons is no doubt influenced in part by expected behavioural changes. People – and organizations – become more cautious in times of uncertainty. And although nobody will deny that COVID-19's economic impact merits a cautious approach, the public sector will have to get a handle on this caution quickly. Several areas of service provision – especially those managed by local authorities, such as social and healthcare – are likely to experience consistently rising demand over the next several years. And dealing with this rise in demand demands an ability to create flexible long term plans.

Your strategy determines your tools

UK Finance leaders' research indicates that around 99% of local authorities rely on spreadsheets as their chief tool in the financial planning process. And what's more, 59% use spreadsheets exclusively. We're big fans of spreadsheets, but it's important to realize that they were not created for complex financial planning and analysis processes, or for formulating strategy.

Creating the strategies your organization needs to succeed will mean adopting specialist tools that can be customized to your particular specifications. This is a fact that 25% of top-tier local authorities have already acknowledged through the adoption of custom, in-house solutions. Smaller authorities have begun (14%) to turn to on-premise FP&A tools to satisfy their requirements. But uptake of cloud-based FP&A tools has been surprisingly slim, with only 9% of authorities questioned suggesting they use them.

Cloud Adoption delivers agility

The failure to adopt cloud solutions means that local authorities stand to miss out on crucial data visibility and architectural flexibility. Currently, no authority claims it can build out different scenarios "with ease" in its scenario planning processes. Both flexibility and data visibility are key to multivariate scenario planning, and cloud solutions provide the compute power, customizability, and security to make both a reality.

Planning and scenario modelling are effective approaches to dealing with financial uncertainty. But in the absence of both the appropriate skills and tools to ensure data visibility and correct application, your organization will struggle to leverage them effectively. And without a more advanced approach and the tools to make it possible, your organization will face continued uncertainty, inaccuracy of projected costings, and exposure to increased risk – especially as income and support from central government is reduced in the future.

This means you must get used to the idea of creating not just a one- or three year plan that's set in stone – but a more robust and flexible array of longer term plans with built in flexibility around pre-agreed milestones and deadline dates (set yearly, half yearly, quarterly, or even monthly depending on your unique needs.)

Unit4 creates enterprise software built specifically for the needs of the public sector, designed to satisfy the need for flexible planning, integrated data visibility, and a fantastic user experience that helps your people focus less on manual data processing and more on delivering the services that citizens rely on you to provide.

Find out here how we are transforming finance in public sector, higher education and not for profit organisations.



Sally Murdoch
Public Sector Director
Unit4
Tel: +44 118 2076767
info@unit4.com
www.unit4.com
https://www.linkedin.com/company/unit4/

What is cloud security? A guide to cyber security in the cloud for the public sector

The experts at QuickThink Cloud explain how the ever-evolving threat of cyber attacks are making watertight cloud security more important than ever for public sector organisations



Cyber attack is an all-pervasive threat, posing significant risk to operational efficiency, cash flow, and reputation. Cloud security has never been more important.

As more and more public sector organisations migrate core processes and systems like payroll and HR to the cloud, understanding how to limit the vulnerability of your data and systems is critical.

As this article will show, cloud computing offers numerous benefits when it comes to evading cyber criminals and safeguarding important information.

The Importance of Cyber Security for the Public Sector

In the last 12 months, 39% of UK businesses identified a cyber attack, with the actual figure likely to be higher as less cyber mature organisations tend to underreport. The average cost of these breaches is £8,460-£13,400 – not including the potential fines for not protecting data effectively. Clearly, whether you host your systems and data in the cloud, are planning on migrating soon, or are still working with on premises servers, the time to step up your security is now.

And yet, as a government survey found, only 54% of organisations have acted in the last 12 months to manage their risk. As technology evolves, so too does the threat. With high profile breaches regularly making the headlines, cyber security is not an optional extra, but should be a core element of your organisational planning.

What is Cloud Security?

Cloud security is a term used to describe the controls, processes, and methods through which organisations and cloud hosting providers can work together to protect cloud based data and IT infrastructure. It is crucial for preserving regulatory compliance and protecting valuable data.

Though some organisations worry that cloud hosting presents a loss of control of data and information, the security of the cloud exceeds that of on premises systems in many ways, providing centralised protection, ultra-backed-up data, auto-patching, and continual improvements.

The cloud offers numerous benefits to public sector organisations, and the UK Government is operating a 'cloud first' policy for all decisions concerning technology. As we discussed in our previous article, the time to migrate to the cloud is now. Cloud security is what will facilitate the public sector's safe and secure modernisation.

Security Benefits of Cloud Computing

Cloud computing has a number of advantages over traditional on premises hosting when it comes to cyber security. Below, we outline some of the most noteworthy.

No Hardware Issues

From HR platforms to payroll functions to day-to-day software, hosting data or applications in the cloud means you won't need to have on

premises servers and hardware. As a result, you eliminate the security risk posed by malfunction, physical theft, or natural disaster. More than that, if a server does become infected, it won't bring down the whole network. Instead, the source of the breach can be isolated and removed.

Data Mirroring & Redundancy

In the cloud, any individual failure or issue is always backed up within the architecture. This is thanks to instant data mirroring, which means there will always be multiple versions of your data and applications stored on different servers. If one should become infected, the information can be reloaded from a different location. This dramatically reduces the chances of your organisation suffering a data loss or experiencing significant disruption.

Network Segmentation

One of the key ways attackers break into networks is through users. They do this using a range of strategies including phishing scams and malware-containing emails. By decentralising the network and segmenting it from the users who are accessing it, an added layer of protection is created for your organisation. Even if a hacker successfully breaks into one segment of the network, that does not mean they can access everything – instead, the threat can be isolated and removed.

Access Management

Platforms and data hosted in the cloud can have enhanced restrictions over access. Your organisation will be able to utilise easy to configure, fine-grained controls and tools, including tracking data access and file sharing, time restricted access controls, and multi-factor authentication.

Proactive Security

Hackers get smarter and more advanced each day, and no cyber security strategy can provide 100% protection; our digitised world inevitably comes with some risk. At QuickThink Cloud, we provide a robust 24/7 monitored service to provide the best chance of defence for cloud based and on premises data and applications. Though the threat can never be eliminated, you can manage your risk, and work with a hosting provider who delivers a proactive and vigilant security solution.

> "As more and more public sector organisations migrate core processes and systems like payroll and HR to the cloud, understanding how to limit the vulnerability of your data and systems is critical."

How Does Cloud Security Work?

To help you understand how cloud security works to dramatically reduce organisation vulnerability, here's an example of our proactive security solution in action.

One of our client's anti-virus software was unable to block malware, but we detected suspicious web requests containing password information and took action. Our analysts sandboxed the infected machine using firewall controls, preventing any further outbound communication and protecting the rest of the network. All within 9 minutes.

We then reviewed user behaviour at the time of the incident, and identified the source of the malware as a document received by email. After recalling all network communication, we made a list of compromised credentials and guided the IT team through necessary remediation work including resetting all passwords. The network was once again secure.

QuickThink Cloud's Advanced Cyber Security Solution

The nature of cyber threats is always evolving, but QuickThink Cloud is always keeping up. Specialising in Unit4 ERP hosting but offering a complete package of IT services and technical consultancy, they are facilitating the public sector's cloud migration and security. With a watertight security solution for both cloud and on premises environments, QuickThink Cloud promises enterprise-grade security for your organisation.

Get in touch to learn more.

QuickThink Cloud

Quick Think Cloud Limited
Tel: +44 (0)20 8798 0093
ian.witts@quickthinkcloud.com
https://quickthinkcloud.com/

Denmark: A blueprint for becoming a digitised society

Richard Davies, UK Country Managing Partner, Netcompany turns the spotlight on Denmark, an excellent blueprint for becoming a digitised society

In 2021, Denmark was ranked 1st as the most digitised society, out of the 27 EU member states. Today it leads the way in connectivity with 94% of households attached to very-high-capacity networks and boasts one of the highest living standards with citizens enjoying digital services which a few years ago would have seemed impossible.

Not only is Denmark one of the leaders in digital public services with high levels of interaction between businesses, the public and all levels of government, but more than half of Danish enterprises use e-invoices and cloud services. As a result, Denmark is now viewed as one of the most advanced and successful Govtech countries in the world.

So how and why has it become the frontrunner in successfully digitising society?

The Denmark Agency for Digitisation (part of the Ministry of Finance) has been the driving force enabling the country to reach its ambitious targets. Set up in 2011, the agency was charged with the government's digitisation policies. With the aim of renewing the Danish welfare state, the agency is responsible for the implementation of the government's digital ambitions and the use of digital welfare technology in the public sector.

An all-inclusive digitised society strategy

Danish digital ambitions were large-scale and highly inclusive, with all levels of government, from central government to regions and municipalities involved. This encompassed both the administrative institutions such as ministries, agencies, public sector institutions, and municipal and regional administrations, as well as hospitals, schools, universities and more.

The Danish digital transformation effort is based on recognition of a unique common responsibility to embrace the digital mindset and the vision of a digital public sector with citizens and the private sector a key partner in this process. For the Danes everyday life is digital. This means the public sector is fast becoming completely digital and digitisation is a prerequisite for today's modern welfare society - creating a coherent, accessible, and citizen-focused environment.

> "94% of Danish households are attached to very-high-capacity networks and Denmark boasts one of the highest living standards in the world."

One of the big wins of the Danish digitisation efforts is the provision of a single digital communications platform for all official letters sent to citizens and businesses. Since November 2014, it has been mandatory for citizens over the age of 15 to receive digital communications from the public sector. Furthermore, it is mandatory for citizens and authorities in Denmark to use digital solutions to communicate in writing with the public sector.

Clear direction for digitisation

This formed part of the Danish Agency for Digitisation's Digital Strategy 2016-2020 which provided clear direction with four main goals:

- The use of public digital services must be easy, fast, and of high quality.
- Public sector digitisation must provide good conditions for growth.
- Security and trust must be at the centre.
- Support democratic and social challenges to ensure that everyone has equal means and ways to access and use public services.

This involved ensuring, for example, a more user-friendly and coherent user-journey when several public authorities at different levels of government were involved. Moreover, the government launched a new strategy for ICT management in central government aimed at improving management of existing operational ICT solutions.

Today more than 250 critical digital society solutions have been delivered, all based on componentised modern technology. This involved replacing legacy technology and combining digital components to create new ones, utilising a vast library of scalable software components.

Changing society for good

This is the way that the Danish government has been able to accelerate initiatives and change society for good. For example, Sundhed.dk, is the Danish e-health portal for public healthcare services. It enables both citizens and healthcare professionals to find patient-centred data, information and to communicate. Another example is Borger.dk, a one-stop national portal, where citizens are able to access any information at any place and time, thereby reducing administrative costs and improving public services. The skat-dmr is the platform for the Danish Register of Motor Vehicles. This has reinvented ways to handle applications for drivers' licenses, distribute license plates and collect tax.

The importance of data

The key to modernisation is the use of basic data. This is fundamental data that is common for many purposes such as addresses, dates of birth, National Insurance numbers, etc. Establishing a common basic data infrastructure for public sector administration which can be updated in one place, is of huge societal benefit. It means that the public no longer has to re-type the same information every time they use a public self-service solution and, in turn, makes for a smoother transition for public-sector employees to work more efficiently.

For example, a first of its kind, is an advanced data warehouse solution that enables a new level of transparency in the Danish educational system by providing reliable behaviour and performance data from schools across 98 municipalities.

These digital solutions are helping Danish citizens throughout their life journey from the day they are born, through to their education, as they enter the job market and into every day life, and when they need social and healthcare support.

Future recommendations from the EU Commission

Looking to the future, the EU Commission has recommended measures to ensure that countries look to secure a resilient healthcare system whilst continuing to strengthen their digital infrastructure and enhance climate action. These measures are key to Denmark's ongoing success and the government is continuously working with, and consulting with, organisations and stakeholders in both the public and private sectors in order to best determine the strategy necessary for a future digital Denmark.

To this end, in Spring 2021 the Danish Authority launched the Digitisation Partnership. Members include senior-level executives and experts from the business community, the research community, civil society and social partners, and local government. This initiative has already made 46 recommendations for Denmark to continue to be viewed as a digital pioneer around the world.

Digital transformation is not a 'one and done' initiative but a journey that requires ongoing development. This means that questions need to be asked around how data can be used, projects prioritised, and Denmark needs to consider how it will take advantage of new technologies such as artificial intelligence to stay at the forefront of digitisation.

Richard Davies
UK Country Managing Partner
Netcompany
Tel: +44 (0)800 567 7196
info.uk@netcompany.com
www.netcompany.com
https://twitter.com/netcompany_uk

How Denmark built a unique governance model for digital ecosystems

Digital Hub Denmark has developed and implemented a unique governance model for digital tech ecosystems that can be leveraged to accelerate sustainable digital impact.

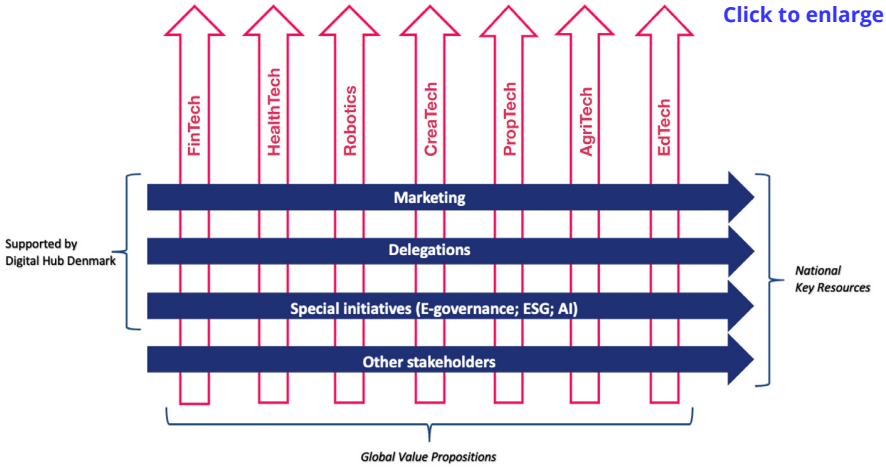
For Denmark to remain positioned as a digital frontrunner and attractor of international talent and investors, Digital Hub Denmark has developed a unique governance model to support the ecosystems of digital tech start- and scale-ups.

The model is termed the Danish Digital Ecosphere, and it is constituted by the Danish leading digital tech ecosystems: FinTech, HealthTech, Robotics, CreaTech PropTech, AgriTech, and EdTech. These ecosystems are all non-for-profit cooperatives, with a top-manager, a secretary, and a professional board. The Danish Digital Ecosphere is governed by a steering committee with the ecosystems' top managers and leaders from Digital Hub Denmark. The steering committee handles shared agendas regarding e.g., marketing and delegations which is illustrated in an Ecosphere canvas.

Denmark's digital tech startup scene is doing well. Investment figures from 2020 to 2021 show an investment growth of approx. 300 % to approx. 2,1 billion Euro. In addition, the number of startups is growing steadily – from an estimated 800 in the summer of 2019 to 1,145 today – approx. 45 % in less than two years.

The common agenda in Denmark's Digital Ecosphere

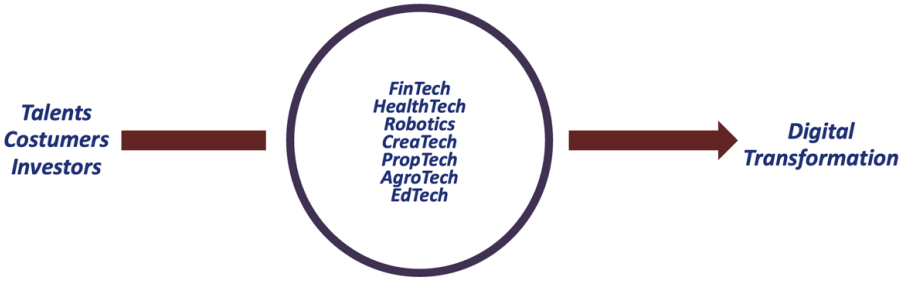
It is completely unique that Denmark has governance across the market verticals that the digital tech ecosystems represent. The thing is, for example, a FinTech company has more in common with a PropTech company in terms of business development than it has with other companies in its domain (banks, etc.). Thus, there is a common agenda in Denmark's Digital Ecosphere regarding talents, customers, and investors that the digital tech companies need for their potential exponential growth and their solutions with a digital transformative value proposition.



All the digital tech companies in the ecosphere are designed for fast growth. To this end, they are not older than ten years or they have revived growth funds within the last five years. Moreover, they all leverage digital disruptive technologies in their solutions sharing a value proposition of digital transformation. Because they all are entrants, they need to introduce radical innovation to compete with incumbent players. Therefore, the Danish Digital Ecosphere might represent the most important radical innovative potential in the digital field.

Digital transformation with a sustainable impact

So, how to govern the direction of this radical innovation of the Danish Digital Ecosphere towards a digital transformative value proposition with a sustainable impact?



The ecosystems in the Danish Digital Ecosphere estimate that more than 100 digital companies in the ecosphere have a value proposition that can be used to reduce CO_2 footprint as a key element in their business model. They also estimate that more than half of the digital tech companies have a value proposition that contributes to at least one of the 17 sustainable development goals (SDG).

To this end, over half of the ecosystem's companies has a value proposition with a sustainable digital impact. Meaning, if a customer buys such a solution, it can be used to e.g., improve health, reduce CO_2, or poverty, if the solution is used correctly. For now, this assessment is quite subjective from ecosystem to ecosystem, and to make the digital tech companies able to account for their sustainable digital impact in a comparable way, there is a need for further R&D in specifying a standard. However, Denmark does have a starting point, and the Danish Digital Ecosphere's steering committee has agreed that is important to mature the standard and techniques for digital sustainable impact.

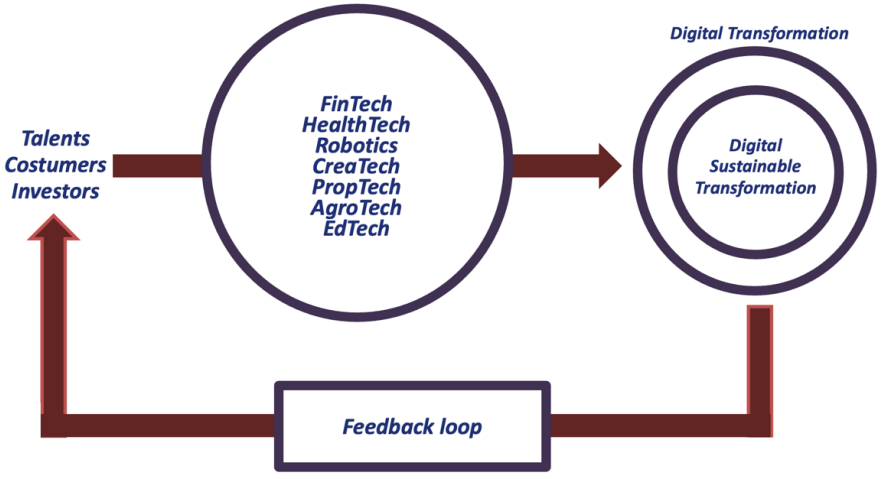
Measuring the sustainable digital impact in its unique governance model

Denmark has with its unique governance model for digital tech ecosystems a point of departure for accelerating solutions for sustainable digital impact. The recipe is to measure the sustainable digital impact from Denmark's Digital Ecosphere and apply this in a feedback loop, as known from regenerative design, to attract and maintain talents, customers, and investors sharing a suitable development agenda. To this end, the goal is a regenerative digital ecosphere.

A regenerative ecosphere governs with an SDG-direction would implicate that Digital Hub Denmark should target talent attraction (and maintain) towards purpose-driven talent, investors with a focus on sustainable investments, and customers who want to contribute to a better world.

Digitalization is important to governments

Denmark is no exception, and in 2018 the private-public partnership Digital Hub Denmark was launched to be a digital frontrunner in Europe by 2023. The private partners are The Danish Chamber of Commerce, Confederation of Danish Industry, and Finance Denmark, and the public partners are the Ministry of Industry, Business and Financial Affairs, Ministry of Higher Education and Science, and Ministry of Foreign Affairs of Denmark. The public and private partners approximately fund the partnership with 90 % and 10 %, respectively; however, all partners have an equal vote in the board of directors with an independent chair. Digital Hub Denmark is founded with two obligations regarding a national platform and marketing activities. The national platform (Denmark's Digital Ecosphere) regards matchmaking and learning, and marketing regards marketing of Denmark and increased attraction of talents, customers, and investors. These obligations are interdependent, as the national platform can be utilized for marketing activities and the marketing activities can be utilized for the growth of the national platform.



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Digital Hub Denmark

Claus Rosenstand
Digital Hub Denmark Professor
Digital Hub Denmark
claus.r@digitalhubdenmark.dk
https://digitalhubdenmark.dk
https://twitter.com/DigitalHubDK

What is open source software and how does it work?

Dr John Yardley, Founder and CEO of Threads Software ponders what open source software is & how it works

If you come up with a great idea for something tangible – such as an engine - and don't want your idea to be stolen, you either keep it secret or you patent it.

Keeping it secret may be difficult because the blueprint could be leaked. Patenting it involves exactly the opposite. You publish the idea in detail, but then you have the right to sue anyone that copies your invention.

However, software is different; in many countries, you cannot patent it. Rather like a food recipe, it can be extremely difficult to enforce the copyright.

Therefore, most commercial organisations tend to keep their software secret, or proprietary. While "reverse engineering" proprietary software is possible, without access to the source code, only the operation can be copied, not the method.

So, what is source code?

Computer programs are normally written in English-like statements such as:

PRICE = COST + PROFIT

This is called source code.

These English-like statements are converted into instructions that the computer can understand, called assembler language which then becomes just a sequence of numbers, called executable code or machine code.

It's possible to convert machine code into source code, but it will be almost incomprehensible. All the convenient names such as "PRICE" will be replaced by numbers and any explanatory comments by the programmer will be lost.

Now that so many applications are run on remote computers in the cloud, it is becoming increasingly rare to get access to even the machine code.

The general public don't like buying proprietary software

The problem with proprietary software, and indeed software in general, is that it is a "grudge" purchase. Because the customer doesn't see anything tangible for their money, they tend to think it has little value. They justify copying a version of Word by saying that it hasn't cost Microsoft anything. But of course, it has.

Microsoft Word is a bit of a special case though. There are thousands of programs that have been written by small companies for very niche applications and making them proprietary severely limits their adoption. Without widespread adoption, they don't have the critical mass of essential testing.

How can open source software solve the issue?

Open source software is one solution to this, and it has many similarities with patents. You make the source code generally available in return for two things: -

1. If you find any problems and fix them, you share your fixes with the community.

2. If you sell a product using the open source code, you pay the developer a royalty.

Wonderful as this idea is, it took a motivated community to get it off the ground – mostly programmers in academia and government. Programmers, like everyone else, have egos and there is satisfaction in knowing your code is embedded in many applications.

The early niche open-source community soon grew to



Dr John Yardley
Founder and CEO
Threads Software Limited

include programmers from commercial organisations. Although not initially keen to give away the code that cost them so much to develop, they realised that other people's software was as valuable as their own and there really was no point in reinventing the wheel. Furthermore, they could massively reduce the development time to make hundreds of new services viable – open-source software can be tried at very little cost.

The evolution of UNIX as an example

The main downside to open-source software is, like anything else you do not pay for, you have no rights to seek damages if it doesn't work. This downside has spawned a complete industry of companies that support, and hence monetise, open-source software.

This is well illustrated by the evolution of UNIX. UNIX is an operating system (like Windows and MacOS) originally developed by Bell Labs for their internal use. It was later made available royalty-free to academic establishments, and as a result saw widespread adoption.

Operating systems are an essential component of mobile phones as well as of desktops and the millions of microprocessors embedded within other devices – from aeroplanes to washing machines, providing the software infrastructure to support application programs.

UNIX remains a proprietary operating system, but other operating systems were developed that behaved identically to UNIX but written from scratch and made available as open source. One such was Linux.

Linux soon became very popular but commercial organisations could not risk basing their products on an unsupported operating system – i.e., one for which staff were not paid to fix bugs and support new types of hardware. In response, Red Hat was born and became one of the main contributors to the ongoing development of Linux, meaning that commercial organisations can use Linux under licence and pay Red Hat to support it.

Would this software have been popular if it wasn't open source?

It's doubtful whether the UNIX "model" would have ever taken off had Bell not made the early decision to distribute the code royalty-free to academic organisations.

So, open-source software has transformed the software industry and this transformation has been super-charged by low-cost, high-speed, reliable internet.

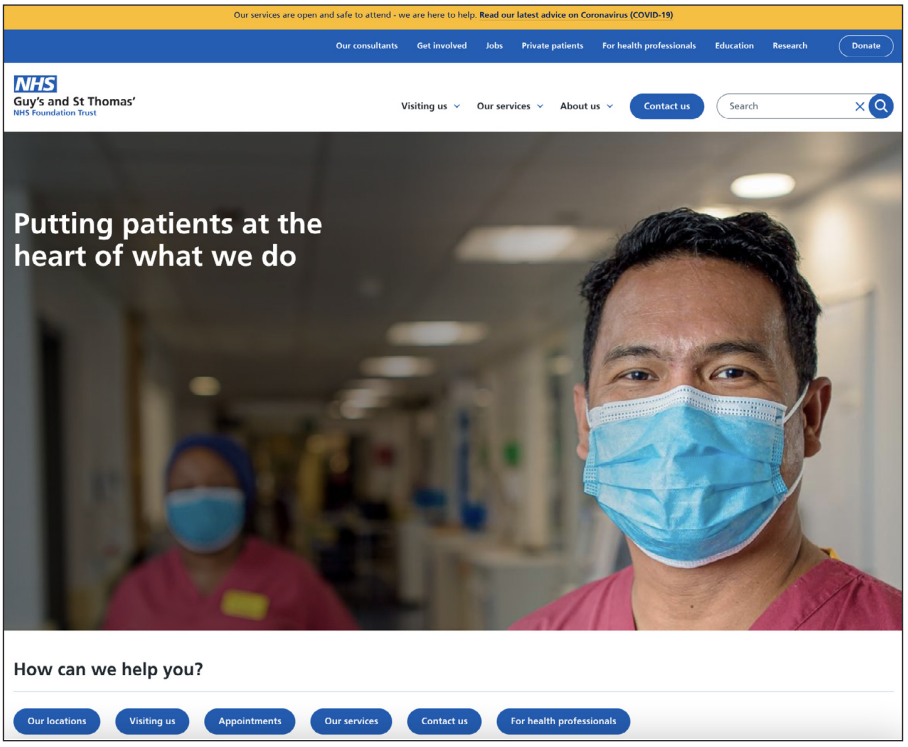
A great deal of open-source software is being used in commercial applications for which the author receives no royalty - simply because it is difficult to police. Yet overall, the system works and because so much today is based upon software, the open-source movement has been a primary driver in the acceleration of technological development. Downsides or not, it is here to stay.

Dr John Yardley
Founder and CEO
Threads Software Limited
Tel: +44 (0)208 390 8487
sales@threads.cloud
https://threads.cloud/
https://twitter.com/threads_app
https://www.quora.com/profile/John-Paul-Yardley

Transforming Digital Experiences in Healthcare - Guy's and St Thomas' NHS Foundation Trust

With over 18,000 staff, treating three million patients a year, Guy's and St Thomas' (GSTT) is one of the biggest and well-known NHS Trusts in the UK. Transforming digital experiences has been at the heart of the website update

With a growing organisation and staff continuously adding content over the years, the site had become over-loaded with information, making it increasingly difficult for patients to find what they needed. The COVID pandemic made this problem even more conspicuous, increasing GSTT's need for a professional and flexible site that worked for their patients. The updated website is now streamlined and accessible, transforming digital experiences of patients across the UK.



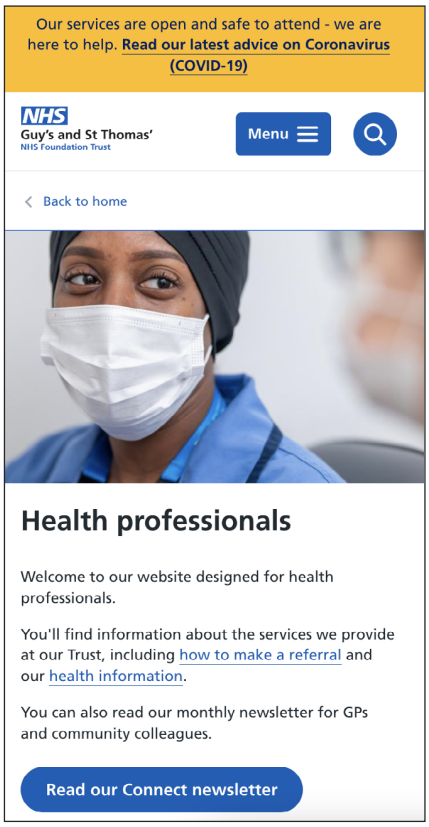
Transforming digital experiences by designing around the needs of users

The transformation of the GSTT website started with a Discovery phase spanning three months. The purpose of discovery was to get a clearer understanding of the issues for the different groups of GSTT users. Although the organisation had some understanding of the problems of the problems with the current website, they wanted to ensure that the new website was designed around the needs of users.

This started with focus groups internally to understand what corporate and clinical staff thought the issues were. Staff were very in tune with patient needs and frustrations and understood the value of improving the digital experience to help patients. For example, once they designated COVID information pages on the website, calls to the Trust reduced by 50% within days.

These focus groups also helped develop the initial user journeys to test. This was explored through three iterations of one-to-one interviews, observing how patients navigated the website. Ensuring the new website was able to cater to all users, regardless of physical, cognitive or any other disability, was of paramount importance. Zoocha have made sure that a high proportion of the users interviewed and tested had a range of accessibility needs, including screen readers and those living with visual and cognitive impairments and chronic conditions.

It was also interesting to compare patients who were new to the hospitals or had only been a handful of times to those who had a long relationship with the trust. The latter likely knew the hospitals intimately. However, even those who had visited regularly had to learn ways of navigating the site and still struggled to find the information they needed.



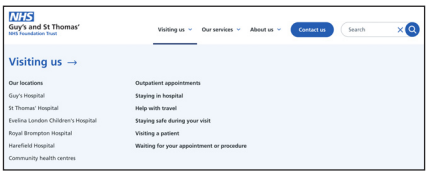
Six clear website behaviours emerged

In addition to the qualitative research, we undertook quantitative research in the form of a survey to get a broader coverage of users and develop a more robust overview of their needs. Overall Zoocha engaged with 780 people, representing a mix of the varied GSTT audience.

The findings of discovery were collated into 6 clear behaviours:

1. **Contact** – I'm looking to find contact details
2. **Appointment** – I'm looking for appointment details
3. **Travel** – I'm looking at how to get to the hospital
4. **Wayfinding** – I want to know how to get around when I am at the hospital
5. **Consultant** – I'm looking for consultant details
6. **Information** – I'm looking for other specific information

These behaviours were aligned with



Click to enlarge

the 40 distinct user needs statements, which were later used to inform the acceptance criteria for developing the new website. With this full understanding of the audience's needs and goals, we could develop and test a new website structure, navigation principles and content design. As a complete website redesign, everything was new and so everything was tested. From card sorting and tree testing for the website structure, to interviews with prototypes for the pages and content, we tested our assumptions and design iterations at each stage of the project. This ensured the users' needs were at the core of the new website, and that in future, the website wouldn't get overloaded with content, like the previous one had done.

The overall patient led approach was crucial to this project's success. For patients to know that their views and needs were being taken on board was very important to both them and GSTT. Throughout the process, none of the people spoken to ever doubted the quality of the care they received and wanted the website to reflect that.

Enhancing Digital Publishing

Zoocha leveraged the content management power of Drupal in order to provide editors with flexibility tools for building content using reusable components. This means that content managers are not restricted by fixed page templates and can build tailored content experiences for any purpose, while guaranteeing that the content is always accessible and mobile responsive across the website.

In order to manage the large volume of content on the website, editors frequently need to reference older revisions of the content when making updates. Drupals 'Diff' module enabled an elegant way of navigating through content history for content managers.

Zoocha also implemented an additional layer of functionality on top of the 'Diff' module, taking inspiration from another Drupal module 'preview_link', giving editors the ability to privately share unpublished content with external stakeholders in order for them to review the content before being made public.

Another implication of the vast amounts of content is enabling users to search the site easily and quickly find the most relevant content for the search terms they have entered. Drupals search API module in conjunction with Apache Solr provides a fast and accurate search experience for website users. It also enables website administrators to fine tune the ranking of different content types so that the most important pages will always appear at the top of the search results. The search user experience was further enhanced with features that would provide a natural way to browse even the most niche section of the website, such as *autocomplete, spellcheck* and *synonyms.*

ZOOCHA
Digital Agency

Will Huggins
CEO
Zoocha Ltd
Tel: +44 (0)1992 256 700
will@zoocha.com
www.zoocha.com
https://twitter.com/Zoocha

Technologies improve human welfare and solve global issues



Shu Wei Goh, Co-Founder of the global AI ecosystem builder and VC firm, Skymind, explores how technologies contribute to the improvement of human welfare & solving global issues

Throughout and beyond the COVID-19 pandemic, new pressures have been placed on the planet and its resources. However, innovative technologies in Asia have been helping to alleviate these issues and are contributing to a better future for society.

Here are three of the most exciting developments happening in Asia right now.

Agritech and its power

As the global population continues to increase, the need for food is rising as well, with demands for world food production to grow by 50% over the coming decade to meet new demand. Land scarcity has paved the way for AI-based innovation to flourish in the agriculture industry, which has been particularly prevalent in the farming fields of Malaysia.

One of the most exciting agritech innovations has been Artificial Intelligence of Things (AIoT) that can monitor crop growth using smart devices. AIoT is the combination of artificial intelligence (AI) technologies and the Internet of Things (IoT) infrastructure that enables automated operation and enhances data management and analytics. In agritech, this could reinvent the future of food production, as predictive software, weather sensors, and drones can scan vast plots of land and then communicate the data to one another.

These IoT advances pave the way for a new level of crop and livestock monitoring by providing valuable data that historically was either collected manually or was unavailable. In remote locations where Wi-Fi coverage is limited, cost-effective and flexibly deployed network infrastructure remains crucial for connectivity as data needs to be sent from sensors to farmers' devices over long distances.

To operate these technologies, energy-efficient ultra-low-power devices have emerged as sustainable and cost-effective solutions. While traditional devices tend to last less than a year, this innovative technology can last up to five years.

"In remote locations where Wi-Fi coverage is limited, cost-effective and flexibly deployed network infrastructure remains crucial for connectivity as data needs to be sent from sensors to farmers' devices over long distances."

IoT and the rise of smart cities

As the world's fourth-largest emitter of greenhouse gases, Indonesia's government has pledged to reduce emissions by 29 to 41% over the coming decade and is using IoT to address the issue. By strengthening its focus on developing Smart Cities, the southeast Asian nation is using IoT to help mitigate the effects of global warming and air pollution and improve human welfare.

IoT devices are being used to measure CO_2 levels and, in time, will be able to pinpoint which businesses are producing excess amounts. In other use cases, IoT sensors can also measure air pollution levels, allowing cities to better budget for improvements, with more data on where the most urgent problems are and clear paths to rectifying them.

Improving human welfare through Medical AI

Lastly, AI has played a critical role in the logistical difficulties of COVID-19 vaccine distribution. Since cold chain storage is required to maintain the vaccine's effectiveness, special transport boxes have been required, and these boxes must remain closed during delivery.

Ultra-low power AIoT has enabled the vaccine's temperature to be monitored as it is being delivered. A small hand-held device is put into the box to track its temperature along the way to the location. The device can share the temperature and communicate it to any laptop or mobile phone, as long as it has Bluetooth so that the box does not need to be opened by a person until the vaccination is ready to be delivered.

In Japan, where children need to undergo regular COVID-19 testing, AI innovation has helped speed up and scale the process rapidly. Vpass, for example, enables quick, seamless diagnosis through self-screening via dispenser machines in multiple locations. AI enables the fast validation of test results and creates a 'green Vpass' for negative results, allowing students and staff to congregate safely.

AI-enabled automation has also led to the creation of the most exhaustive database of proteins through AlphaFold, an AI system that predicts a protein's 3D structure from its amino acid sequence. This breakthrough could revolutionise our understanding of biology, as this freely available open-source online database holds the three-dimensional structures for over 350,000 proteins, completely changing how scientists can navigate public health crises such as super-resistant bacteria.

All around the world, AI has been pushing forward human welfare. These technologies have allowed humans to make significant progress faster than could otherwise have been possible, and what is even more exciting is what is to come next.

Shu Wei Goh
Co-Founder
Skymind Global Limited
Tel: +60 12 371 8060
support@skymind.global
https://skymind.global/
https://twitter.com/skymind_global

Reading & deciphering ancient writing systems with AI

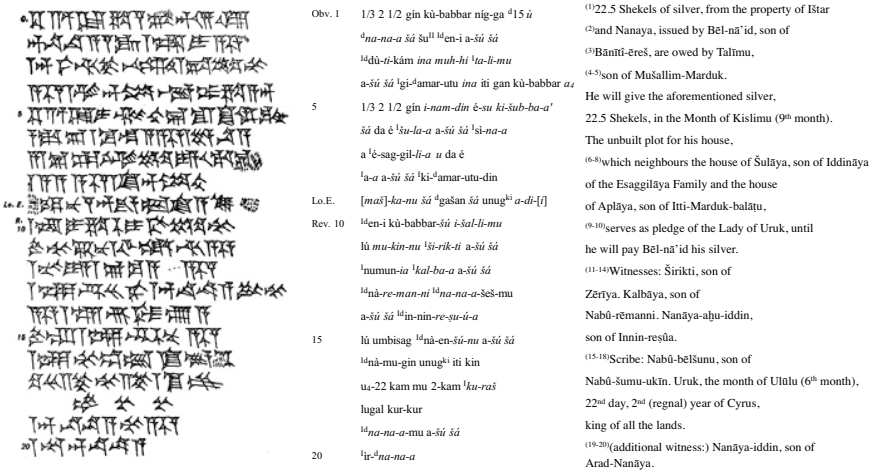
Shai Gordin, Senior Lecturer at Digital Pasts Lab, Ariel University in Israel, provides intriguing insights about reading & deciphering ancient writing systems using AI

Can computers read ancient language systems better than experts? And why would we want AI to do that? How exactly do computational models read texts?

Computational methods to study ancient texts & scripts

There are multiple benefits of using computational methods for studying ancient texts and scripts, like Egyptian hieroglyphs or Mesopotamian cuneiform writing. Imagine all ancient texts were available with an effective search engine. You can search for specific words or sign sequences, or even general keywords. The benefits of searchable databases for texts in hieroglyphic, cuneiform, or any of the alphabetic scripts of the ancient world are already well established, with websites like *Trismegistos*, the *Cuneiform Digital Library Initiative*, *Hethitologie Portal Mainz*, or the *Comprehensive Aramaic Lexicon Project*, to name a few.

Another benefit is consistency in the work process. Often historical research involves reading substantial amounts of texts and extracting relevant information. In other words, it is a task of meticulous close reading, later synthesised by an expert. Doing this process digitally helps to maintain consistency and accuracy. In fact, saving pieces of data in digital format



Obv. 1 1/3 2 1/2 gín kù-babbar níg-ga ^{d}15 *ù*
^{d}*na-na-a šá* šu^{II} ^{Id}en-i a-*šú šá*
^{Id}dù-*ti*-kám *ina muh-hi* ^{I}*ta-li-mu*
a-*šú šá* ^{I}gi-^{d}amar-utu *ina* iti gan kù-babbar *a*
5 1/3 2 1/2 gín *i-nam-din é-su ki-šub-ba-a'*
šá da é ^{I}*šu-la-a* a-*šú šá* ^{I}sì-*na-a*
a ^{I}é-sag-gil-*li-a u* da é
^{I}a-*a* a-*šú šá* ^{I}ki-^{d}amar-utu-din
Lo.E. [*maš*]-*ka-nu šá* ^{d}gašan *šá* unug^{ki} *a-di-*[*i*]
Rev. 10 ^{Id}en-i kù-babbar-*šú i-šal-li-mu*
lú *mu-kin-nu* ^{I}*ši-rik-ti* a-*šú šá*
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u$_4$-22 kam mu 2-kam ^{I}*ku-raš*
lugal kur-kur
^{Id}*na-na-a*-mu a-*šú šá*
20 ^{I}ir-^{d}*na-na-a*

(1)22.5 Shekels of silver, from the property of Ištar
(2)and Nanaya, issued by Bēl-nā'id, son of
(3)Bānītī-ēreš, are owed by Talīmu,
(4-5)son of Mušallim-Marduk.
He will give the aforementioned silver,
22.5 Shekels, in the Month of Kislimu (9th month).
The unbuilt plot for his house,
(6-8)which neighbours the house of Šulāya, son of Iddināya
of the Esaggilāya Family and the house
of Aplāya, son of Itti-Marduk-balāṭu,
(9-10)serves as pledge of the Lady of Uruk, until
he will pay Bēl-nā'id his silver.
(11-14)Witnesses: Širikti, son of
Zērīya. Kalbāya, son of
Nabû-rēmanni. Nanāya-aḫu-iddin,
son of Innin-reṣûa.
(15-18)Scribe: Nabû-bēlšunu, son of
Nabû-šumu-ukīn. Uruk, the month of Ulūlu (6th month),
22nd day, 2nd (regnal) year of Cyrus,
king of all the lands.
(19-20)(additional witness:) Nanāya-iddin, son of
Arad-Nanāya.

Figure 1: From Left to Right, the original cuneiform line art, the transliteration, and the translation of the Achaemenid period Babylonian text Yale Oriental Series 7 11.

is not at all different from traditional methods of card-file catalogues. Instead of storing small papers with pertinent information in specific boxes, they are stored digitally in files that are like cabinets: their structure, which is easy for a computer to process, is like folders within folders, which can easily take you to the information you are looking for. The important difference is that when these folders and cards are digital, you can easily rearrange them, visualise, explore them and reuse them in ways that were not possible before.

Computational text analysis is far from simply translating analogue methods to digital ones. Using computational methods with ancient texts and scripts can open new avenues of research that were completely impossible before. Computers understand text very differently from humans. A computer often needs to translate words into numbers or vectors, and then it can analyse lexical similarities and meanings using mathematical formulae. While this practice is completely foreign to traditional textual analysis, it opens an opportunity to view texts from a new perspective. This is just one example of many possibilities. Moving in a digital direction also provides opportunities for interdisciplinary research on an unprecedented scale. Think of the card-file catalogue example from above. When it is analogue, these boxes are of use to a limited number of scholars with access, and they cannot be connected to catalogues of

other scholars from the same or adjacent fields. But if they are digital, these files can be shared, compared, and joined together through the semantic web.

Natural language processing (NLP) models

While digital corpora of ancient texts are constantly growing, many are still far from full digitisation. Reading ancient documents is difficult, the decipherment takes time, the size of the corpus is substantial and may include several ancient languages. Natural language processing (NLP) models can aid these tasks. NLP is a subfield in computer sciences and linguistics, that studies and develops methods for computers to understand and analyse human languages. The best models are often neural networks, advanced machine learning (ML) models whose mechanism attempts to imitate the workings of the human mind, ergo their name. But while a human does not need to see millions of images of cats and dogs to differentiate between the two, neural networks do. This is not a problem when training models on the English language, for example. It is easy to extract tens of millions of words in English from the internet. Many ancient languages, however, fall under the category of low-resource languages – these have a limited number of examples, and some of them, like Akkadian, also have more complex morpho-syntactic structures. The upside of some text genres, even historical ones, is that many are formulaic and repetitive, unlike modern languages which are highly variable in nature. This counteracts, to a certain extent, the sparseness of available texts.

One of the common tasks in NLP is restoring masked words in a sentence – a task which, in practicality, is equivalent to restoring broken passages in ancient texts. Based on the complete sentences which the model has seen, it can predict how to restore fragmentary sentences. The more examples it will see, the better the results are. My research team at the Digital Pasts Lab, as well as another group from the Hebrew University, have shown the effectiveness of NLP models for restoring fragmentary cuneiform tablets written in Akkadian. A related NLP task is predicting sequences of words or in the case of cuneiform, which can also be signs. By using Neo-Assyrian royal inscriptions and their equivalent Unicode cuneiform glyphs, it was possible to effectively train a model to provide transliteration and segmentation of cuneiform signs. This was performed using neural networks, as before, and statistical models, which look at the frequency in which certain sign readings follow each other. The above tasks could be performed, by training models on existing digital texts. The greatest challenge, however, lies in optical character recognition (OCR), the visual identification of cuneiform signs; be that from drawings of cuneiform tablets, 2D images or 3D scans.



Figure 2: Fragmentary obverse of the house sale contract YBC 7424. Courtesy of the Yale Babylonian Collection. Image credit: Klaus Wagensonner (Yale University, New Haven, CT).

The future of reading ancient texts and scripts

The success of this kind of research allows us a glimpse into what will reading ancient texts and scripts look like, if computers will be able to perform all tasks, from visual recognition to transliteration and segmentation, even translation. Can we then say that the models are reading texts, like a scholar? Not yet. It is important to remember, that even when the models perform well, they do not perform perfectly. There is always a margin of error. Besides the fact, that there is not necessarily an ultimate truth when reading and reconstructing ancient texts – some issues are open to interpretation.

The scholar, then, needs to guide the models, correct them and analyse their results from a humanistic perspective. The combination of human and machine-based approaches will offer fresh perspectives on classical problems, as well as raise new avenues for research. Lastly, digitally curating ancient texts in this fashion, will allow smaller or marginalised fields of research, like studies of Indigenous and ancient civilisations, to join the global community of knowledge and make this specialist field more present and impactful in historical research at large.

Shai Gordin
Senior Lecturer
Digital Pasts Lab, Ariel University
Tel: +972 546 917 588
shaigo@ariel.ac.il
https://digitalpasts.github.io/



How do we activate AI in the public sector?

Sofia Ihsan, Trusted AI Lead at EY, explains her stance on activating AI in the public sector

The UK Government has a clear ambition when it comes to Artificial Intelligence (AI), and activating AI in the public sector. While the UK is already a leader, the aim is to make Britain a global AI superpower.

Indeed, the Government's own research shows that more than 1.3 million UK businesses will use AI by 2040 and spending on AI is expected to reach more than £200 billion by the same date. However, in contrast to the private sector, AI adoption in the public sector has a long way to go.

AI in the public sector has some very distinct challenges. It's particularly beset by tighter budgets, work within strict measures when it comes to taking on new technology projects, has a lack of technical skills, and in many areas is still reliant on legacy technology.

However, there is a clear appetite for change. For example, AI has the potential to make a significant difference in health and care settings through its ability to analyse large quantities of complex information. That's why the NHS Artificial Intelligence Laboratory (NHS AI Lab) was created and tasked with bringing together government, health and care providers, academics, and technology companies to help realise AI's potential.

For the implementation of AI to be effective, it should cover three transformational pillars: function (the part of the organisation where change will happen), people (who will deliver the benefit) and technology (the tools and partners employed).

> "The UK Government has a clear ambition when it comes to Artificial Intelligence (AI), and activating AI in the public sector. While the UK is already a leader, the aim is to make Britain a global AI superpower."

However, there are some fundamentals to unite public organisations and their partners around getting the right investment in and understanding these projects: the benefits AI could deliver for the public sector in particular and ensuring the ethical use of AI. And that's what we'll explore here.

The application of AI in the public sector

One of the biggest benefits of AI is its ability to streamline processes. This doesn't mean eliminating the need for humans, but instead helping them with their role to ensure that back-office processes are tightened up so they can focus on bigger picture tasks – such as driving legislation to better support citizens or developing business strategies that work towards improving public sector experiences.

The use of AI in the public sector can improve efficiency and effectiveness, thus increasing overall productivity in classically manual processes. For example, whether this is using AI to support medical diagnosis or screening for resource optimisation and allocation, which involves assigning scarce resources, such as doctors, nurses, police officers, and paramedics, to locations and activities where they are more likely to be highly utilised.

"It's not always about throwing out the old technology to bring in something radically different, but instead working with the right partners who can be trusted to deliver complex transformations at scale."

The public sector can use this current implementation of AI to build forward-looking solutions based on employee and citizen needs, but this requires a multifaceted approach across scientific disciplines, industries and government. The UK's National AI Strategy was developed in recognition of this need for collaboration to make AI a success, and it's a notion we've seen reflected in our work in the sector.

Ethical use of AI

It's widely known that the future of AI rests in the implementation of an ethical framework and adhering to the regulations that surround it, particularly when using, storing, and handling data. In fact, we know the Government is soon set to release a whitepaper covering the regulation of AI.

What we can say now, is the ethical use of AI ultimately comes down to trust. People are increasingly aware of the value their data holds and they do not take kindly to those who fail to protect it, making data ethics, regulation, and security essential to consumer or citizen trust.

Ethical AI isn't just about preventing bias, it's also about being to explain why a course of action has been suggested or a decision has been made. To ensure citizens feel comfortable sharing their data, organisations need to be clear and transparent about how that data will be used and be able to provide an appropriate explanation as to how an outcome or decision was reached for those impacted. Citizens also want assurance that should there be an error or a problem they have a clear path to getting this addressed – accountability. This will create a virtuous



Sofia Ihsan

circle: the more people that trust you, the more data they'll share with you; the more data they share, the better your AI – and ultimately, your organisation's outcomes.

Moving forward we can expect to see organisations intensify their focus on issues of AI governance including security, privacy and ethics to make sure that trust is at the cornerstone of any new solutions.

AI is not the preserve of the private sector

When reflecting on the past, present, and future of AI we must remember one thing – AI is not solely reserved for private sector use. Whether it's a local council, a non-for-profit or a global private corporation, the value AI can deliver is huge.

We believe that it's not always about throwing out the old technology to bring in something radically different, but instead working with the right partners who can be trusted to deliver complex transformations at scale.

By having an in-depth understanding of AI's future potential, leaders across both the public and private sectors can make sure they're setting their organisations up to succeed and doing so responsibly.

Sofia Ihsan
Trusted AI Lead
EY
www.ey.com/en_uk
https://twitter.com/EYnews



The synthetic data approach: The new unlimited data plan for AI models

Dayna Arnold, Project Manager at Zest Consult, discusses the benefits of using a synthetic data approach to machine learning as an innovative solution for increasing the availability, accuracy & security of more cost effective data

Innovation is critical for the growth of businesses today with the development of artificial intelligence (AI) as a key driver. When successfully deployed, AI improves how a business engages with customers, manages day-to-day operations, and gains a competitive edge. Machine learning, an application of AI, requires vast amounts of data and uses algorithms to successfully imitate how humans learn. Machine learning is used in a wide range of applications. (i.e., object recognition, text translation, smart devices, etc.) Successfully deploying AI models is not without challenges, which, if handled inadequately, could prevent the business from moving forward with their AI deployment goals.

The data challenge

The machine learning approach for performing object recognition requires the acquisition of vast amounts of labelled data to successfully train machines. Obtaining these large amounts of real-world data sets can prove to be a major roadblock for an organisation's AI deployment plans, as the large amounts of labelled data required may be unavailable, excessively time consuming, and/or prohibitively expensive to obtain.

For effective machine learning, real data needs to be labelled (identifying objects in the data and tagging them with labels that will help the machine learning model learn from the data). Good quality labelling enables the machine to make accurate predictions and estimations. Paying labellers for their time and effort significantly increases the cost of developing AI. Therefore, not only can it be difficult to get large quantities of real data, manually labelling datasets is labour-intensive and excessively expensive.

Considerations must also be made with respect to accuracy and security. Real-world data sets have the potential to exclude certain populations or contain errors that can lead to inaccurate models of real-world scenarios which prove to be unsuccessful during testing or produce results that are inaccurate or biased. Finally, those who have access to real-world data are responsible for ensuring that sensitive data (i.e., personal identification data) is used ethically and in compliance with General Data Protection Regulations (GDPR). Sensitive data must be protected from unauthorised access or unethical use. Securing data can be expensive and restrictive which limits the amount of data available.

Synthetic data approach

Using the latest research in AI and machine learning for vision, a collaborative team of members from Zest Consult, Costain, and the University of West England developed and applied a synthetic data approach to designing a leading-edge AI and machine learning system for the remote monitoring of construction sites. This system was designed with AI technology that enables the machine to simulate Visual Recognition. The main challenge limiting automated site monitoring was the lack of labelled data sets to train object recognition machine learning models. However, the initial data set generated with the AI algorithm is automatically labelled, as it is synthetic data, therefore, human effort for annotations or quality validation was not required; further saving the team both time and money as a result.

Ensuring accuracy is another benefit when applying a synthetic data approach to machine learning. Synthetic data is created using AI algorithms that represent data with appropriate balance, distribution, and other parameters as opposed to using real-world events where there is less control over such parameters. This reduces the bias in datasets which ultimately increases the accuracy of the predictive modelling used in machine learning.

The synthetic data approach addresses the challenges of protecting sensitive data as well. The data generated is new data that has the same characteristics of the original real data thus producing the same results. However, instead of merely altering the data, the synthetic data replaces the original data mimicking only the statistical properties while maintaining the same predictive ability. As a result, it is nearly impossible to recreate the original data which keeps the original data secure. This eliminates the obstacles of privacy and security regulations which would otherwise have made it more difficult, costly, and time consuming to obtain.

The synthetic data approach developed and used by the Zest Consult collaborative team was an augmentation approach, in which a synthetic data set was generated using various computer algorithms. These algorithms were applied to a combination of a small quantity of real-world images (Construction site and Google images) and a 3D model of a common guardrail. This approach eliminated the need to collect a significant amount of real data which is especially beneficial where data collection would not have been feasible due to time/location limitations.

Once the initial synthetic data set had been established, the amount of time and effort involved in generating more synthetic data decreased considerably, driving the cost and amount of time needed in the development of their AI model even lower than had they obtained only real-world data. From this initial synthetic data set, the vast amounts of synthetic datasets resembling real-world scenarios using these 3D virtual scenes, 3D models of workers, components, and plant equipment were generated and used to train the machine to recognise, track, and record the presence and proximity of construction equipment and workers from various camera feeds.

Results

The Zest Consult collaborative team's synthetic data approach was proven to be highly effective when applied to machine learning (Patent No: 2204397.0 pending). Their Object Recognition AI models performed with a high level of accuracy, as evidenced by the significantly high rate of ~80% reduction in false positives yielded in the field.

This synthetic data approach to AI/machine learning provided a qualitative improvement over the traditional manual site monitoring services and enabled the team to achieve their goal of delivering a system that performs robust object recognition, tracking, and photogrammetry that would result in boosting environmental, safety and productivity capabilities.

Overall, the team found when they were not bound by the restrictions of collecting and using solely real-world data for machine learning, they were able to generate the vast amounts of synthetic data required for machine learning in significantly less time and at a much lower cost that resulted in the development of a more accurate AI model.

ZEST
CONSULT LTD

Geoff Hoyle
Director
Zest Consult Ltd.
Tel: +44 (0)7887 991 973
enquiries@zestconsult.co.uk
www.zestconsult.co.uk
https://twitter.com/ConsultZest

Threats from terror attacks and keeping communities safe



Cllr Nesil Caliskan, Chair of the Local Government Association's Safer, Stronger Communities Board, explains how councils take terror attack threats very seriously and work hard with partners in keeping communities safe & connected

This year marks the fifth anniversary of a number of devastating terror attacks across the country, the effects of which continue to be felt around our communities to this day.

Sadly, alongside the devastation of larger-scale tragedies such as that at the Manchester Arena, recent years have also seen an increase in 'low-sophistication' terror attacks at public places, targeted attacks on politicians, including MPs Jo Cox and more recently Sir David Amess.

Acts of terrorism have a devastating and far-reaching impact on victims, their families, and friends - and on communities more widely, disrupting feelings of safety and affecting social cohesion.

As place-shapers with a key role in ensuring the safety and security of residents, councils take the threats from terrorism very seriously and alongside wider partners, work hard to keep their communities safe and connected.

How can governments keep communities safe from future terror attacks?

The LGA supports the Government's recent review into what more can be done to protect public places from attacks, with the Government confirming its commitment to introduce a new legislative Protect duty in the Queen's speech.

While there is little detail in the consultation response or the Bill announcement, there will likely be a number of implications for councils beyond their existing role in the safety and security space; as owners and operators of venues in their own right; as employers of large organisations; and potentially a wider role in enforcing compliance. While councils are ready to support new measures, there are a number of concerns that Government must consider as the new duty is developed including the need for greater clarity on how it will operate in practice.

It was positive to see that both the draft Bill announcement and the Government's response to the

consultation's findings acknowledged the need for an appropriate and proportionate approach to protecting the public from attacks. It's essential to acknowledge that it's impossible to eliminate all risks and threats entirely, despite the best efforts of all parties involved; therefore, measures must, therefore, strike the right balance and not stop residents and visitors from enjoying the places and spaces that are a crucial part of local life.

Terrorism risk and other health and safety issues

To maximise the effectiveness of a new Protect duty, it's important that it is introduced as part of a wider approach that considers terrorism risks alongside a range of other health and safety issues. This would ensure that resources and mitigations reflect the true nature of the risk, that they are focussed on the places and events where they are most needed, and that protective measures taken for one risk do not create new risks elsewhere.

"Local partners should be empowered to balance the level of risk with reasonable mitigation measures that consider the setting of proposed events, building on local insight."

Alongside multi-agency partners, local authorities already undertake considerable work to assess and mitigate against the risks of terrorism alongside broader safety risks, at and around venues and for specific events. There needs to be further consideration about how the new duty will sit alongside these existing provisions.

Given the likelihood the duty will considerably increase the number of venues and events that might be subject to these sorts of measures, this also raises inevitable questions about the significant resource and capacity that will be required for successful implementation. Any new requirements must not place undue pressures on already stretched council services and budgets.

A risk-based approach to safety

It is important that any new obligations only apply to relevant venues and only impose reasonable burdens. A risk-based approach instead of a capacity-based approach would help to achieve this.



Nesil Caliskan

Local partners should be empowered to balance the level of risk with reasonable mitigation measures that consider the setting of proposed events, building on local insight. Similarly, the duty should not extend to public spaces such as beaches unless they're being used for specific events. Too broad an application of the duty raises many practical questions about how the measures could effectively be introduced and what the impact could usefully be.

The new duty should be just one aspect of a number of measures to keep our communities safe from terrorism. It is also vital that measures to increase security continue to sit alongside investment in prevention programmes, that aim to stop people being drawn into terrorism, tackle extremism and build cohesion and resilience.

Cllr Nesil Caliskan
Chair of the Local Government Association's Safer, Stronger Communities Board
cllr.nesil.caliskan@enfield.gov.uk
www.local.gov.uk

Boosting commercial capability with the Contract Management Pioneer Programme

The Contract Management Pioneer Programme is boosting commercial capability across the public sector, Crown Commercial Service writes

Crown Commercial Service (CCS) is committed to being at the forefront of the Government's efforts to make procurement a force for economic, social, and environmental good.

Last year, the organisation delivered £2 billion in commercial benefits for our 20,000 customers across central government and the wider public sector, and its ambition now is to go further, faster in growing the benefits generated for customers - extending its reach and influence and supporting the UK to build back better, fairer, and greener.

That also means building resilience in the public sector during periods of uncertainty in global supply chains, making the most of CCS's commercial expertise, and its position at the heart of the Government Commercial Function.

CCS, the Department for Levelling Up, Housing and Communities, and the Government Commercial Function are, therefore, working in partnership to invest in uplifting commercial capability across local government through a new contract management training programme.

The Contract Management Pioneer Programme

Almost 200 local government officers who are required to manage contracts as part of their duties will complete the Contract Management Pioneer Programme.

Contract management skills are needed to manage every aspect of the contract lifecycle. The training programme supports the Government's agenda to build back better by ensuring that contracting authorities are able to effectively manage the key stages of commercial delivery.



It is funded by CCS, the UK's largest public procurement organisation, and the Local Government Commercial Team in the Department for Levelling Up, Housing and Communities, in collaboration with the Local Government Association. Training is provided by the Government Commercial Function through the Government Commercial College.

Simon Tse, CEO of Crown Commercial Service says: 'We are making this investment as part of the Government's broader strategy to level up the country, boosting commercial capability and ensuring that local government has the tools and expertise it needs to get the best deal for the taxpayer.

'With the opportunities presented by public procurement reform on the horizon, we are determined to help our partners across the public sector to play their part in building back better.'

Boosting commercial capability across local government

Boosting the commercial capability of the public sector is at the heart of the Government's National Procurement Policy Statement.

The statement requires all contracting authorities to consider whether they have the right policies and processes in place to manage the key stages of commercial delivery it sets out, where relevant to their procurement portfolio.

During 2020, the Local Government Association identified 32 local authorities most in need of contract management learning and development support – including some that have faced challenges over their management of commercial affairs.

These authorities were offered the opportunity to apply for training that would inform and drive organisational change around contract management. Identifying good practice, sharing evidence-led best practice, and embedding stronger behaviours for local authorities that manage contracts worth billions of pounds every year.

Olivia Cooper, Service Manager, Contract Management and Quality Assurance at Warwickshire County Council, which is taking part in the scheme, says: 'Warwickshire County Council has been pleased to be part of the Pioneer Programme for the last six months.

'It combines knowledge and skills development through a structured learning programme with significant networking to drive the sharing of best practice and peer support.

'The stepped approach to learning has allowed us to roll training out to a number of colleagues at a level appropriate to their involvement with contract management, and we are also seeing a number of benefits from increased skills, knowledge, and peer support.'

What does the programme include?

There are five elements to the Contract Management Pioneer Programme:

- Each attendee will complete the Government Commercial College Foundation level programme. An online module based training programme covering the basics of good contract management.
- A further two levels of Practitioner or Expert in Contract Management are then available through a series of instructor-led webinars, leading to accreditation.
- The learners will apply this knowledge to their own local authority – identifying what works, why it works, and how it works, in how they currently manage commercial contracts
- All delegates will join a learner's network to support their peers across local government.
- A Senior Responsible Owner from each council will join a network tasked with embedding learning, providing challenge, and helping the findings of the programme to be shared across local government.

Want to find out more about the essential elements of effective contract management?

Read Crown Commercial Service's Procurement Essentials series.

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A look at the CCS Tail Spend Framework

When it comes to the CCS Tail Spend Framework, the framework covers several elements that are critical to the success of businesses across all sectors.

In public sector organisations, specific products are classified as tail spend. This can be products that are often low volume and low value, that are likely to be bought to meet a specific, short-term need – with low likelihood of being bought again in the imminent future.

They're likely not visible, until they appear in an organisation's end of year accounts – creating significant budget pressures if not resolved. Normally, this is around 20% of an organisation's spend.

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Five ways to bring sustainability and social value to your supply chain

Dave Emsley, Head of Public Sector Tail Spend Services from OT Group Limited explores how the world has woken up to an urgent need to be greener, outlining five key ways to bring sustainability and social value to your supply chain

The global pandemic has revived the hope that a more sustainable future is within our grasp – so long as we come together. Through an explicit lack of adaptability and resilience, as well as arresting imagery revealing the dramatic decline in air pollution in the absence of commuters, the crisis unearthed headwinds that have since spurred a need for dramatic action.

Businesses and individuals from all walks of life are increasingly seeking changes – large and small – they can make to improve their individual impact on the planet and help drive collective change.

And, as this target continues to gain optimistic momentum, so too does pressure from investors, shareholders, customers, and colleagues, for companies to push the green agenda within their own supply chains.

By working in conjunction with suppliers and ensuring better governance of procurement processes, professionals can not only boost the environmental, social, and economic performance throughout the entire supply chain lifecycle, but they can also meet the economic and reputational imperatives that contemporary sourcing and buying demands.

While incorporating sustainability and social value into your procurement process may feel like a challenging feat, failure to act could be the biggest risk of all. With that in mind, here are five ways to foster a sustainable supply chain for your public sector organisation...

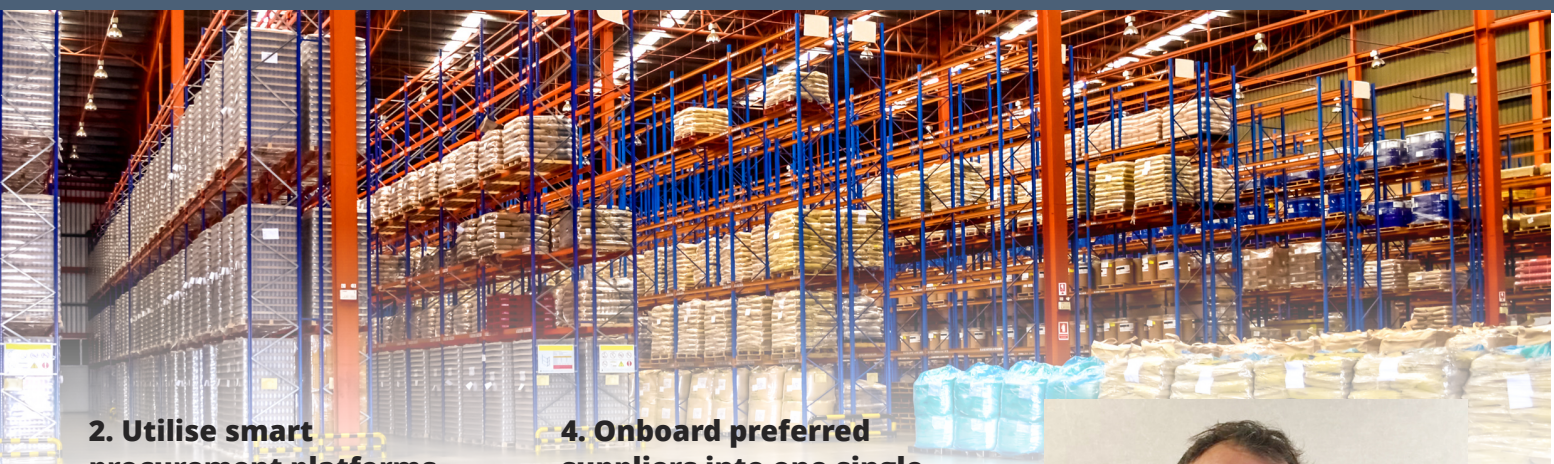
1. Partner with suppliers boasting strong warehouse and logistics capabilities

Being armed with innovative warehouse space can not only allow you to select from 100,000s of products under one roof, but also utilises state-of-the-art automation, increased delivery capabilities, and smarter packaging options – meaning sustainability is always at the forefront of the agenda.

By consolidating deliveries and scheduling orders, you can guarantee products exactly when you need them, without creating wasteful journeys and contributing towards unnecessary carbon emissions.

At OT Group, we're deeply committed to improving our sustainability and social value credentials – and our new 275,000sq ft flagship Ashton site is already helping us do just that.

With a capacity to house 18,000 pallets and over 22,000 products under one roof, state-of-the-art pick-by-light and box-cutting solutions to afford smarter operation, plus a breakthrough electric delivery fleet, we're making a valiant effort to reduce our carbon footprint in line with Government requirements to be Net Zero by 2050.



2. Utilise smart procurement platforms

With the evolution of intuitive, purpose-built eCommerce solutions, it's now easier than ever for procurement professionals to access a complete wraparound facility that connects teams with products, choice, value, and services to help businesses buy better.

While hosting extensive product ranges, smart procurement platforms can offer a clean user experience, with sophisticated search features, which allow visitors to filter products to fit their own environmental and sustainable agendas – flagging recycled products, carbon-neutral suppliers, SME brands, and Fairtrade goods.

3. Set up user restrictions

Sophisticated, user-defined approval criteria on said platforms are given with the option to notify the authoriser via an email alert for immediate sign off before a product or basket is procured.

From maximum product grabs and specific user restrictions, to product list and category refusals, authorisation rules can play a crucial role in spearheading your sustainability and social value cantered business strategy.

As well as preventing rogue spending and helping organisational leaders keep a firm hold of budgets, these functionalities can compel team members to only seek and purchase products with clear CSR elements which align with your own company's sustainability agenda.

4. Onboard preferred suppliers into one single program

Organisations of all scopes and sizes rely on external parties to deliver 'business as usual' to their customers – with lots of different cogs working simultaneously to achieve a shared goal. And, while you won't have direct control over your suppliers' operations, you can still encourage 'best practice' approaches to ensure your entire supply chain is as responsible as possible.

Urge your trusted suppliers to register on your preferred procurement portal – allowing them to promote their service to other environmentally conscious organisations, and in turn, enabling you to curb your tail spend and buy from one single source, like OT Group's SmartPad platform.

5. Measuring environmental performance

Measuring the impact of all your environmental efforts is key to the puzzle – as investors, shareholders, customers, and colleagues, will respond to performance indicators to determine if the entire initiative is a success. Look for procurement platforms that have built-in analytics which measure and track the performance with key CSR criteria in mind. Everything is designed to empower informed decision making when it matters the most.

Ultimately, people are talking about the environment and social responsibility more than ever before. The procurement process has changed and



Dave Emsley

corresponding teams looking to deliver best value to their organisation need to consider responsible sourcing in its entirety – from selecting suppliers and reviewing their supply chain, to delving into logistical processes.

Armed with OT Group's industry's leading procurement engine, SmartPad, you will have valuable access to procurement data, dynamic business intelligence, and a range of innovative functionality, so customers can continually buy greener and overcome barriers to strategic growth.

And with an extensive network of trusted industry partners, all available in one place, the benefits of supply chain consolidation really do come to the fore.

OT Group Limited
Part of Paragon Group

Dave Emsley
Head of Public Sector Tail Spend Services
OT Group Limited
Tel: 07732 602 856
dave.emsley@otgroupltd.co.uk
https://otgroupltd.co.uk/ccs/tailspend/



Social value: A better investment all round

Paul Styler, Executive Director of Infrastructure Solutions, Lexica, argues that social value can be a greater driver for investment over financial gain

It was simple in the old days. People had ideas and initiatives and needed money. Others had money and wanted to make more out of it. The marriage of investor and investee worked well in a symbiotic manner. Investment opportunities were identified and appraised; those projecting above threshold return were invested in, the underlying assets were managed, and financial returns were generated and shared back amongst the investor group.

Pension funds expanded, the economy grew, and everybody was happy. Inadequate propositions were left to wither, or were re-evaluated and re-appraised; costs cut, business models changed, assets stripped, start again. Survival of the fittest, dog eat dog and capitalism continues.

Something has changed recently

The soft and fluffy public sector doesn't work by the same rules as hard-nosed capitalists. They aren't driven by profit but by different outcomes such as better health, less carbon, more education, and better services. But over the years this change of perspective has started to rub off on the private sector. Corporate social responsibilities, the triple bottom line, the ESG agenda and public and consumer perception have meant organisations have started to look at and learn from the investment decisions and processes of others. It is not purely financially motivated. We are now finding that the once un-investable do have value and are sensible propositions.

> "Economists supporting the public sector can now compute the value of public sector interventions compared to the investments of public funds – comparing apples with apples."

Over the last decade, many in the public sector will have got used to the phrase "social value" encapsulating everything at the heart of the outcomes that the public sector is trying to achieve. The concept is supporting several public sector initiatives to allow a better understanding of what can be achieved from the respective investment of time, resources and all funds.

The public sector is seen by many as the solution to market failure. Nobody else will build a new school or hospital or waste treatment centre using taxpayers' funds on the presumption that there is no return on investment. But now, social value methodology can be applied to the outcomes of public sector decision-making processes to determine the return on the investment made - be it the annual cohort of A-grade students, a better quality of life following hospitalisation, or a cleaner environment.

"Investment decisions will always be driven by financial returns. Today, however, the global and the local pension funds along with SMEs have a methodology and currency by which they can see how they impact the world, and how changes in behaviours and decisions improve that impact."

Economists supporting the public sector can now compute the value of public sector interventions compared to the investments of public funds – comparing apples with apples. Across the sector, there are many initiatives to deploy principles to the justification and quantification of outcomes. Building a hospital, for example, is today not seen as a funding burden to the state, rather it can be demonstrated:

- How longer lives create better value for society.
- How better working environments make people happier and therefore more efficient.
- How better locations improve accessibility and, therefore, improve take-up of early intention which has lower cost and better results.
- How better infrastructure improves the environments in which it sits and supports regenerative initiatives and socio-economic improvements.

Taken together, a £1 billion price tag of a new hospital is dwarfed, but the quantification of the improvements to society across a range of themes, as well as a range of improved tax revenues back to the exchequer. Taken further, the methodology also offers a rationale for investment by one public sector body, when benefit or return is received by unrelated parties.

To give you an example, a local council may invest millions in waste recycling and the return on that investment may be captured by:

- Homeowners as house values increase due to a pleasant outlook and cleaner air.
- Reduced burden on the health system air quality-related illnesses.
- The global population as CO_2 and other related emissions add to the marginal impact towards achieving "Net-Zero."



Paul Styler

So how does this impact the private sector?

Investment decisions will always be driven by financial returns. Today, however, the global and the local pension funds along with SMEs have a methodology and currency by which they can see how they impact the world, and how changes in behaviours and decisions improve that impact.

The impact is twofold

Firstly, making more well-rounded decisions with an understanding of impact and benefits to a wider audience but still under the profit motive. It provides a rationale for employing apprentices or converting to green energy solutions or process re-engineering to employ different technologies, all of which may return no value in the short or medium term.

Secondly, as many cross-jurisdictional themes and initiatives have done so before, this methodology will eventually find a standardised way of reporting and governance standards which will raise socio-economic indicators within the shareholders' agenda and in turn may change motivations as well as behaviours of those shareholders away from pure financial gain.

Paul Styler
Executive Director of Infrastructure Solutions
Lexica
Tel: +44 (0)20 3976 3000
contactus@etl.co.uk
www.etl.co.uk
https://twitter.com/etlinsights

Training & consultancy in effective governance, risk & compliance

Michael Wuestefeld-Gray at WuDo Solutions discusses how to deliver effective governance for the public, private and charity sectors



WuDo Solutions deliver effective governance for the public, private and charity sectors. Ranging from conflicts of interests to risk management to GDPR compliance, our team of experts use their skills and experience to deliver transformative change for individuals and organisations

Our Mission and Values for effective governance

We are here to enable people, teams, and organisations to become better and achieve more through the development of core skills and systems that drive success and sustainability.

At its core, our experience is that those with effective governance and compliance systems are more likely to:

- Be agile in the face of changing conditions.
- Plan ahead more effectively.
- Work together more collaboratively.
- Avoid pitfalls.
- Build trust among stakeholders.
- Overcome challenges.

Since 2015, we have served dozens of clients and hundreds of training participants to build knowledge, skills, and resilience. Our focus is on delivering practical expertise and building resilient systems by combining our years of experience with industry best practice. Our team has been at the front line of delivering and embedding improvement in a range of industries including:

- NHS commissioners and providers.
- Social care.
- Research and innovation.
- Manufacturing and infrastructure.
- Pharmaceuticals.
- Education and Teaching.
- Transport and logistics.

Services such as risk management and information governance

We bring value through three key offers:

- working directly with clients through short to medium term project and programme delivery
- building longer-term relationships by delivering functions on behalf of clients, such as being their Data Protection Officer
- delivering training to people at all levels to give them the skills and knowledge they need to succeed.

Our core expertise is in:

- risk management
- information governance and GDPR
- freedom of information
- tacking conflicts of interests, fraud and bribery.

Our aim, whatever you ask us to do and whatever the focus, is to:

- motivate people to work more confidently and effectively
- give them a sense of optimism and positivity about achieving their goals
- make governance, risk, and compliance come to life and be seen as enablers, not barriers
- reduce costs, effort and time
- provide access and information that helps the transition from the classroom to the real world.



Case Study

We have been acting as Data Protection Officer for London Luton Airport since 2019. Over the last three years we have supported colleagues there deal with subject access requests for passengers, balance the need to maintain safety and security with their obligations under the GDPR, and ensure that data sharing with third parties is supported to achieve business goals, but also well managed and in line with the Data Protection Act. We have done this against the back-ground of Covid-19 and the huge disruption it caused to the travel industry, and the different ways people needed to work during lock-down and beyond.

Our commitment to the UN Development Goals

The team is committed to delivering the highest possible standards of delivery, with a tireless focus on your needs and outcomes. We will build a close working relationship with you to ensure things are as smooth and simple for you as possible, from start to finish. We will go the extra mile in our dedication to being the very best.

As well as this, we are proud to have signed up to support the United Nation's Development Goals, and we give a portion of our income to deliver projects in the UK and abroad.

The WuDo Community

Because building relationships and sharing the benefit of our experience are our core values, there are many ways in which you can engage with us and be part of our community.

Our website is full of information, guidance and free resources for you to use and adapt, which are constantly being updated and improved.

We also run a series of free, focused events on a range of topics to help explore and tackle significant issues.

Finally, we have a fantastic newsletter full of advice, interesting articles and exclusive offers such as discounts on courses and priority access to events.

Contact Us

To discuss your needs and how we can help, feel free to contact us at any time by:

- emailing hello@wudo.solutions
- calling +44 (0)330 221 0547
- visiting our website to make an appointment

WUDO SOLUTIONS
World Class Governance Expertise

Michael Wuestefeld-Gray
Managing Director
WuDo Solutions
Tel: +44 (0)330 221 0547
michael@wudo.solutions
www.wudo.solutions
https://twitter.com/WuDoSolutions
https://www.facebook.com/wudosolutions/
https://www.linkedin.com/company/wudo-solutions

Smarter working from a human resources perspective

Micael Johnstone, Strategy and Future of Organisations Expert and Co-Founder of Wading Herons, provides thought leadership on smarter working from a human resources perspective

The COVID-19 pandemic was the single most disruptive global event in most of our lifetimes. Its profound impacts are still being felt – many catastrophic and traumatic, but some offering the potential for lasting beneficial (and necessary) change into smarter working.

Moving from presenteeism to output

An acceleration of emerging trends in how we work is one of these. Advances in ICT have given us the tools to work in very different ways - to stay connected and productive without being physically in the same space. Prior to the global pandemic, attitudes to productivity and effective working had failed to keep pace with workplace technology.

Some more progressive organisations had already started to realise the futility (and additional cost burden) of a prescriptive "stay at your desk" approach to human resource management. The majority of managers were still wedded to the notion that presenteeism was the best means to ensure that their people were actually doing the jobs they were paying them to do.

"A recent Great Place to Work survey of 800,000 employees found stable or increased productivity after employees started working from home."

Measuring hours over output is a hangover from old "clock in clock out" industrial factory line hierarchies, where hours in and top-down centralised "clipboard" control would often equate to greater production efficiency. In an increasingly knowledge-based economy, where high-performing people – not machines – are our biggest asset, different approaches are required.

Change imperatives: Leadership from the public sector

A global lockdown and the necessity to work from home (for people that could) was the chance to test whether organisations where remote working is an option could continue to operate without their employees all being in the office. We know now that the answer to this question is a resounding "yes".

"The majority of employees prefer working from home and enjoy a better work-life balance and have no desire to go back to a daily commute."

After some initial investment in communications and remote-working solutions, leading global private sector organisations saw record profits during 2021. Civil servants continued to perform their duties, despite the significantly enhanced stress and workload associated with managing a global health crisis. Businesses and government departments benefitted from significantly reduced real-estate, energy and travel costs. A recent Great Place to Work survey of 800,000 employees found stable or increased productivity after employees started working from home.

The majority of employees prefer working from home and enjoy a better work-life balance and have no desire to go back to a daily commute. A 2021 survey by EY found that four in five people wanted flexibility where they worked, and 47% went as far as to say they would consider changing their jobs if flexible working wasn't an option.

There are generational differences – however – many young people enjoy the social aspect of going to the office more regularly and don't have the residential space to make working from home so attractive.



"Advances in ICT have given us the tools to work in very different ways - to stay connected and productive without being physically in the same space. Prior to the global pandemic, attitudes to productivity and effective working had failed to keep pace with workplace technology."

Challenges & limits to remote working

One of the primary barriers to a move away from presenteeism is an absence of trust and this works both ways. Employers who don't trust their people to work from home (despite evidence suggesting that performance and retention often improve) are likely to be resented by their employees, who may ultimately choose to leave for a more flexible place of work. Building trust between colleagues isn't easy (especially when legacy cultures didn't engender it) and managers need to invest in building stronger, more empathetic and collaborative relationships with their teams.

With less time together in one place, opportunities for collaboration and connection should be prioritised on in-office days. In-person days should be about building stronger bonds and working relationships between colleagues.

While it's still early days in what has been a massive overnight shift towards smarter working, it's clear that there is no going back to the way things were. Embracing innovation and more creative approaches to work is an opportunity to drive greater productivity and for us all to be happier human beings.

Micael Johnstone
Strategy and Future of Organisations Expert
Co-Founder
Wading Herons
info@wadingherons.com
https://wadingherons.com/
https://twitter.com/WadingHerons

What is the role of the meeting room in the post COVID pandemic workplace

Alison White of PLACEmaking asks what impact the post COVID pandemic workplace has had on the traditional office meeting room

In the world of office based work pre pandemic there were six acknowledged types of face to face interactions generally associated with the term 'having a meeting'

1. Decision making – generally senior management
2. Status updates or Town Halls
3. Progress reporting
4. Team Building
5. Problem Solving, and
6. Innovative brainstorming

Each of these activities had different purposes and desired outcomes but essentially all of them were all focused on communication. Some carefully choreographed, others more spontaneous. Large numbers of them were routine and with a predictable pattern of information gathering and message delivery. Post pandemic we're still doing all of these activities, we're just doing them differently now.

A common theme in pre pandemic staff surveys was how often people were not at all clear which of these six types of interactions applied to the event they were attending nor the purpose, why they were invited and what was expected of them.

Changing opinions on the traditional meeting room

Opinions on meeting rooms was also revealing. These spaces had not evolved since 'space planning' was



first introduced in the UK in the 1970's. Aside from decorative differences, any manager from then would recognise the same basic room layout now: a large table with chairs facing inwards. This made sense in that past when we were all physically present, listening to what we each had to say, reading papers and validating agreements and actions. There may have been a few modernising touches like a large format digital screen fixed to the wall at one end of the table but essentially the typical meeting room hasn't changed and neither has how meetings are conducted.

Yet how we work has changed dramatically. During the two years of world wide 'disruption' the take up of change has been so significant that if one of the UK government's favoured graphs showed the rate of escalation of work related change the trend line would be almost vertical. We've heard a lot from a UK minister or two about 'encouraging' people to return to the office but we've heard very little about what they'd be returning for and therefore what types of facilities they need when they actually go there.

How key are they in the post COVID pandemic workplace?

Meeting rooms have a key role in welcoming a new and different era and way of working, both as a place that hosts hybrid collaborative activities but also as a symbol to acknowledging the transition we've all experienced and how we're willing to carry on embracing new solutions. Many organisations have adopted hybrid working: encouraging remote working balanced with high value time spent

in the office. The landscape of the retained office, no matter how big or small must change to reflect this different way of working and any assumptions that the 'good old' meeting rooms can be the sole solution for all six collaboration and interactive activities is short sighted.

Surveys also highlight that whilst we might not like going to meeting or being in a typically dull meeting rooms, not having them or changing them for something different and unfamiliar seems to worry both those responsible to provide and service our office spaces as well as those of us that use them.

A quick trot through history might suggest it might be about 'aspiration', perhaps being invited to a 'meeting' suggests a step up the career ladder. Meeting rooms had a specific function in times past when business management methods were slower and more formal. Most organisations had a small number of meeting rooms exclusively used by management grades. The board room was of course, the most special of all and only used by very senior management and for very formal meetings.

Back then collecting information was generally a manual process: administrative teams processed specific performance information in paper reports that were collated and passed to senior managers manually. The only people who had full view to all of the business performance information were senior management. Their meetings were confidential, held behind closed doors where something apparently magical happened because instructions emerged and were passed down the chain of command to the shop floor to "do somethingdifferent/faster/better/etc." and then of course the same reporting process starting all over again for the next round of meetings. Therefore being invited to a meeting suggested you had something of value to contribute, you felt special.

More recently technology has been introduced in these same blueprint rooms including large format screens often added on the wall at one of the table but aside from that, rooms went largely unchanged. This changed the focus from eye contact across the table to all gazing at the screen viewing what was displayed often away from eye contact with the presenter of the information. This was regarded as 'modern' so the same blueprint was replicated across multiple meeting rooms without understanding the consequence. In place of active interaction, participation in meetings became passive often reduced to 'death by power point' presentations.

"Culturally we need to be convinced that time spent ' meeting' others will be rewarding. We want choice on how best we can contribute - in person or digitally attending." .

These same rooms, furniture and technology assets are now often the only option for meetings with many participants increasingly attending digitally. With limited investment in the physical infrastructure and preparing people for successfully hosting and participating in such hybrid 'meetings' there is a risk that what should be a new opportunity falls in to the same trap of frustrating the participants and failing to meet new challenges and expectations.

So how do we change our meeting room culture?

We need to rethink the culture and purpose of meetings. In fact let's stop calling them meetings. Let's tell people which of the six activity types we're inviting them too, what they can expect and what is expected of them. Let's provide a range of spaces with facilities and assets that they can choose to properly host the activities we want to encourage.

Culturally we need to be convinced that time spent 'meeting' others will be rewarding. We want choice on how best we can contribute - in person or digitally attending. When we do meet, we want facilities that are richer in quality and variety, inspire us to innovate, problem solve and envisage better ways to achieve shared objectives.

We want spaces that we can adapt to best meet our needs. The experience of everyone should be equal and not giving priority just to those who are physically present. We all have limited time to waste so we expect intuitively functioning technology with materials, tools and equipment on hand and fully functioning. In other words we want properly serviced solutions relevant to our now well established change in ways of working.

PLACE making .co.uk

Alison White
Founder & Director
White Workplace Consultancy Limited
(Trading as PLACEmaking)
Tel: +44 (0)776 808 1242
awhite@placemaking.co.uk
www.placemaking.co.uk

Major winners & losers through the UK Shared Prosperity Fund

Nigel Wilcock, Executive Director of the Institute of Economic Development, provides analysis on the UK Shared Prosperity Fund, arguing that "the landscape is most definitely being tidied up after years of confusing approaches"



The £2.6 billion UK Shared Prosperity Fund (UKSPF), the long-awaited replacement for European Structural Investment Funds which is billed as one of two pillars of the UK government's Levelling Up plans and provides new funding for local investment between 2022 and 2025, was finally launched on 13th April.

Under UKSPF, places are being empowered to identify and build on their own strengths and needs at a local level. The fund itself is focused on building pride in place and increasing life chances, and it will be delivered through three investment priorities: communities and place, local businesses, and people and skills. All areas of the UK will receive an allocation from the fund via a formula rather than a competition, which is welcome, however the focus on population will mean that some areas lose large allocations of funding – whilst some areas will receive funding of this type for the first time.

Funding allocations are badged as the same as what was previously spent although programme durations have prevented this being validated fully. Local areas across England will see £1.58 billion, Scotland £212 million, Wales £585 million and Northern Ireland £127 million made available. Activity will be planned and delivered by councils in England, Scotland and Wales, working closely with local partners. In Northern Ireland, it is different, and the UK government will work with partners to develop and deliver the fund. The allocations in England underscore the pre-eminence that the government is now placing on local authorities in economic development funding ahead of LEPs.

"All areas of the UK will receive an allocation from the fund via a formula rather than a competition, which is welcome, however the focus on population will mean that some areas lose large allocations of funding – whilst some areas will receive funding of this type for the first time."

Transport, regeneration and town centre investment, and culture

UKSPF is provided to a large extent against revenue requirements – and as such can be seen as 'core funding' for local economic development activity – but sits alongside other funding. Those other streams are the £4.8 million UK-wide Levelling Up Fund, generally

focused on capital projects, with fierce competition for funding based on applicants submitting detailed Green Book-based business cases often involving significant effort and expense. These projects are intended specifically for transport, regeneration and town centre investment, and culture. In addition bespoke City Deal/devolution agreements based on specific asks and promises will be extended from Mayoral Combined Authorities into new and different tiers of devolution with clear rules in place for each layer.

My general observation is that all funding bids should highlight data, need, strategic alignment, delivery and evaluation – and crucially remain faithful to the principles of Levelling Up:

- Boost productivity, pay, jobs and living standards by growing the private sector, especially in those places where they are lagging.
- Spread opportunities and improve public services, especially in those places where they are weakest.
- Restore a sense of community, local pride and belonging, especially in those places where they have been lost.
- Empower local leaders and communities, especially in those places lacking local agency.

Funding bids should also consider the '5 capitals' which is a golden thread of the Levelling Up White Paper, published in February. A further observation which is worth all applicants considering is that government requires certainty that all the applicants with whom it contracts must be able to deliver the project – applicants have focused huge effort on describing the strategic worth of a project but too often the delivery aspects rely on a wing and a prayer.

Levelling Up as a long-term strategy

Overall, the landscape is being tidied up after many years of confusing approaches – with a multitude of funding regimes since 2011 – and arguably no strategy. The White Paper is intended as a long-term direction of travel and additional policies can be inserted into interventions, but UKSPF is likely to fund significant levels of 'day-to-day' economic development activity.

Levelling Up itself is either a brilliant concept to rally around or more rhetoric around a loose concept that can never be achieved. Whilst it is nonsense to suggest that after a few policy measures the UK will be 'levelled



Nigel Wilcock

up' in one of the developed world's most centralised developed economies, we should commend an agenda that recognises left-behind communities. The issue of spatial inequality, economic under-performance and the need for Levelling Up is broadly clear. Whilst it is recognised that political change is inevitable over the long term, it is hoped that principles of the White Paper are enshrined in future policy thinking – and the White Paper is a serious attempt to understand the underlying issues that have resulted in the spatial inequalities of the country.

Improved transparency and coordination

Driven by a Levelling Up Cabinet Committee, Levelling Up Directors and procurement with an emphasis on outcomes, values and transparency, we are seeing a re-shaping of central government decision-making. In particular, through improved transparency about place-based spending, hardwiring spatial considerations into decision-making and evaluation, improved coordination of central government policies at the local level, and greater focus on local places.

There is no doubt that the approach is place-based, and UKPSF (and other funding streams) provide some certainty for the next two or three years.

Nigel Wilcock
Executive Director
Institute of Economic Development (IED)
Tel: +44 (0)1925 730 484
admin@ied.co.uk
http://ied.co.uk/
https://twitter.com/theied

ATTRACT as a funding experiment for innovation: the final part

Sergio Bertolucci, Chair of the ATTRACT R&D&I Committee, discusses his final remarks on the ATTRACT funding for innovation

After the successful completion of Phase 1, where 170 promising projects have been each awarded €100K to develop a proof-of-concept in 12 months, an open thematic call was launched in mid 2021 (Phase 2) to take forward the most promising opportunities generated in Phase 1 across 9 themes, with a total funding of €25M. In the ATTRACT philosophy of a staged management of risk, Phase 1 was essentially dealing with risk absorption, while Phase 2 is meant to provide a tool for risk mitigation, in consideration of the higher Technical Readiness Level (TRL) expressed by the projects *(see figure below)*.

In order to further improve the process, the call had two submission modalities

Modality A: Demonstrator (up to 500,000 Euros) (h4)
Proposals in this modality, at a TRL of 3 or higher at submission time, should prove to be capable of reaching at the end of the project a TRL of 5 or 6, understood as:

- TRL 5 – technology module validated in relevant scientific and industrial environment(s).
- TRL 6 – technology module demonstrated in relevant scientific and industrial environment(s).

Modality B: Industrial System (up to 2,000,000 Euros)
Proposals in this modality, at a TRL of 3 or higher at submission time, should prove to be capable of reaching at the end of the project a TRL of 7 to 9, understood as:

- TRL 7 – system prototype demonstration in a real case operational environment.
- TRL 8 – system complete and scientifically and industrially qualified.
- TRL 9 – actual system proven in operational environment.

Applicants to the Modality B are required to describe their foreseen



pathway to market, the resources dedicated to this goal, which must be complementary to the funding received from ATTRACT, as well as the estimated timeline.

Eighteen projects (out of 68 submitted) have been funded, 7 in modality A, 11 in modality B. We have observed a large confluence among the 170 projects of Phase 1 as well as the influx of external industrial partners in most of the proposals.

All the projects have signed their Third-Party Project Agreement with the EU Commission and have already started their 26-month endeavour, as testified by the recent kick-off meeting on May 31.

Testing the vision of ATTRACT innovation

As in the case of Phase 1, which provided a great quantity of invaluable data and insight to test our assumptions, we expect to learn a lot from the evolution and the outcome of Phase 2, which eventually will be the culminating experimental test of the ATTRACT vision.

In the previous articles I have also addressed the potential integration of ATTRACT into the EIC Pathfinder in terms of the governing structure, funding dynamics and potential entry points for private investment. The main conclusions are as following:

- The integration of the ATTRACT governing structure into the EIC as a running funding instrument would not require drastic changes with respect to the current framework.
- The phase-based funding approach of ATTRACT could enhance the quality of the projects funded within the EIC with respect to their breakthrough innovation potential.
- This phase-based funding approach could offer an incentive for investors in the EIC Accelerator, since during ATTRACT Phases 1 and 2 the inherent risk of breakthrough technologies or deep tech is absorbed and mitigated using public funding.
- ATTRACT has the potential for enabling a diversity of entry points for private investment within and outside the EIC Accelerator. Moreover, it can connect the R&D&I agendas with national funding programmes or existing schemes such as EUREKA and Eurostars.

I have also briefly addressed the possibility of translating the ATTRACT funding approach on a national level, to be then implemented through national funding agencies. The main conclusions of these exploratory considerations are the following:

- The deployment of a funding instrument like ATTRACT would not require drastic changes in its governing structure and it could be integrated into existing National funding agencies structures.
- Its deployment could represent a hands-on opportunity for aligning R&D&I agendas between the EC and the National funding programmes, as well as the possibility for providing funding opportunities for excellent projects that otherwise would not be realized.
- It could enable the strengthening of existing national and regional specialized technology clusters and channeling of private investments.
- It could enable to retain young talent at regional level that otherwise would look for developing opportunities somewhere else.
- It could prove being an instrument supporting existing EC initiatives for closing the innovation divide across European Member States.

Finally, in the name of all the members of the ATTRACT Consortium, I would like to thank the support received from the European Commission for the funding of ATTRACT Phase 1 and Phase 2 and for its strong support during the execution of the project.

I would also like to thank the ATTRACT community and in particular Markus Nordberg, Pablo Garcia Tello, Jonathan Wareham for having provided invaluable insight and a lot of material.

ATTRACT has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 777222.

Sergio Bertolucci
Professor
Chair of the ATTRACT R&D&I Committee (IC)
Tel: +39 348 818 4395
Sergio.Bertolucci@cern.ch

From basic research to private innovation

What's the return on basic research spending? What can policy makers do to make basic research more valuable, beyond simply spending more taxpayer money? And what role will private innovation have?



Science generates new ideas. Ingenious firms exploit them to create new products and services. Examples are the new drugs to overcome the COVID crisis, new solutions to stop climate change, and the digital revolution.

Basic and Applied Research

Basic research generates new ideas with yet unknown applications. The results of basic research can be used by all without 'using them up'. Basic knowledge with yet unknown and diverse applications is also hardly patentable. For these reasons, basic research is a truly public good and a classic responsibility of government which can use tax-payer money to finance it.

True, some very large corporations engage in basic research as well. These are firms with hundreds of products and services. They can make use of the unspecific and unpredictable outcome of basic research. If not useful in one area, they can use the results elsewhere or set up entirely new product lines. Large corporations are also those who are most intensively cooperating with universities, thereby contributing third party funding. Yet, for the bulk of the private sector, own basic research is not profitable. They focus on industrial R&D with very specific applications, quality improvements and new products.

University-industry collaboration typically rests on applied research. Applied research is closer to specific applications and can help firms to develop quality improvements or entirely new products and services. Firms are willing to pay for inputs to their own R&D investments. They pay for patents and consulting services, and financially contribute to applied university research to get better access to new solutions. Altogether, third-party funding may become an important source of revenues to relax tight university budgets.

Incentives to push innovation

The distinction between basic and applied research can be fuzzy. In fact, many researchers pursue both basic and applied projects. In addition, a core mission of universities is teaching. Teaching absorbs time and effort of professors which subtracts from research time. Complementarities can relax the trade-off. Teaching in PhD programmes promises competent help by doctoral students in doing experiments, collecting data, and providing other tasks. The same holds for applied research. Students value the private sector relevance of teaching which helps their prospects with reputed employers. Firms obviously value skills that are close to their needs.

Time is limited and financial resources are scarce. Universities must thus strike a balance between basic research, applied research and teaching. To resolve this trade-off, they tend to specialise. Some universities are truly research-intensive with few students and little 'distraction' from consulting. Others are mainly engaged in high quality teaching, accepting lower rankings in academic research. The contribution of third-party funding varies across universities.

Universities respond to incentives created by funding rules, and by market prices such as student fees, patent prices and consulting fees for private sector cooperation. Budget rules can be linked to success in academic research such as publication frequency in top tier scientific journals, and quality and number of citations. They may be sensitive to student numbers and existence of third-party funding. Funding of basic research is subject to tight competition for research grants by national science funds or the Horizon Europe programme.

Intrinsic motivation through recognition and reputation are important. However, much like private firms respond to prices and profitability, universities and their professors respond to financial incentives. Incentives can be powerful. For example, Norway enacted in 2003 a reform that shifted two thirds of the ownership rights from patents and other third-party funding to universities, whereas professors had full rights before the reform. Hvide and Jones (2018) found that entrepreneurship and patenting rates declined by about 50% thereafter. Letting university researchers participate in their inventions affects the knowledge flow to the private sector.

A multiplier of private innovation

What is the role of universities in promoting private innovation? Basic research is still far away from commercial applications and might get stuck in the 'ivory tower'. It doesn't automatically become useful in private R&D. Applied university researchers can serve as 'intermediaries' between basic researchers and private sector firms. University patenting, research cooperation with industry, consulting, and academic entrepreneurship leading to spin-offs are examples. Universities can offer valuable inputs to industry R&D, depending on how they share revenues from patenting and third-party funding with their researchers.

Another channel is teaching. The success of industrial R&D rests on hiring research personnel endowed with state-of-the-art methods and know-how at the frontier of research. Private R&D is the most skill intensive activity in the economy and benefits the most when universities supply more high-skilled labour. Implementing new technology by setting up production of entirely new products and services is similarly skill intensive. Much of the knowledge transfer from universities to the private sector is embodied in well trained graduates. Altogether, universities need to strike a balance between basic research, applied research and high-quality teaching.

Policy

The social return on basic research and innovation is certainly larger than the private market return. However, the value of university funding is endogenous and can be increased by good policies: install a good incentive structure that leads to the right balance in basic and applied research and advanced teaching; facilitate the knowledge transfer to the private economy to make academic research productive for society; make sure that new ideas get financing from venture capital, private equity, and banks; and implement an efficient bankruptcy law and other policies that help labour and capital to flow more easily to the most rewarding uses. Beyond spending more money, governments can do a lot to make university funding even more profitable for society.

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Christian Keuschnigg is Professor of Economics at the University of St. Gallen and Director of the Economic Policy Competence Center WPZ (www.wpz-fgn.com).

University of St.Gallen

Christian Keuschnigg
Professor
University of St. Gallen
Tel: +41 71 224 3085
Christian.Keuschnigg@unisg.ch
www.fgn.unisg.ch/keuschnigg,



Disaster victim identification, training & human rights of the dead

Prof Emilio Nuzzolese from University of Turin sheds light on disaster victim identification, training and the human rights of the dead

Forensic experts involved in human identification collect information from police and families of the missing, compare them with the identifying features and the data collected during the autopsy, and successfully restore the identity of a dead person. Forensic pathologists, odontologists, anthropologists, biologists and fingerprints technicians are involved in the identification process of human remains where visual recognition is not possible or not appropriate.

What is Disaster Victim Identification (DVI)?

For the families of the missing, returning an identity to unidentified human remains is a crucial part of the process of grieving. A human being is a person, either alive or dead, but without an identity, a person has no rights. The work done by forensic experts, while performing a human identification, is also aimed at restoring the human rights of the dead and a whole dignified management of procedures throughout.

One of the activities of the human identification process is **Disaster Victim Identification** (DVI), which is a more complex and often international operation. DVI specialists collect dental data, dental radiographs, DNA, fingerprints and record other identifying features (tattoos, scars, jewellery, personal belongings, clothing). An identification cannot avoid the postmortem collection and analysis of dental data for the preliminary reconstruction of the biological profile of the cadaver.

"A key for best practice in the management of the dead is training and planning, before a disaster occurs, to be ready with DVI specialists and logistic resources."

The DVI process requires and the collection of information from families and next of kin of the victims. These are medical and dental records, as well as old radiographs, portrait pictures and selfies showing teeth. Data collected is then compared with



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the postmortem data in order and, through a reconciliation process, the victim's identity is achieved.

Training and planning before a disaster happens

Countries have set up DVI teams to perform the human identification process applying best standards and allow international cooperation. Mass disasters very often involve multinational casualties and fatalities, and international cooperation is pivotal to achieve positive results, as the postmortem data collection from the victims is only on the stages of the process and the antemortem data must be obtained from the country of origin of the victim.

A key for best practice in the management of the dead is training and planning before a disaster occurs, to be ready with DVI specialists and logistic resources. Training must develop knowledge and skills in the management of the technical and forensic activities related to Disaster Victim Identification following mass disasters, major accidents or terrorist attack.

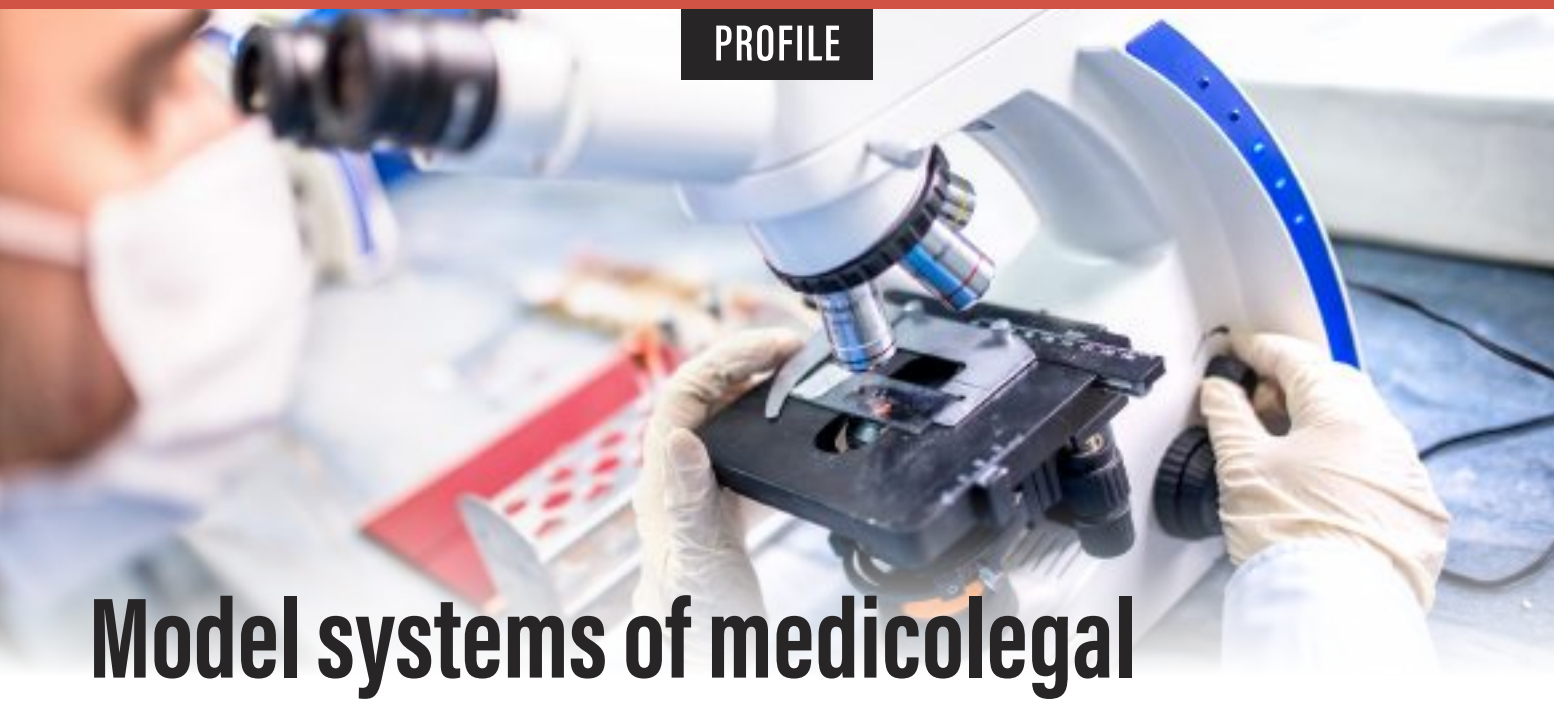
Knowledge and competences in forensic sciences are the starting point, but DVI training goes further. The recovery, collection recording and analysis of postmortem data protocols must be applied, and the forms suggested by Interpol (and NATO) used.

DVI training goes further than forensic sciences

The international scenario of mass disasters requires standards and operational procedures which allow experts from various countries to work effectively, independently from their nationality and spoken languages. DVI teams within police agencies have usually periodical training, sometimes open to consultants, as forensic odontologists. Some universities and forensic organisations offer also specific training in DVI. But one should never forget the identification after a disaster is always a police investigation, with some rare exceptions.

Among international agencies and resources available in this field are groups of international experts, like the one created in Lyon, France, in 2015, named *Forensic Odontology for Human Rights,* which became in 2019 a volunteering association (AFHOR) of all those experts interested or involved in best practice in human identification and age estimation. Today AFOHR has a network of over 100 experts from almost 30 nationalities.

Prof Emilio Nuzzolese, DDS, LLB, MSc, PhD
Forensic Odontologist, Associate Professor of Forensic Medicine,
Head of Human Identification and Forensic Odontology Laboratory
Department of Public Health and Pediatric Sciences, University of Turin
Tel. +39 011 670 5919
emilio.nuzzolese@unito.it
enuzzolese@cittadellasalute.to.it
www.dsspp.unito.it/do/docenti.pl/Alias?emilio.nuzzolese#tab-profilo
https://twitter.com/emilionuzzolese



Model systems of medicolegal death investigation

Chief Medical Examiner Victor W. Weedn, MD, JD, highlights the ways in which medicolegal death investigation (MDI) systems vary widely in the U.S. and the world

Medicolegal death investigation (MDI) systems vary widely in the U.S. and the world. They can generally be categorised as police, coroner, medical examiner, or mixed systems.

Police homicide investigations

Where the police conduct all death investigations, they consult forensic pathologists of their choosing. Such investigations are limited to known violent and suspicious deaths and do not include other cases that might be investigated in the public interest, such as deaths from industrial accidents. A conflict of interest occurs when the police are themselves involved in the death.

Coronial systems and certifying deaths

Coroner systems are usually headed by civilian officials. They act as magistrates who certify deaths as pronouncements on behalf of the communities they serve. Unlike police systems, they are not limited to violent and suspicious deaths, and they do not face the conflict-of-interest concerns of police systems.

Most coroners in the U.S. are elected, although in some states they are appointed. The work of the office should not be political; it should be apolitical. Elected officials are most often not MDI professionals and MDI professionals are not usually skilled politicians. A national search for the best person for the job is not possible when the position is elected. Often coroner positions are filled by individuals who aspire to higher political office rather than those who view it as their career profession and dedicate themselves to it.

Significant qualifications generally cannot be required for elected positions, merely that they be of age, without a felony conviction, and residing in the jurisdiction of the position sought. In the U.K., such officials are required to have a background in medicine and/or law, but in the U.S. there are no such requirements. In most coroner jurisdictions, no on-the-job training is required. A few states require their coroners to be physicians – any physicians, not specifically forensic pathologists. Regardless, two weeks of training is simply insufficient for the job. Training is generally a perpetual need as new coroners are elected with each election cycle.

Since most coroners are not physicians, they cannot perform autopsies and thus essentially serve as investigators. They determine which cases to send to a forensic pathologist. Coroners, despite being non-medical, have the responsibility to sign death certificates and thus must interpret the forensic pathologist's autopsy report to fulfil this duty. Coroners are the exception to the need for a physician to complete death certificates; attending physicians and medical examiners complete all other death certificates.

A legacy of their historical roots, all coroner systems are county-based. Most counties in the U.S. are rural counties of less than 100,000 population and cannot well support their own independent system. Adequacy of funding is the most important determinant of quality and requires an adequate population base. Large populous jurisdictions benefit from economies of scale. Some jurisdictions are wealthy enough to support a good system despite a small population base. Even if a city can support its own system, the surrounding counties may not be able to support their own system. Therefore, regional or, better yet, state systems are preferable.

"Forensic pathologists, serving as medical examiners, should oversee medicolegal death investigators, issue reports, and certify the cause and manner of death."

Medical examiner systems and overseeing medicolegal death

Medical examiner systems are headed by a forensic pathologist. Forensic pathology is the subspecialty of anatomic pathology devoted to death investigation and addressing questions in court. Forensic pathologists have had to graduate from medical school and pathology residency before undergoing specialised training in forensic pathology in a medical examiner's office, which includes performing hundreds of autopsies, examining piles of microscopic slides of tissues, and interpreting many toxicology reports, before being allowed to sit for the forensic pathology board certification examination.

Forensic pathologists, serving as medical examiners, should oversee medicolegal death investigators, issue reports, and certify the cause and manner of death. In a few states in the U.S., a state medical examiner office has been established to perform the autopsies for local county coroners. In these jurisdictions, the forensic pathologists do not oversee the investigators, nor do they certify the cause and manner of death-on-death certificates. The forensic pathologist may request further investigation and may suggest a cause and manner of death, but the forensic pathologist is fundamentally dislinked from and at the mercy of the information provided by local investigators and does not have final say over the death certifications.



The National Academy of Sciences has recommended replacement of coroner offices by medical examiner systems in 1928, 1932, 2003, and 2009, but the pace of such replacement has slowed to a near standstill.

Situs, where the office sits, is important functionally as well as for perception. In the U.S., medical examiner offices can be independent or under criminal justice, public health, homeland security, or a state university. Most offices are independent, but a large number are under departments of public health. When subservient to another entity, prioritisation falls under the priorities of the parent agency, although when independent their voice is often weak. When under the police or prosecutors, the office may be seen as an extension of their function and susceptible to bias. Regardless, the office must have the ability to assert jurisdiction and independent authority to investigate the falling under its jurisdiction without the approval of prosecutors.

Medicolegal death investigation offices, as investigatory agencies, must have the legal authority to investigate. Jurisdiction of the office should be defined. Offices need the power to enter a premises to collect and transport bodies; sometimes evidence is collected. They need the ability to talk to next-of-kin and other witnesses. They need access to police reports, medical records, and emergency medical services run sheets. They should have subpoena power, but often don't. They need the authority to conduct an autopsy, even over the objection of a family member. This authority should include the ability to collect, examine, test, retain, and dispose of tissues and organs.

Today, a modern medical examiner office should be accredited and be staffed with board-certified forensic pathologists and ABMDI-registered medicolegal death investigators. Furthermore, it should be supported by strong statutory authority.

Victor W. Weedn, MD, JD
Former Chief Medical Examiner of the
Maryland Office of the Chief Medical Examiner
Tel: +1 412 600 4211
vweedn@gwu.edu

Learning the lessons of resilience for smart & sustainable mobility

Henrik Hololei, DG MOVE Director-General at the European Commission, outlines the importance of learning the lessons of resilience for smart & sustainable mobility

In order to make our transport and mobility system fit for future we need to increase efficiency, capacity, cut emissions and make sure it is a smart and sustainable system that can integrate all transport modes in multimodal way. It is a pre-condition for modern and sustainable European transport and mobility.

At the same time it is equally essential to build more resilience into our transport system – resilience to deal with unexpected shocks what we have experienced by the COVID-19 pandemic, and then by Russia's illegal and unprovoked aggression of Ukraine. In times of crises, a concerted, proportional and a timely response at EU level is necessary.

Sustainable mobility is already in motion

The good news is that our ongoing work to make transport more sustainable and smarter is already reinforcing resilience in many ways. Digitalisation increases efficiency and flexibility, which is invaluable when dealing for example with fluctuating demand. The lessons learned over the last two years are now helping us to reinforce resilience in preparation for the next crisis, whenever it comes, and whatever form it takes.

That is why our Sustainable and Smart Mobility Strategy was very timely and important. The success of this strategy depends on a solid and well-functioning Single Market, where competition is the norm and bottlenecks, missing links and unsubstantiated barriers are removed. It is also essential that the EU and its Member States must do their utmost to continue to preserve the integrity and enhance the functioning of the Single European Transport Area.

The three objectives of the Sustainable and Smart Mobility Strategy

The Strategy has three key objectives: making transport sustainable, smart and resilient. The last objective, resilience could not be more relevant in the context of the ongoing Russian aggression in Ukraine.

In making our transport system more resilient we have a variety of policy instruments at our disposal at EU, national and local level. These range from research funding to technical standards to EU Directives to investment support. We need to "pull all levers" in order to make the transformation happen.

Making transport more sustainable lies on three pillars. First, we need to make all transport modes more sustainable, secondly, make sustainable alternatives widely available in a multimodal transport system and lastly, put in place the right incentives to drive the transition. Let me be clear – our intention is to reduce emissions not mobility. Greening mobility must be the new licence for the transport sector to grow.

Last year has also been very intense for us, with tabling two major policy packages that drive further sustainable and smart mobility in the EU. The Fit for 55 policy package of July 2021 is a significant package with a dozen policy initiatives. As part of it, the Commission proposes an ambitious revision of the CO_2 standards for cars and vans so that by 2035, emissions from all new cars and vans have to be reduced by 100% compared to the requirements in 2021. There is also a review of the CO_2 standards for heavy-duty vehicles foreseen for 2022.



Henrik Hololei, DG MOVE Director-General European Commission

This is complemented by our proposal for the Alternative Fuels Infrastructure. Where we proposed a set of binding targets for Member States to ensure that sufficient publicly accessible infrastructure is in place for zero-emission vehicle uptake. Such a push for vehicles and infrastructure is flanked by measures to address user behaviour and incentivise the uptake of such vehicles.

In December last year, we published another major transport policy package, including the proposal for the revision of the TEN-T guidelines and for the revision of the ITS Directive.

Smart mobility is today a key buzzword, and rightly so. We need to take full advantage of the smart digital solutions and intelligent transport systems and make connected and automated multi-modality a reality. Cooperative and automated systems have enormous potential to fundamentally improve the functioning of the whole transport system and contribute to our sustainability and safety goals.

Data will pave the way to implementation of strategies

But the key to get there is access to data. Therefore, we have proposed a revision of the ITS Directive to increase the deployment and operational use of Intelligent Transport System Services and to create better conditions for the collection and use of critical data.

This year we intend to modernise the legal framework supporting multimodal travel information, booking and ticketing services. This should give us new possibilities for selling ticketing or mobility services, as well as enabling smart and interoperable payment services.

Our intention is to make transport and mobility smarter and more digitalised. One action is the finalisation of the implementing framework on electronic freight transport information, with the aim to have paperless freight transport by 2030. I would also like to see more progress on updating the Single European Sky, which has real potential to reduce CO_2 emissions from aviation, but has been stuck in inter-institutional negotiations for too long and turn it into a genuine Digital European Sky.

In ensuring consistency between all these different strands of action and the broader Commission initiatives in this area, Commission has put forward the idea of a common European mobility data space. This should facilitate access, pooling and sharing of data from existing and future transport and mobility databases.

In two and a half years, we have delivered many key actions listed in our Strategy. Nevertheless, we do not intend to rest on laurels and slow down as there is plenty more to achieve. We will be working hard and in close collaboration with our stakeholders to achieve all the goals of the Strategy and to make sure that European transport and mobility system is fit for future, sustainable and smart.

Henrik Hololei
DG MOVE Director-General
European Commission
Tel: +32 2 299 11 11
move-infos@ec.europa.eu
https://ec.europa.eu/info/departments/mobility-and-transport_en
https://twitter.com/Transport_EU

The background scenario for Autonomous Shipping

Marco Molica Colella, project coordinator for AUTOSHIP, discusses the EU's role in autonomous shipping and changing of transport emissions globally

With less than 100,000 vessels worldwide, shipping represents the highest percentage of world trade (80-90% according to different sources). The coarse numbers include ca. 10% of transport emissions as well as up to 4.9% of global emissions, increasing in 2021.

But CO_2 is not the only drawback. Shipping is, in fact, co-responsible of ocean acidification and emissions of air pollutants like sulphur dioxide, which can travel long distances.

Socially speaking, the labour conditions are also changing as well as challenging: the number of seafarers quitting the industry is reported to increase every year due to safety, unsettled life and hard work. They usually give up, picking up jobs on the shore.

Keeping the EU technology leadership in autonomous shipping

With this challenging background defined, shipping is however a key sector and a cheap means of transport, to potentially support the modal shift targets to decongestion EU roads. Indeed, maritime transport has a higher energy-efficiency than others and is, in general, less harmful to the environment[1].

To this purpose, since 2001, the concept of a Motorway of the Sea (MoS)[2] has been developed. At its base, there is a new intermodal maritime-based logistics chain in Europe and EU target is to shift 30% of road freight of more than 300 km to multimodal solutions by 2030 (corresponding to 216 bn tonne-kilometres), and more than 50% by 2050, compared with business-as-usual developments[3]. How- ever, its capacity in this scenario is not keeping the pace yet, and it needs improvement since it is still losing competitiveness with respect to trucks in terms of costs and reliability.

In this context, autonomy – provided at different levels and degrees - is not the final goal, but an enabler to improve the sector with better work conditions, more safety, reliability, resilience, and business opportunities. It is not only a matter of ships, though. Highly automated and autonomous ships and ports are both expected to address the challenges of efficiency, environment, safety, and economy.

The whole logistics is involved, and it is not a surprise that latest EU announcement of autonomous shipping services are promoted by cargo owners (YARA and ASKO). Keeping the EU technology leadership is key to be at the center of this change.

Launching next generation of autonomous shipping across Europe

Although Asia has dominated the shipbuilding industry for several decades due to lower-cost manufacturing, Europe has maintained a leading market share in specialized, high-quality vessels and is effectively supporting new paradigms of multimodal transport to develop sustainable businesses and relieve roads congestion and related pollution.

Supported by the industrial and technological expertise of leading European maritime companies, the EU-funded project AUTOSHIP - Autonomous Shipping Initiative for European Waters aims at speeding-up the transition towards a next generation of autonomous ships in EU by developing and operating two self-navigating ships, demonstrating their operative capabilities in Short Sea Shipping and Inland Water Ways scenarios.

The two use cases developed by AUTOSHIP will optimize efforts and investments in order to advance common standards and enabling operations in a shorter timeframe than expected, and this will also help ship operators and owners to improve the economy of scale of their invest-





ments, to effectively gain competitiveness and renew their fleets, making them more competitive to replace road transport.

The project coordinator: CiaoTech (PNO Group)

https://www.pnoconsultants.com/

CIAOTECH S.r.l., a wholly owned company of the PNO Group, is Europe's largest independent public funding and innovation consultancy with more than 30 years of hands-on expertise with more than 500 funding programmes in most EU countries, annually raising approximately 1 billion Euro for its clients. PNO provides support services to private and public organizations in fostering connections and stimulating, realizing and financing innovation in an ever faster and more complex innovation landscape – changing the world for the better.

In the frame of AUTOSHIP, PNO acts like a professional project management company, coordinating the activities, and it is also the partner leader of the Dissemination, Communication and Exploitation management tasks: the dedicated R&D Advisory team is involved in the development of the Stakeholder and Market analyses, in the first Cost-Benefit-Analysis for autonomous vessels use cases and in the definition of the exploitation plans and to facilitate a successful dissemination and transfer of the project results.

About the Authors

Marco Molica Colella (PhD) is a mechanical Engineer with Innovation and Financial Education. He is Team Manager in PNO for the R&D Advisory Services, as Head of the Innovation Analysts unit. He is the AUTOSHIP project coordinator and has developed a strong knowledge of the maritime innovation landscape.

Manuela Guiducci is Communication Consultant in PNO Group and supports AUTOSHIP D&C Strategy.

1. COM (2004) 453 final. The energy consumption per km/ton of transported goods on inland waterways is approximately 17% of that of road transport and 50 % of rail transport.
2. Transport White Paper- European transport policy for 2010
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PNO CiaoTech

CONNECTING AMBITIONS

AUTOSHIP

Autonomous Shipping Initiative for European Waters

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 815012.

Marco Molica Colella
Senior Innovation Consultant
CiaoTech (PNO Group)
Tel: +39 06 33 268 972
M.MolicaColella@ciaotech.com
https://www.pnoconsultants.com/it/
https://www.linkedin.com/in/marco-molica-colella-a3548239

The Brenner Motorway looks to the future in attempt to reduce environmental pressures



Carlo Costa, General Technical Manager explores what the future has in store for Autostrada del Brennero SpA and their environmental focus.

Sixty-three years after it was founded, Autostrada del Brennero SpA remains a joint-stock company with a predominantly public shareholding. Specifically, the 16 founding local authorities hold 84.75% of the shares. This strong public coordination, which ensures management choices in line with the collective interest, is flanked by a private shareholding (14.16%), which in turn guarantees an approach to efficiency typical of the private market.

The results of this particular governance model over almost 50 years of operation are tangible and measurable. With only two lanes in each direction and a total length of 314 km, the A22 guarantees more than 5 billion km travelled per year. In spite of the large volume of traffic, it has an overall accident rate of 16.99, compared to a national average of 28. Despite supporting high traffic volumes, the artery appears to be perfectly maintained and even the most recent inspections have revealed excellent care of the infrastructure. The absence of maintenance delays has enabled the Company to anticipate certain decisions that have become topical in terms of the digitalisation of road transport and the ecological transition.

Digitalisation and ensuring connected driving

As part of the European C-Roads Italy project, the Brenner Motorway has developed a message transmission protocol that - through a C-ITS server, the 63 Road Side Units (RSUs) and the virtual RSU implemented for short-range and long-range connectivity - is already able to communicate with connected and autonomous vehicles. This is the first significant step towards a digital connection between the infrastructure and the vehicles travelling on it, aimed at developing Cooperative Intelligent Transport Systems (C-ITS) that are increasingly functional for autonomous and connected driving.

Ecological Transition for a greener future

In terms of ecological transition, in 2014 Autostrada del Brennero Spa added to the widespread distribution of electric vehicle recharging stations offered free of charge to users the first and still the only green hydrogen production and distribution centre in Italy. Thanks to this experimental centre, more than 3 million kilometres have already been travelled emitting only water steam. The Board of Directors has also approved the construction of five more green hydrogen refuelling points along the motorway. In this context, the BrennerLec project deserves a mention: years of experimentation on the correlation between vehicle speed and atmospheric pollution have made it possible to develop an algorithm that, by cross-referencing air quality, weather and traffic data, is able to indicate the ideal speed to reduce travel time, polluting emissions and environmental pressures.

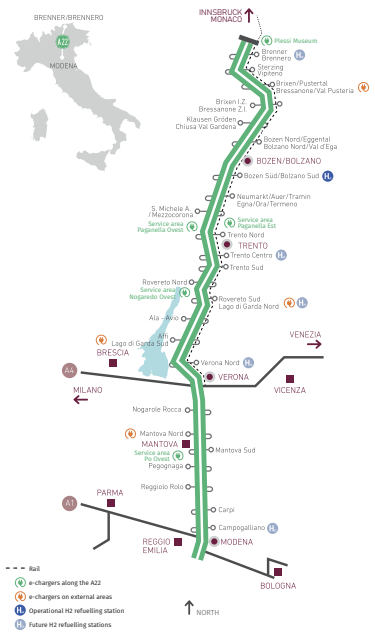
Intermodality and environmental pressures

Moreover, concern over the environmental impact of the artery on local communities in a scenario of constantly increasing traffic led the company, as early as the late 1990s, to invest in the railway. Today, the three railway companies that belong to Autostrada del Brennero Spa (Rail Traction Company Spa, InRail Spa and Lokomotion Gmbh) cover a significant share of national and cross-border freight traffic. In particular, the recent acquisition of majority shares in InRail Spa was also decided with the aim of structuring the Group's railway sector in view of the future opening of the Brenner rail tunnel and a progressive shift of freight traffic from road to rail, one of the pillars of the Green Corridor project.

Towards the Green Corridor

The Brenner Motorway has been concerned for more than twenty years to adopt policies that offer a prospect of environmental sustainability for the territories crossed by Italy's first overland link with the rest of Europe. For more than ten years, it has been committed to the decarbonisation of transport along this strategic axis with the aim of turning it into Europe's first Green Corridor.

Net of the uncertainties caused first by the pandemic and then by the conflict in Ukraine, the contextual conditions all seem to be pointing towards a sudden evolution of the mobility models known to date. On the one hand, the demise of the endothermic engine, progressively replaced by zero-emission electric propulsion systems, promises to radically change the very perception of the road as a source of pollution. On the other, the development of self-driving vehicles makes it possible to



Click to enlarge

plan and no longer just imagine a near future in which journeys can be made more quickly, land consumption for widening existing roads drastically reduced and the human factor, currently the main cause of accidents and deaths on the roads, potentially eliminated. These technical factors are compounded by political, financial and cultural factors.

The growing awareness of the risks of global warming is creating the conditions for a positive contribution by public opinion to the development of new mobility models. The perspectives shared at European level and the decisions taken by the Italian Government have laid the foundations for a historic season of investment in infrastructure, particularly for the mobility of persons and goods. To date, in order to achieve a new concept of mobility in which cooperative relations between the various sectors of the transport sector and between the various vehicles on a motorway can replace the sum total of the individualisms that make up the current model of mobility, it is necessary first and foremost to make up for the delay in the technological development of infrastructures, particularly road infrastructures, which are largely stuck in an analogue dimension that prevents the interconnection that is essential, for example, to fully exploit the potential of autonomous driving vehicles.

In this context, Autostrada del Brennero Spa is planning investments of over 7 billion euros, totally self-financed and hinged on 15 objectives that will guide the Concessionaire's entire future activity with a view to full sustainability: smart Highway; intermodality, sustainable mobility and synergy with local transport; ecological transition; circular economy; protection of resources; safeguarding ecosystems and biodiversity; mitigation of emissions and environmental pressures; landscape ecology and architectural quality; safety and protection of human health; Integrated services for travellers and lorry drivers; promotion of historical and cultural values; the maintenance process combined with constant renewal of infrastructure, structural, plant, technological and digital works; Innovation, research and development; training, health and safety of workers; sharing with users and operators.

Autostrada del Brennero SpA
Brennerautobahn AG

Carlo Costa
General Technical Manager
Autostrada del Brennero SpA
Tel: +39 0461 212801
direzione.tecnica.generale@autobrennero.it
www.autobrennero.it

Renewable geothermal energy: A climate champion

Gudlaugur Thór Thórdarson, Minister of the Environment, Energy and Climate in Iceland, discusses renewable geothermal energy, which in his opinion, is a climate champion for the clean energy transition

The climate crisis is at its core an energy issue. Fossil fuels are the main source of anthropogenic carbon emissions. Coal, oil and gas powered the industrial revolution. Yet, there are solutions in clean energy options like renewable geothermal energy.

Today there is still a huge demand worldwide for more energy, understandably so in developing countries. But we cannot burn fossil fuels for much longer without inviting a planetary climate catastrophe. For disaster-free development we urgently need clean energy.

Luckily, Iceland is blessed when it comes to renewable energy sources. Hydro energy is abundant. The wind energy potential is perhaps the best in Europe. Tidal and wave energy are enticing future possibilities. (Solar? Well, you can't have it all.)



Gudlaugur Thór Thórdarson

How is geothermal energy the best form of clean energy in Iceland?

And then there is geothermal. Much of Iceland is really an active volcano, where the Earth sweats off the internal heat from its molten interior. It makes for dangerous living at times, but from an energy perspective, this is a blessing for a cool country. Today, Iceland gets almost 100% of its heating and electricity from renewables, hydro and geothermal.

Often overlooked in the discourse on renewables. Geothermal is a clean and tested energy source that is actually widely available around the globe.

Iceland is a pioneer in utilising renewable geothermal energy. Our capital, Reykjavík, takes its name from the plumes of steam from hot springs that greeted its first Norse settlers. Yet, the city was heated by coal until Icelandic engineers found ways to bring natural hot water into houses.

Today over 90% of houses in Iceland are heated with geothermal. The benefits are immense, in the form of energy security and clean air, in addition to low energy bills. The countless swimming pools and spas that dot Iceland are a nice bonus, as well as greenhouses that bring our sub-Arctic nation fresh tomatoes and flowers year round.

Today, Icelandic know-how in geothermal utilisation is an export item. Icelandic experts are working on geothermal projects all over the world. For a long time Reykjavik could boast the biggest geothermal utility for house-heating in the world; today that title belongs to the city of Xianyang in China.

Geothermal is not only expanding in China, but also in Indonesia, East Africa, Central America and elsewhere. Active volcanic zones are hot spots of renewable geothermal energy use, but geothermal can also be harnessed outside such regions. As with other fields of renewable energy, innovation and technological development are lowering costs and expanding opportunities.

Innovation often begets innovation

Geothermal steam used for electricity generation contains some CO_2. Icelandic scientists wondered if it was possible to pump the CO_2 underground and store it there, as the basalt rock is porous and very receptive to carbon. An experimental project was set up and – lo and behold – the dissolved carbon dioxide did indeed solidify into minerals in the rock pores. The process even turned out to be quicker than predicted.

This pioneering process, dubbed Carbfix, has now moved on. Carbfix has teamed up with the Swiss company Climeworks to launch the world's largest direct CO_2 air capture and storage plant, located at the Hellisheiði geothermal power plant near Reykjavík.

While in an early stage, this gives hope that we can employ direct air capture of CO_2 anyplace where suitable basalt rock is found. Viable direct air capture could be a game changer in our quest to reach net-zero carbon emissions on a global scale.

So, has Iceland, with its renewable energy plus carbon capture, met its climate goals? No. We have set very ambitious goals regarding clean energy and climate mitigation. We want to phase out fossil fuels completely and reach carbon neutrality before 2040. These goals will be hard to reach, but we want to rise to the challenge.

One priority is decarbonising mobile sectors. With passenger cars, things are going well. Iceland is now #2 in the world, behind Norway, in the share of electric cars of total car sales, thanks in part to generous tax exemptions for clean cars and a rapid government-supported build-up of charging stations.

Iceland needs to harness more clean energy to achieve climate targets

For ships and airplanes, things are tougher – the transformation from fossil fuels has barely begun. We have an electrical ferry in Iceland and some experimental projects in other fields, but we rely on imported technology in aviation and ship engines.

To reach its ambitious climate goals, Iceland needs to harness more energy. One of my first decisions as a new Minister responsible for energy and climate issues was to order a report on Iceland's options for energy development. The report was issued in March 2022 and finds that a new push for energy development is needed in order to complete Iceland's clean energy transformation and reach our climate goals.

This task is a tricky one. Iceland has ample untapped renewable energy sources, but many projects would affect Iceland's unique nature, which is our heritage and a magnet for foreign tourists. So, the task is to find a compromise between two green goals: Conserving our nature and harnessing our clean energy sources for the benefit of Earth's climate. I am convinced we can achieve both.

Iceland wants to be an example to others in climate affairs. We want to be first in completing a clean energy transformation. We want others to compete with us in reaching that goal – the main winner in such a race would be Planet Earth.

Gudlaugur Thór Thórdarson
Minister of the Environment, Energy and Climate
Ministry of the Environment, Energy and Climate
urn@urn.is
www.umhverfisraduneyti.is

Increasing efficiency: High-temperature corrosion & materials research

The University of Iceland charts the opportunities & challenges concerning the utilisation of geothermal energy, understanding high-temperature corrosion

The global chase for renewable and green energy has led to an increased requirement for geothermal power generation. In this regard, one of the key elements for higher well output and increased efficiency of geothermal turbines and production equipment is the reduction in mechanical energy loss and increased lifetime of materials. Materials used in geothermal systems which are in direct contact with the geothermal fluid can be subjected to corrosion, which can result in high costs associated with materials, labour, and production efficiency of the system.

The corrosion aggressiveness of geothermal fluids depends on the physical character and chemical composition of the fluid, as well as the exploitation parameters such as temperature, pressure and flow rate. The main corrosive agents in the geothermal fluid are the dissolved gasses such as H_2S and CO_2. Components used in construction of geothermal wells and production of geothermal power from high-temperature geothermal fields can experience different corrosion attacks as well as wear and erosion.

Energy efficiency & lifetime increased with more durable materials

To address these issues, we in the Materials Engineering and Corrosion Center at University of Iceland have participated in several research projects with a focus on the development of coating materials as protection against such damages. These include the Horizon 2020 funded projects: Geo-Coat, GeoDrill and GeoHex.

At the Materials Engineering and Corrosion (MEC) Center, University of Iceland, the research focuses on material testing and corrosion research for the development and progress of novel materials for various demanding applications, particularly in the high temperature and corrosive environment for the utilisation of geothermal energy.

Deeper and hotter

Around the world, there has been an increased interest in exploring the deep roots of geothermal systems by drilling deeper geothermal wells with higher enthalpy fluids for potential utilisation. It involves subsequently higher temperatures (>300°C) and pressure (>100 bar) and a more corrosive environment than in typical high-temperature geothermal wells. Several material challenges are encountered in the design, construction and production of deep superhot geothermal wells. These include stresses and strain exceeding the yield strength and plastic strain limits due to the thermal cycling of carbon steel (CS) casing materials. Additionally, due to high temperatures and corrosiveness of the geothermal fluid, increased corrosion and erosion-corrosion can be expected. The CS casing materials also lose their strength at elevated temperatures; therefore, lower loads are needed for failure.

The CS casings commonly used in these projects are not corrosion resistant and are susceptible to various corrosion forms such as hydrogen embrittlement, sulphide stress corrosion cracking and micro-cracking due a high-temperature hydrogen attack. Thus, materials that have higher corrosion resistance and better resistance against thermal cycling effects are needed to achieve the structural integrity of superhot wells.

In an effort to fill the knowledge gap that exists in this field, Prof Karlsdottir's research group and collaborators, Gerosion Ltd., have been undertaking research on the corrosion behaviour and high-temperature stability of casing materials in the superhot and supercritical geothermal environment. Recently, their project called "Material Research and Modeling for High Temperature and Superhot Deep Geothermal Wells" received funding from the Icelandic Centre for Research.

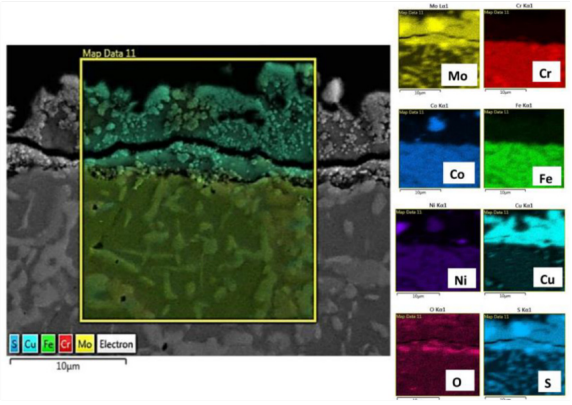
Materials engineering & Corrosion Center geothermal research projects:

GeoDrill

The objective of the project is to develop a novel materials and drilling technology for geothermal systems. Geo-Drill aims to reduce drilling costs through DTH hammer, to advance

Scanning electron microscopy and mapping with Energy dispersive X-Ray Spectroscopy of the cross-section of a corrosion coupon:

Corrosion testing in superheated condition



Andri Isak Thorhallssona, Ioana Csáki, Laura Ekeba Geambazu, Fridrik Magnus, Sigrun Nanna Karlsdottir.

Effect of Alloying Ratios and Cu-Addition on Corrosion Behaviour of CoCrFeNiMo High-Entropy Alloys in Superheated Steam Containing CO_2, H2S and HCl, Corrosion Science,
https://doi.org/10.1016/j.corsci.2020.109083

HTHP Corrosion Facility:



drill monitoring through low-cost and robust 3D printed sensors and improve component life through advanced materials and coatings. The GeoDrill project started in 2019 and received funding from the European Union's Horizon 2020 research and innovation programme, Grant agreement no. 815319.
https://www.linkedin.com/in/geodrill-project/

Geo-Coat

The objective of the project, which started in 2018 is to develop novel and cost-effective corrosion-resistant coatings for high-temperature geothermal applications. In this project, various potential corrosion resistant coatings were tested by Prof Karlsdottir's research group to identify the best coating material for critical parts of the production line in geothermal power production. The coatings were tested in a simulated geothermal environment in a high-temperature corrosion testing facility at the MEC Center, University of Iceland. The project was funded by the European Union's H2020 research and innovation programme, Grant agreement, no. 764086.
https://www.geo-coat.eu/

GeoHex

The objective of the GeoHex project is to develop advanced materials with anti-scaling and anti-corrosion properties for cost-efficient and enhanced heat exchanger performance for geothermal applications. The project received funding from the European Union's Horizon 2020 research and innovation programme in 2019. Grant agreement no. 851917.
https://www.geohexproject.eu/

Material research & modelling for high temperature & superhot deep geothermal wells

The objective of the project is to investigate the corrosion resistance and high-temperature stability of casing materials in supercritical and superheated steam that resembles conditions in a deep geothermal environment. This will increase the knowledge concerning corrosion behaviour of materials in deep geothermal well environments. In this project, unique High Temperature and High Pressure (HTHP) autoclave corrosion facility located at the MEC Center will be used for simulating the chemistry and conditions of superhot geothermal wells to test selected developed materials. The project is funded by the Icelandic Technology Development Fund, and by the Icelandic Centre for Research (RANNÍS). Time Period: 2021-2024. Grant no. 2113356-0611.

University of Iceland
+354 525 5310
www.hi.is
snk@hi.is

There is no "box" in geothermal resource utilisation – each case is unique

Iceland is at the forefront of energy transition and is seeking ways to become independent of fossil fuels via geothermal resource utilisation

Iceland has put energy transition high on its agenda. In the same manner as earlier in the 20th century, the country has shifted from fossil fuels for space heating to geothermal, it is today seeking ways to become independent of fossil fuels for transport. Not only are alternative fuels an important part but the country is also attracting players interested in buying the green energy produced from geothermal and hydropower. In this context, it has become important to optimise the energy production processes of already existing power plants without developing new geothermal fields.

Geothermal resource utilisation – hidden potential

Although the applications related to geothermal, from power production to bathing, space heating, drying of crops, are well-known and use proven technologies, we at Verkís approach each project as a unique project where solutions can be found to optimise the utilisation of the resource and harness it in a sustainable manner.

The "Geothermal Resource Park" concept in the Reykjanes in Iceland is one of the best examples of how geothermal resources can be best exploited. Although initially developed to produce hot water for space heating for the local community and later on electricity, the main products and areas of operation of the parks nowadays include hotels, balneology, fish drying, fish farming, wellness tourism, production of methanol, algae, cosmetic products etc. from substances present in the geothermal resource and resources involved in the process of the geothermal power plants such as fresh water and seawater.

Companies in the Resource Park use leftover streams from HS Orka's power plants in Svartsengi and Reykjanes for a wide range of activities that create about 1.200 jobs.

As Albert Albertsson, concept creator of the geothermal resource park, mentioned: "in geothermal there is no box and no one solution fits all". The Reykjanes geothermal power plant belongs to the Geothermal Resource Park, owned by HS Orka, and some features developed there to harness geothermal resources at best are an example of how this way of thinking can be applied.

Energy optimisation at the Reykjanes power plant

The Reykjanes power plant is among the most challenging geothermal power plants ever built in Iceland. The power plant started to produce electricity in 2005 and it is currently being expanded from 100 MW to 130 MW without drilling any additional well. The separated geothermal water that was initially partly reinjected and partly discarded at 210°C into the ocean will now be used for electricity production thanks to a unique design feature.

Initial development of the Reykjanes power plant

The geothermal field is one of the hottest, with temperatures of the geothermal fluid in boreholes reaching up to 320°C. Scaling and corrosion, in combination with high salinity and high temperatures, was one of the main design challenges. In order to avoid silica scaling, a steam separation pressure of 20 bar was required, which is considered unusually high for a geothermal plant. The turbine was designed by Fuji for a 19 bar single inlet pressure, which is unique. It also has special features to increase tolerance against erosion and corrosion.

Whereas the steam, separated from the geothermal fluid at high pressure, is used to produce electricity, the separated hot geothermal water has high silica and salinity levels and has remained unused for many years. It is due to the fact that severe scaling occurs if it is flashed to a lower temperature. Although various technical solutions exist, such as the use of acid to mitigate scaling, the hot geothermal water was difficult to exploit.



"Iceland has put energy transition high on its agenda. In the same manner as earlier in the 20th century, the country has shifted from fossil fuels for space heating to geothermal, it is today seeking ways to become independent of fossil fuels for transport."

Expansion of the plant thanks to an original concept

With changing time and better knowledge gained through trials of how the geothermal fluid behaves in various operational conditions and how scaling can be controlled, it is now possible to harness the energy contained in the separated water. The expansion of the Reykjanes power plant to 130 MW consists of adding a low-pressure turbine unit that uses the thermal energy of hot brine, while handling the geothermal water in such a manner that scaling can be handled without using any additives or inhibitors.

HS Orka and Verkis, in collaboration with Kemía, developed an experimental project that involved applying new steam separation technology that handles silica saturated geothermal water from the existing high pressure steam separators. The steam separators developed in this experimental project are the first of their kind and aim at controlling where silica deposition occurs in the system to avoid negative impact on the power plant operation. Silica can then be collected and utilised as a by-product of the power production. Pilot separators have been developed and tested and their design has been scaled to the planned power plant expansion.

Seawater, purified naturally through lava, will be extracted at wells at a temperature of about 10°C and used at the plant's condensers. The cooling process produces seawater at 35°C, used for fish farming at the geothermal resource park. This approach enables to recover and use thermal energy that would otherwise go to waste as part of the overall concept of the HS Orka's Resource Park. The power plant expansion will not utilise all the separated geothermal water available from the high-pressure steam separators and part of it will be used to provide thermal energy for fish drying.

Development of such a solution has enabled HS Orka to better use the geothermal resources at hand and produce electricity with fairly low capital cost compared to a project requiring drilling of new geothermal wells. It is also in the spirit of the concept creator of the geothermal resource park, not to waste any resources.

Verkis was the main engineering consultant for the initial phase of the project and is now responsible for all engineering design and preparation of tenders and is the owners engineer for the implementation phase of the 30 MW expansion.

VERKÍS 90 1932 2022

Carine Chatenay
Marketing Manager
cc@verkis.is

Co-author
Thorleikur Jóhannesson
Marketing Manager - Project director
tj@verkis.is

Co-author
Mr. Vigfus A. Josefsson
Project manager
vaj@verkis.is

Verkís
Tel: + 354 422 8000
www.verkis.com

The energy crisis as a catalyst for the energy transition

Thomas Kattnig, Member of the European Economic and Social Committee, argues that the energy crisis is a catalyst for the energy transition



Thomas Kattnig

The EU is supposed to be climate neutral by 2050. The Green Deal aims to reduce greenhouse gas emissions in all relevant sectors:, from energy production, via efficiency gains, to reducing consumption in industry, households, transport and agriculture and strengthening environmental protection. Despite the ongoing COVID pandemic and the worsening energy crisis, we must not lose sight of the climate crisis.

To achieve these ambitious objectives, it is important to ensure that all environmental transition actions are socially fair and equitable in the interest of a just transition. Energy renovations must not jeopardise the affordability of the housing. A two-tier energy society must be avoided at all costs.

The energy transition will, therefore, play a crucial role in the fight against climate change and is central to people's lives and to the EU economy. In addition to developing renewable energies and increasing energy efficiency, action must be taken to combat energy poverty.

Massive increase in energy prices

However, we are currently experiencing a massive increase in energy prices, putting a particularly heavy burden on low-income households as petrol and gas are becoming extremely expensive. At the same time, the economy is also under severe pressure. This creates uncertainty for people.

A more detailed analysis shows that the massive rise in energy prices is mainly due to rapidly increasing global demand for gas and has been further exacerbated by a shortage of supply to the EU and a lack of investment due to austerity policies following the financial and economic crisis. It is noteworthy that the Emissions Trading System (ETS) has had only a very limited effect on price rises.

Russia's war of aggression on Ukraine has further aggravated the situation on the energy market. In addition to the unimaginable human suffering it is causing, the conflict in Ukraine clearly shows how dependent EU Member States are on imports of fossil

fuels – all the more so when certain countries, such as Russia in this case, use this dependency as a geopolitical weapon.

It is particularly regrettable that not only have the EESC's calls in recent years for a reduction in strategic dependency on third parties gone unheard, but on the contrary this dependency has increased further. The current energy price crisis would not be hitting European citizens and companies anywhere near as hard if Europe were not so highly dependent on imports of fossil fuels from Russia. As a result, European businesses and consumers are suffering.

Transforming the European energy sector

The process of transforming the European energy sector, therefore, needs to be pushed forward as quickly and efficiently as possible, which will entail significant investment in sustainable zero- and low-carbon energy sources. This underlines the need to maximise efforts to increase the share of renewable energy, which could lead to lower prices and will certainly increase the EU's energy autonomy.

The increase in energy prices prompted the European Commission to issue a toolbox for action and support to help vulnerable groups. And in response to the Russian invasion of Ukraine, the Commission proposed the REPowerEU plan, which aims to make the EU independent of Russian fossil fuels well before 2030.

These two initiatives are steps in the right direction, as they include short-term solutions in line with the objectives of the Green Deal and the European Energy Union: increasing green energy production, diversifying supply and reducing demand. The aim is to accelerate the production of gas from renewable sources and to use it to replace gas for heating and electricity generation. These measures together are intended to reduce the EU's demand for Russian gas by two-thirds by the end of 2022.

This plan must be supported, but we must not lose sight of the fact that it will be a huge challenge for the European economy and society. This entails huge efforts and requires diversification, firstly, and primarily in the short term, via LNG and biomethane, and secondly via energy efficiency and the expansion of renewables.

Particularly in times of crisis, it is necessary to keep overall objectives in mind instead of only trying to solve the most urgent problems. The EU thus needs to consistently adhere to the basic objectives of its energy policy and energy systems: security of supply, reasonable costs and prices, and carbon-neutrality.

A versatile energy production palette, could be a catalyst for the energy transition

A versatile energy production palette is part of the security of energy supply. In addition to wind and solar power, it is thus important to make use of the wide variety of low-carbon energy sources that fit economically and ecologically within an energy system that is primarily based on wind and solar energy. These include, for example, bioenergy, hydro and geothermal energy.

The Commission's offer to coordinate gas storage replenishment, e.g., through joint procurement, collection of orders and coordination of deliveries, is an interesting one. The question of ownership of gas storage facilities, which are to a large extent privately owned by groups such as Gazprom or Lukoil, also needs to be addressed in order to achieve greater independence.

However, this also means that a financial instrument will be needed to support investment in hydrogen-friendly infrastructure such as interconnectors and storage facilities. Plans must also be drawn up for individual Member States, taking into consideration the size of the storage facilities, the country's consumption and the capacities of the storage to serve other countries in the region, to avoid unbalanced burden sharing on a regional dimension.

It is particularly important that, in the aforementioned documents, the Commission provides the Member States with tools to combat energy and mobility poverty. It confirms that, in the current exceptional circumstances, Member States can set regulated prices for disadvantaged consumers, households and micro-enterprises; it also confirms that Member States may adopt temporary tax measures on windfall profits.

Energy suppliers as key players

High energy prices lead to high profits for many oil companies, as well as some energy suppliers and

traders. The International Energy Agency estimates these "windfall profits" in the EU at around €200 billion and proposes that these profits be skimmed off by means of taxes and redistributed as financial compensation to energy consumers, such as vulnerable households and energy-intensive companies, and used for the expansion of renewable energy production and the necessary grid infrastructure.

The important role of energy suppliers as key players in the availability of services of general interest should be highlighted. It is also clear that the reshaping of the energy market over the last 20 years has left the Member States with fewer policy instruments at their disposal to deal with rising energy costs. The current design of the energy market seems to prevent an adequate response to price fluctuations. The European Commission, therefore, needs to come up with a proposal that will offer an effective response to these shortcomings and do justice to the green transition. There is also a need for improvements in the transmission and distribution system and a more developed storage infrastructure.

European Commission energy policy

It is worth highlighting the Commission's statement that action related to rising energy prices must not undermine climate protection efforts. To ensure that no one is left behind, the new Social Climate Fund is intended to support investment in energy efficiency and provide financial support to vulnerable households and small businesses.

The package of measures could be a good step forward because it cannot be a question of choosing between climate protection and social peace; we need both, and we must get the people behind us.

The danger of not taking the population along with us in the course of European climate policy and a flare-up of widespread protests, such as the" yellow vests" protests, must be prevented at all costs. There is, therefore, a need for further-reaching accompanying measures and resources at the EU and national levels. The Member States now need to exploit the synergies of the Social Climate Fund with other available financial resources and to use it as efficiently as possible.

Responding to high energy prices

Responding to recent exceptionally volatile and high energy prices, the European Commission in May 2022 set out several extra short-term measures to combat energy prices and look at possible supply disruptions from Russia. Also, it shows areas where electricity market design can be optimised, making it ready for the move away from fossil fuels and more resilient to price shocks, while also delivering affordable electricity and protecting consumers.

Commissioner for Energy, Kadri Simson, provided more details on this important policy announcement, which is an example of what the European Commission are doing to address energy prices: "The EU has put in place a well-functioning and interconnected energy market that continues to provide reliable energy supply in today's challenging situation. But exceptional times require exceptional measures and today we present additional steps that the Member States can take to combat the high prices.

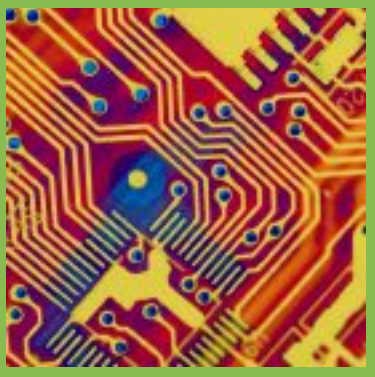
"As Russia pursues its unprovoked war in Ukraine, we must also plan for gas supply disruptions and their impact with solidarity measures and possible price interventions. In parallel, we are taking forward the work to improve the electricity market to better protect consumers, reduce volatility and continue to support the green transition." (1)

1. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3140

Thomas Kattnig
Rapporteur for the EESC opinion on Energy prices
Member, European Economic and Social Committee (EESC),
Workers' Group (Group II)
Tel: +32 (0)2 546 90 11
www.eesc.europa.eu
https://twitter.com/EU_EESC











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First Semi-Industrial Demonstration of Novel Gasification Technology for Biofuel Production

The Horizon 2020 project CLARA, coordinated by the Technical University of Darmstadt, investigates a novel gasification technology to provide sustainable second-generation biofuels for the transportation sector in order to move it towards CO_2 neutrality.

In this context, biogenic residues, such as wheat straw, are to be converted into syngas by means of a new gasification technology and are thus made usable for downstream synthesis.

The synthesis gas obtained during gasification is then treated and purified to enable efficient fuel production, yielding the entire Biomass- to-Liquid (BtL) process, shown in **Figure 1**.

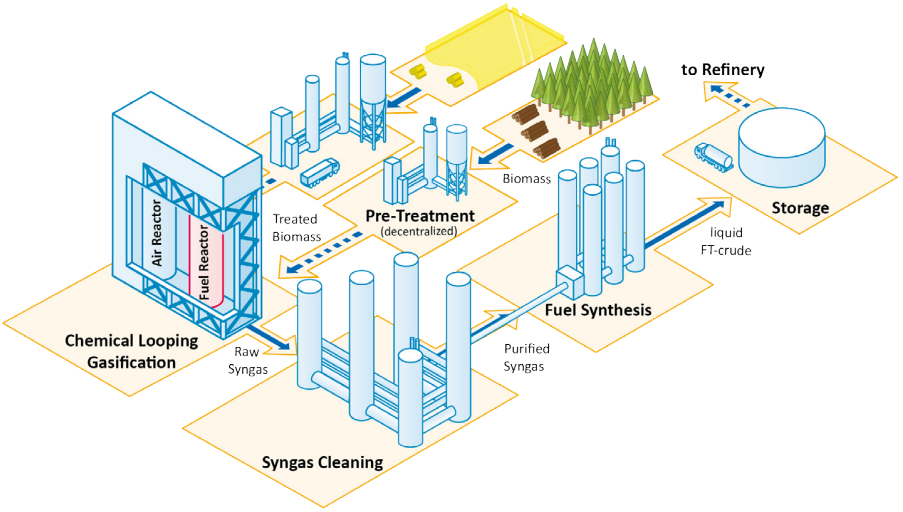


Figure 1: Schematic Illustration of the Biomass-to-Liquid (BtL) process chain investigated within the CLARA project.

Chemical Looping Gasification (CLG) – Technology Development

To this end, twelve partners from academia and industry are working together with Technical University of Darmstadt on the further development and optimization of the novel BtL chain, with the aim of bringing it to market maturity.

Here, elevating the technology readiness level (TRL) of the novel gasification technology, Chemical Looping Gasification (CLG), beyond the state of lab-scale testing to semi-industrial demonstration (i.e. TRL 6), is key. The major advantage of the CLG technology is that the oxygen required for efficient feedstock conversion is supplied through the cyclic reduction and oxidation of an abundant, non-toxic metal oxide, a so-called oxygen carrier. Hence, CLG does not rely on a costly air separation unit, commonly required for oxygen-driven gasification processes. Moreover, CLG allows for an efficient capturing of the CO_2 formed during the autothermal gasification step from the N_2-free product gas in the downstream syngas purification unit, thus allowing for net negative CO_2 emissions of the BtL process chain.

In order to achieve the goal of further advancing this auspicious technology, the gasification process was firstly investigated in small-scale facilities with thermal loads up to 10 kW_{th}, to gain deeper insights into the process fundamentals, such as reaction kinetics and governing reaction pathways.

Subsequently, this knowledge was employed and extended in small pilots with thermal loads of 50 and 100 kW_{th}. Inside these pilots, extensive parameter studies were carried out, laying the foundation in deriving a new process control concept, allowing for an efficient implementation and control in industrial size.

Moreover, important insights with regard to material selection, process requirements, operability, and process efficiency were obtained. The experimental endeavors aiming towards elevating CLG towards market maturity, illustrated in **Figure 2**, were accompanied by simulation and modelling efforts for validation of the experimental findings and deeper optimization through sensitivity analyses, amongst others.

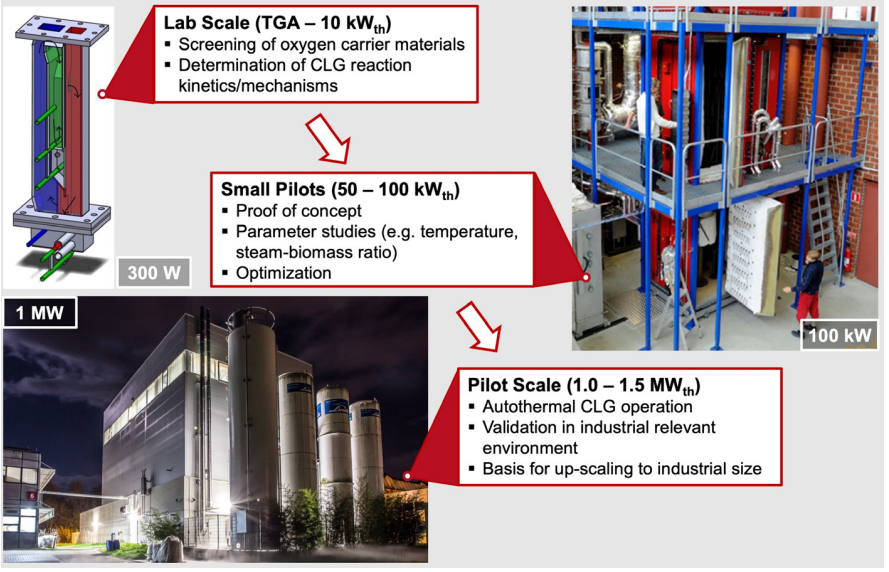


Figure 2: Illustration of the experimental activities within the CLARA project, aiming towards boosting the CLG technology towards market maturity.

1 MW$_{th}$ Pilot Testing

By combining the progress made both during the small-scale experimental investigations and process modelling, the pilot plant of the Technical University of Darmstadt (**see Figure 3**, left) has been extended to be able to demonstrate the entire BtL process chain in an industrially relevant environment, in the year 2021.

The tailored and extended plant was put into operation for the first time in March and April 2022. During this test campaign, the novel CLG technology (see **Figure 3**, right) was demonstrated in autothermal operation, i.e. without additional external energy input (e.g. electrical heating of the reactor system), for the very first time globally.

During the two-week test campaign in 1 MW$_{th}$ scale, important further insights into the governing sub-processes of the CLG technology and indispensable insights with regard to operability and process up-scaling were generated. Based on these findings, the gasification operation is now to be optimized in two further test campaigns and the downstream process steps, i.e. gas purification and fuel synthesis, are to be demonstrated.

Summary of large-scale implementation of biofuels

The data generated during small pilot testing and especially 1 MW$_{th}$ pilot operation will subsequently serve as an important basis for the large-scale implementation of the investigated concept for the production of liquid biofuels from biomass residues, which will be further expanded and refined in the further course of the project. More information on the CLARA project and updates on further progress can be found on the project homepage.

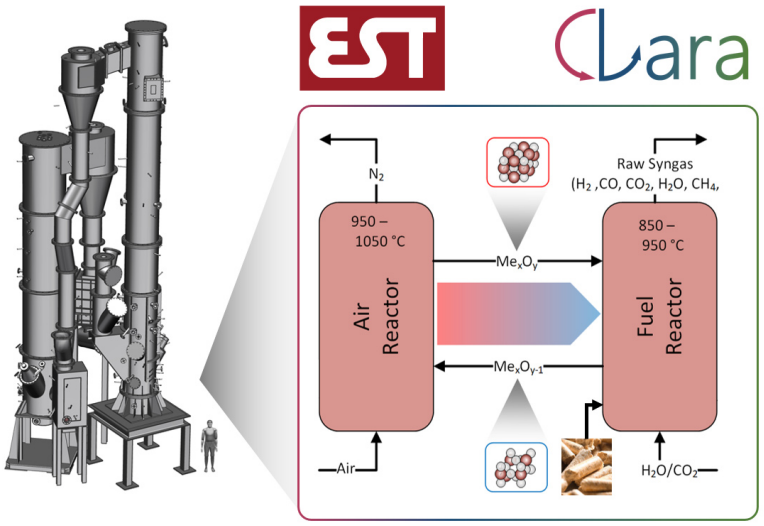


Figure 3: 3D-view of the 1 MW$_{th}$ CLG plant (left) and illustration of the novel CLG process (right).

This project has received funding from the European Union's HORIZON 2020 Research & Innovation programme under the Grant Agreement no. 817841.

TECHNISCHE UNIVERSITÄT DARMSTADT

Jochen.Stroehle
Tel: +49 170 855 9242
Jochen.Stroehle@est.tu-darmstadt.de
http://www.est.tu-darmstadt.de/

District heating is necessary to repower EU's heating sector



Carsten Østergård Pedersen, Rune Kaagaard Sørensen and Asbjørn Ebbesen discuss the necessity of district heating to speed up the phasing out of Russian fossil fuels

Securing a Europe that is no longer powered by Russian fossil fuels demands that the current Fit-For-55 package raises its ambitions and embraces better district heating.

Therefore, the Commissions has presented its REPower EU strategy, which directly addresses how they think it should be done. However, it is worrying that the new strategy does not raise the ambitions on district heating, as it will play a crucial role for the speed, energy production capacity and cost-effectiveness of phasing out Russian fossil fuels in heating.

Following Russia aggressions in Ukraine, the EU no longer want to be dependent on energy from Russia. The EU Commission new energy strategy, REPower EU, therefore, sets out how the Union can become independent of this energy import, through energy efficiency, renewable energy, and diversifying natural gas import.

The plan is to get the strategy implemented into concrete legislation in the Fit-For-55 package, where the Renewable Energy Directive (RED), Energy Efficiency Directive (EED), Energy Performance of Buildings Directive (EPBD), and more are under revision.

However, phasing out Russian fossil fuels will be a huge task within the European heating sector. 75% of residential heating within Europe comes from fossil fuels[1], most of which is imported natural gas from Russia used in boilers.

The REPower EU strategy, therefore, aims at doubling the replacement rate of boilers to heat pumps and increasing energy efficiency targets, all of which are warmly welcomed. But it is worrying that higher ambitions regarding district heating are ignored, as it can increase the speed and cost-effectiveness of phasing out Russian fossil fuels in the heating sector.

THREE REASONS WHY DISTRICT HEATING AMBITIONS MUST BE RAISED

The need for speed

Short term crisis actions are necessary since Russia is using natural gas supply to Europe as a tool in their macro political agenda. Gas supply to European countries is at danger, if energy companies are not willing to pay in Rubles, whereby gas supplies could be in short fall in coming winter seasons. Although new district heating grids take longer times to implement, existing grids should be utilized as much as possible.

Therefore, the EU should now promote that we quickly connect current gas-supplied areas to closely located existing district heating grids. This can increase the replacement rate of boilers and ease bottle necks on other heating technologies. Moreover, existing grids should be retrofitted for higher

energy efficiency levels, for lowering unnecessary heat production trough lower heat losses.

More connections for the same amount of energy

Secondly, district heating can meet a larger number of connections without increasing the energy use. Retrofitting current district heating grids to demand driven temperature zones can, by our own calculations, free up heating capacity for more than 800.000 European homes as 20% in heat loss can be saved in many parts of the grids.

Moreover, district heating can be powered by a currently massive unused green energy potential in geothermal energy and surplus heat from datacenters, industry, and supermarkets where surplus heat alone can deliver 25% of energy for district heating[(2)]. Neglecting district heating in a strategy for being free of Russian fossil fuels, which are so dominant in heating, therefore, is unwise. The EU should tap into these huge energy savings in a 2-5 year time horizon, by pushing for retrofitting and expansions of new district heating grids to low-temperature zones and thereby utilizing surplus heat and geothermal energy.

Crisis thinking must not disrupt rational thinking

Lastly, district heating also plays an important role in the long term, due to its ability to secure cheap heating in densely populated areas. The leading energy research team at Aalborg University has outlined in HeatRoadMap Europe that district heating could cost-effectively deliver up to 50% of Europe's heating demand3 due to the enhanced integration of green energy sources such as surplus heat and geothermal energy, which otherwise will remain unused.

Therefore, neglecting heat planning can become costly for society, since an unplanned roll out of individual heat pumps can prevent the roll-our of district heating and thereby prevent the utilization of surplus heat and geothermal energy in certain areas, as it then will not be economic feasible to implement district heating due to low connection rates.

HOW TO IMPLEMENT NEW AMBITIONS INTO FIT-FOR-55

The positive implications for higher ambitions on district heating, therefore, is crystal clear. It must be a central part in freeing Europe's heating sector from Russian fossil fuel, and the Commission together with the Parliament should, therefore, push for high ambitions on district heating in the Fit-For-55 package. We propose the following steps for raising the district heating ambitions thoughtful:

- **The EED should:** Secure mandatory heating plans in cities with over 20,000 inhabitants and surrounding villages, which must include the assessments of low-temperature zones, geothermal energy, and surplus heat recovery.

- **The EPBD should:** Implement that National Renovation Buildings Plans is planned in zonal approaches in line with heat planning, so renovation of the building stock and roll out of energy efficient heating goes hand in hand. This is necessary as both heat pumps and energy efficient district heating runs more efficient on lower temperatures compared to boilers.

- **The EED should:** Implement binding targets for the Member States for the usage of surplus heat (50% of the waste heat should be utilized in 2025 and 75% in 2030).

- **The EED should:** Secure requirements for data centers (and other industries with a lot of surplus heat) to be connected to the heating grid: Data centers of sufficient size (with a total rated energy input exceeding 1MW) should consider being connected to the heating grid to maximize the use of waste heat.

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Carsten Østergård Pedersen
Head of District Energy
Grundfos Holding A/S
Tel: +45 87 50 14 00
cpedersen@grundfos.com
www.grundfos.com
www.linkedin.com/in/carsten-%C3%B8sterg%C3%A5rd-pedersen-79b6821

Rune Kaagaard Sørensen
Public Affairs, Grundfos Holding
rsoerensen@grundfos.com

Asbjørn Bjerregaard Ebbesen
Public Affairs, Grundfos Holding
aebbesen@grundfos.com



Cut energy needs and promote renewable to reach net-zero

To win the net-zero race, we must cut energy needs and make energy sources renewable, argues Professor Phil Hart, Director of Energy and Power at Cranfield University

We live in a world where green energy technologies are a workable reality. However, we have legacy infrastructures for heat both in homes and industry that are hardwired for fossil fuels.

We're now experiencing what a challenge this is for governments: how do we make the transition en masse to sustainable models without major pain from the costs of change? The situation has been further highlighted by current fossil fuel prices, and the reliance on some uncomfortable geopolitical relationships.

> "Hydrogen boilers are not yet practical because of problems with producing enough hydrogen at the right cost to meet the volume of domestic demand."

Gas emits only around half the CO_2 of coal and oil, making it a useful lower carbon transition fuel while we build capacity to meet the longer-term goal of renewables-based electrification. The transition period could last decades as we build enough renewables to provide for our needs, so there needs to be an increased urgency (and consistency) to build out local and national renewable energy systems.

In domestic heating in the UK, the picture is dominated by natural gas (estimated to supply around 87% of homes). The Government has begun the process of change with legislation that means from 2025 new homes won't be built with fossil fuel boilers.

Hydrogen boilers are not yet practical because of problems with producing enough hydrogen at the right cost to meet the volume of domestic demand. There are also issues with storage and the distribution networks needed to pipe hydrogen to homes. And, however unjustified they might be, public concerns about the safety of hydrogen could be a real challenge.

A look at heat pumps to cut energy needs

Heat pumps have many advantages, especially their efficiency and zero emissions at the point of use. The Government recognised this in its Energy Security Strategy and the announcement of the Heat Pump Investment Accelerator Competition: a £30 million incentive for British manufacturers to develop products and increase their viability. This should accelerate take-up, and with other drivers and policies over the next 10 to 20 years they ought to become a default solution. Ultimately though, the sustainability

credentials of heat pumps depend on the electricity supply. If the electricity used comes from renewable energy sources, that would be a genuinely sustainable cycle. The danger is that, due to limitations in renewable capacity, electricity is supplied from a fossil fuel plant – not great and not green!

Heat pumps provide a moderate level of constant heat, designed to maintain an ambient temperature rather than providing instant bursts, and that makes the issue of home insulation critical. This was something sadly missing from the Energy Security Strategy. Householders need to be told what difference insulation could make to their lives and wallets and supported to fix the situation. Improving insulation and energy efficiency generally seems to have dwindled in importance on the agenda, and that must change. We need to push down both avenues — making energy sources renewable and cutting energy needs — if we are to win the net-zero 2050 race. Doing one while ignoring the other doesn't make any sense.

"Heat pumps have many advantages, especially their efficiency and zero emissions at the point of use. The Government recognised this in its Energy Security Strategy and the announcement of the Heat Pump Investment Accelerator Competition: a £30 million incentive for British manufacturers to develop products and increase their viability. This should accelerate take-up, and with other drivers and policies over the next 10 to 20 years they ought to become a default solution."

Excellent insulation is essential for both making heat pumps a universal heating option and helping to reduce the overall energy demand. If we can connect the dots between installing heat pumps and the installation of solar panels (and perhaps thermal solar panels), we can move much closer to self-sufficient heating systems and truly sustainable domestic heating.

Industries, and especially those that depend on high temperatures for basic processes (like steelmaking, concrete, and chemicals production), face tougher challenges. A technology like heat pumps can't deliver the required performance and fossil fuels are more difficult to replace. We need a drop-in replacement with the same flexibility and performance characteristics, and in this case, hydrogen makes more sense.



Professor Phil Hart

Hydrogen & renewable energy capacity

The hydrogen supply chain is a source of much debate, but it is likely that hydrogen will depend on a different kind of distribution system than what we have been used to. A large centre for production and a web of smaller and smaller distribution pipework like we have with natural gas is not necessarily the best solution. We could see lots of smaller, localised producers, based at individual factories, or as part of clusters of operations sharing a facility. Logistics centres may become the new hydrogen fuelling centres of the future, but with the fuel (hydrogen) being produced on-site from fresh water (green H2) or natural gas (blue H2).

Fundamentally, the UK needs more renewable energy capacity and the support of wind energy in the Strategy is a good option for the UK. But a focus on the individual elements to the exclusion of others doesn't fix the problem. We must think 'system': ensuring there's a coherent and joined-up picture combining reduction in energy use and electrification.

Government strategy is critical for setting out the full opportunity landscape for businesses, and then proactively supporting and incentivising the best kind of holistic 'systems-wide' package of solutions for the long term.

Professor Phil Hart
Director of Energy and Power
Cranfield University
Tel: +44 (0)1234 758 249
P.R.Hart@cranfield.ac.uk
www.cranfield.ac.uk/people/professor-phil-hart-21294543
www.cranfield.ac.uk/themes/energy-and-power
https://twitter.com/CranfieldUni

Stationary fuel cells reliably boosting industry growth

Frank Wolak, President and CEO, Fuel Cell and Hydrogen Energy Association, argues here that stationary fuel cells reliably boost industry growth

You'd be hard-pressed to scroll through an energy news feed without seeing several major announcements involving hydrogen. The first element on the periodic table has become somewhat of a fuel celebrity nowadays, not only for its environmental and economic benefits, but because of its versatility in both production and utilisation pathways. Hydrogen is capable of being generated from numerous feedstocks and methods and can be used in practically limitless market applications.

Hydrogen has a role to play in the decarbonisation of society

While the transportation sector tends to receive the majority of media coverage, hydrogen has a tremendous role to play in the decarbonisation of our entire society, including where and how we work and live. This includes reducing carbon intensity of industrial processes such as steel, cement, and glass production, blending with natural gas in pipelines, stabilising and providing long-term energy storage for intermittent renewable energy sources, and providing reliable, efficient, and clean energy with stationary fuel cell systems.

Fuel cell units are deployed for both primary and backup power at utility substations, telecommunications networks, retail stores, hospitals, universities, municipal facilities, data centers, and many other private and public sector sites. The Fuel Cell and Hydrogen Energy Association (FCHEA) estimates more than 550 megawatts (MW) of stationary fuel cells are currently in operation in the United States (U.S.). Throughout the past year, FCHEA member companies reported more than 80 MW of sales, orders, or installations for fuel cell systems that will collectively be deployed in not just the usual California and Northeast region in the U.S., but in North Dakota, Texas, and Washington. Outside the country, stationary/backup fuel cell sales announcements included customers in Canada, Germany, Malaysia, the Philippines, and South Korea.

Most large-scale fuel cell installations depend on natural gas right now

Currently, the majority of the large-scale fuel cell installations run on natural gas, which provide high efficiencies, leading to significant emissions reductions compared to conventional technologies. Many of these systems are configured to capture waste heat and utilise it in various ways, including for hot water, space heating, and even cooling and refrigeration, which increases the efficiencies even more. A growing portion of fuel cells are utilising renewable biogas, renewable natural gas, or methane generated from landfills or wastewater treatment plants, which in some cases, are calculated as being carbon negative. Smaller units for backup or remote/off-grid power typically operate on hydrogen or methanol, replacing loud, dirty, and inefficient diesel generators.

There has been significant and innovative progress in the market, with FCHEA members introducing larger systems that use hydrogen; and small-scale systems that run on ammonia. This allows for growth in existing areas, such as data centers, microgrids, and telecommunications, but also opens newer markets focused on powering and complementing competing energy pathways such as oil/gas exploration equipment and electric vehicle charging stations. Fuel cells are proving to be a great complementary technology to batteries as well, with hybrid applications allowing users the ability to reduce the size, weight and volume of the batteries required to store renewable energy while also extending the life and duration of the batteries' charge and their lifetimes.



Copyright Bloom Energy, fuel cell system installed at a customer's corporate office, image used with permission

Stationary fuel cell manufacturers are now in the marine and mobility sectors

Also noteworthy is the expansion of companies traditionally known for focusing on one end-use application, with new products, partnerships, or installations into other market areas. This includes stationary fuel cell manufacturers entering marine and mobility sectors, and automotive and transportation-focused companies demonstrating systems for stationary use.

In the U.S., much fanfare has been made about the Infrastructure Investment and Jobs Act (IIJA), otherwise known as the bipartisan infrastructure law (BIL), that was signed by President Biden last November. The law provides $1.2 trillion for a range of transportation and energy infrastructure programs, including $9.5 billion for clean hydrogen research, development, and deployment programs.

The BIL will push for efficiency of energy, alongside decarbonisation

However, the BIL also allocates more than $16 billion to several grant programs focused on improving grid reliability and resilience via low-or no-carbon emission sources, with hydrogen and fuel cells listed as eligible technologies. These programs are coordinated by both the U.S. Department of Energy and the Department of Transportation, and include:

- Port Infrastructure Development Program
- Program Upgrading Our Electric Grid and Ensuring Reliability and Resiliency.
- Preventing Outages and Enhancing the Resilience of the Electric Grid Grants Program.
- The Energy Storage Demonstration Pilot Grant Program.
- Natural Gas Distribution Infrastructure Safety and Modernization Grants.

While each program has its own criteria for eligibility and timeframe for engagement, they each offer potentially significant opportunities for stationary fuel cell systems, which have a proven track record providing reliable and resilient power through major weather disasters and power outages.

As the BIL rollout unfolds, FCHEA and its members will be ready to showcase how vital fuel cell and hydrogen technologies are to help the U.S., and the world at large, meet necessary climate goals while boosting economic growth across the globe.

Frank Wolak
President and CEO
Fuel Cell and Hydrogen Energy Association (FCHEA)
Tel: +1 202 261 1331
info@fchea.org
www.fchea.org
https://twitter.com/FCHEA_News

Enhancing waste valorisation for a sustainable industry

The development of more sustainable technologies for energy-intensive industry is imperative to meet the ambitious targets that UK and Europe have recently announced by 2050

The net-zero innovation platform recently issued by UK government mostly rely on renewables technologies that will enable the electrification of several sectors including power generation as well as other very energy and carbon-intensive industries such as steel manufacturing, cement, chemicals. Some of these processes are hard to decarbonise given the variety of streams and complexity of the process, as well as the difficulties to retrofit or combine with electrification or green sources such as biomass or hydrogen from electrolysers.



Figure 1: small (left) and large (right) high-temperature and high-pressure laboratory scale rigs at the James Chadwick Building in Manchester

To help the transition towards net zero and at the same time reduce the operational costs of these processes, waste valorisation should be pursued generating additional revenues and reducing the overall carbon emissions into the atmosphere.

At the University of Manchester, we are committed to clean and sustainable chemical processes, and we are developing next generation cutting-edge technologies to teach future engineers and at the same time we work closely with industries to move innovation from laboratory to industrial settings. Several research projects are currently ongoing specifically looking at new and more sustainable technologies by waste valorisation to produce hydrogen and other relevant chemicals for energy and transport applications. Our laboratories are located in the James Chadwick Building, a three-stores building used for undergraduate teaching laboratories, fundamental research and pilot scale processes, fully integrated with advanced control systems.

Waste glycerol to added value products (H2020 GLAMOUR project)

Glycerol is an abundant by-product of biodiesel plants as well as other bio-based feedstocks. The University of Manchester is leading the H2020 GLAMOUR (GLycerol to Aviation and Marine prOducts with sUstainable Recycling). The 4 years project has received a €5 million grant from the European Union's Horizon2020 programme, and officially started on May 2020. The aim of the project is to convert waste glycerol from 1st and 2nd generation biodiesel plants into sustainable aviation and marine fuels. The H2020 GLAMOUR project is a broad collaboration covering the complete value chain from feedstock supplier to end-users. Coordinated by the University of Manchester, the consortium includes two universities, three research centres and five industries (including 2 SMEs) with participants from six EU countries (Figure 2).

This project is looking at three integrated technologies and by the end of the project, the GLAMOUR technology will reach a TRL5 demonstration innovating in material science, process engineering, sustainability and socio-economic studies. Main technologies which are currently under study are:

Waste glycerol refining: by combining physiochemical processes (Figure 3) and advanced analytical data processing methods led by Argent Energy in collaboration with the University of Manchester. Current advances within the state-of-the-art includes electric-

Figure 2: the H2020 GLAMOUR consortium

driven process testing to further reduce the impurities of the feedstock.

Glycerol gasification: the purified glycerol is converted into syngas via chemical looping reforming in packed bed reactors. This process - developed in the past 6 years by the University of Manchester and TU Eindhoven - relies on the use of an oxygen carrier and catalyst which produce syngas while separating CO_2 at high purity that is suitable for storage or utilisation.

Fuel synthesis via Fischer-Tropsch reactor: the conversion of syngas into sustainable aviation and maritime fuels occurs via 3D-printed structured reactor to achieve high yield, and efficient thermal management.

The pilot plant is under construction at TU Eindhoven and the testing campaign will start in the next year to produce overall 0.5 kg per hour of syncrude for 1,000 hours. The conceptual design at industrial scale simulation is confirming the expected key performance indicators also in terms of life cycle assessment. Finally, the project has linked with >10 other European and national initiatives of next generation biofuels sharing joint communication and dissemination activities.

Hydrogen production from energy-intensive industry

Applications of a new intensified process using gas-solid reactions are currently under development to produce hydrogen from different sources. After successfully demonstrating the use of blue and renewable-based hydrogen production with chemical looping reforming, we are preparing the feasibility study for the Department of Business, Energy and Industrial Strategy (UK) in collaboration with Johnson Matthey, TotalEnergies and Element Energy, to build the first modular and flexible hydrogen demonstration plant in Manchester within the next 4 years based on dynamically operated gas-solid reactors (BEIS-RECYCLE).

In terms of waste valorisation, a similar process is being studied using blast furnace gases from integrated steelmill. In Manchester, we are looking at new configurations that will integrate renewables energy (EPSRC BREINSTORM). However, a TRL7 demonstration of the 1st generation calcium-chemical looping process will be reached in 2024 under the H2020 C4U project (coordinated by UCL) through an international collaboration between CSIC, Arcelor Mittal, TNO, Carmeuse, Johnson Matthey and Manchester.

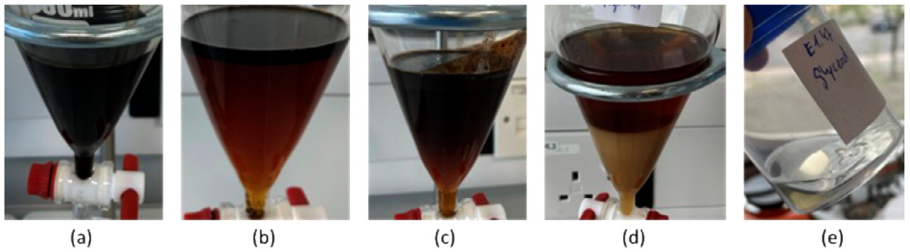
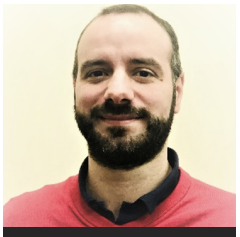


Figure 3: Glycerol refining from industrial waste feedstock (a) to purified product (e).

Acknowledgements

Vincenzo Spallina would like to acknowledge the EU Horizon 2020 research and innovation programme under grant agreement no. 884418 (https://c4u-project.eu/) and no. 884197 (https://www.glamour-project.eu/). The work reflects only the author' view and the EU is not liable for any use that may be made of the information contained therein. The author would like to acknowledge also the Engineering and Physical Sciences Research Council (EPSRC) as part of the UKRI program (BREINSTORM - EP/S030654/1) and the Department of BEIS in the framework of the Low Carbon Hydrogen Supply 2: Stream 1 Phase 1 Competition - GOV.UK (www.gov.uk) (TRN 5044/04/2021) (RECYCLE: REthinking low Carbon hYdrogen production by Chemical Looping rEforming, HYS2137) for providing funding and support to development of this study.



Vincenzo Spallina

Author

Vincenzo Spallina is Senior lecturer of Chemical Engineering at the University of Manchester and project coordinator of the H2020 GLAMOUR project. He is also Principal Investigator of EPSRC BREIN-STORM and BEIS RECYCLE project.

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 884418 and 884197.

Vincenzo Spallina
Department of Chemical Engineering
School of Engineering
The University of Manchester
Tel: +44 (0)161 306 9339
vincenzo.spallina@manchester.ac.uk

Artificial Photosynthetic Chemical Process (ARPChem) project in Japan: achievements and future challenges

Here, Professor Kazunari Domen, Shinshu University and The University of Tokyo, summarizes the 10-year ARPChem project conducted from 2012 to 2022 under the support of New Energy and Industrial Technology Development Organization (NEDO).

The ARPChem project aimed to develop three key technologies toward the production of basic chemicals from carbon dioxide and water using solar energy: (i) renewable hydrogen production by sunlight-driven photocatalytic water splitting, (ii) modularization of photocatalytic reactors and hydrogen separation membranes, and (iii) lower olefin production from hydrogen and carbon dioxide with high selectivity. Among these, the development of particulate photocatalysts and reaction system was an unprecedented challenge, and a great deal of effort was made by the author's group.

Achievements and efficiency of the project

Figure 1 shows the performance of representative photocatalysts that existed before the project and those developed during the project. Before the project, some oxide photocatalysts exhibited high apparent quantum yields (AQYs) in the water splitting reaction, but only under middle ultraviolet light that was not included in sunlight. Some other oxynitride photocatalysts decomposed water but had low AQYs and under short-wavelength visible light with wavelengths of 500 nm at most. During the project, the AQY of $SrTiO_3$ was improved to more than 90% at the near ultraviolet region [1]. This high quantum efficiency indicates that particulate photocatalysts can drive the uphill water splitting reaction as efficiently as the photon-to-chemical conversion process in photosynthesis.

In addition, it became possible to drive the water splitting reaction under visible light using as (oxy)nitride and oxysulfide photocatalysts such as Ta_3N_5 [2] and $Y_2Ti_2O_5S_2$ [3] having an absorption edge wavelength equal to or longer than 600 nm. It is also possible to combine hydrogen evolution photocatalysts (HEPs) and oxygen evolution photocatalysts (OEPs) for water splitting. Such systems utilizing two-step excitation of HEPs and OEPs are called "Z-scheme" after the photosynthesis process. In the project, Z-scheme photocatalyst sheets that could be scaled-up and drive the water splitting reaction under visible light efficiently were developed **(Figure 2)** [4]. The solar-to-hydrogen (STH) energy conversion efficiency at the ambient pressure was improved to 1.0%, which was highest among ever existing systems based on particulate photocatalysts.

More than 70% of the produced hydrogen was recovered

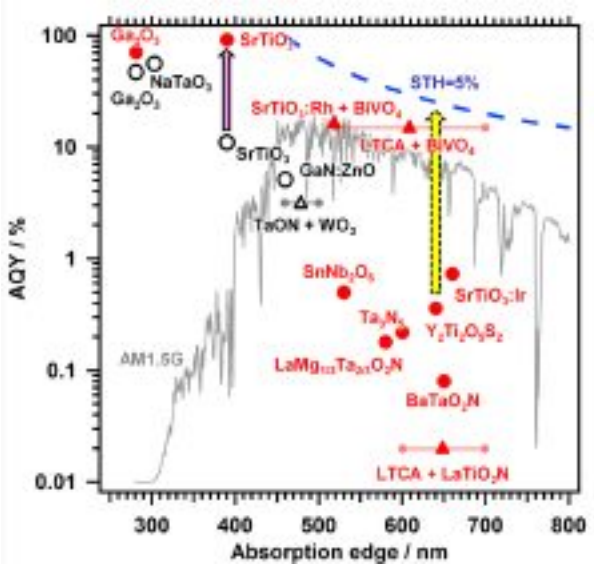


Figure 1. AQY in water splitting of representative photocatalysts before and after the ARPChem project (plotted in black and red, respectively) and their absorption edge. LTCA refers to $La_5Ti_2Cu_{0.9}Ag_{0.1}O_7S_5$. A standard solar spectrum (AM1.5G) is also shown.

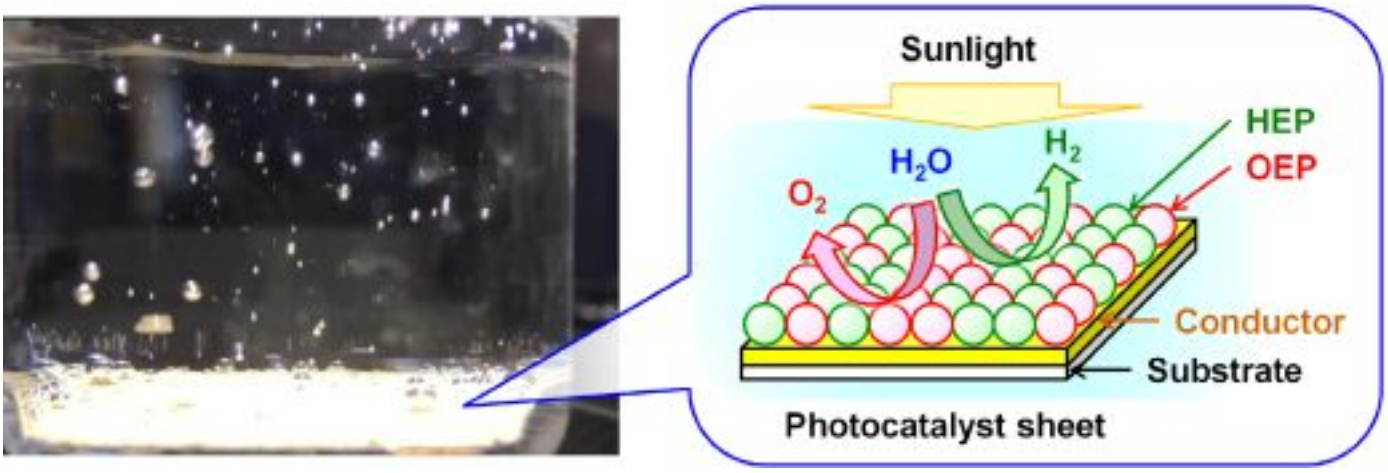


Figure 2. *Z-scheme particulate photocatalyst sheet evolving hydrogen and oxygen from water under light irradiation.*

Regarding the system development, extensible photocatalyst panel reactors and modules for separation of hydrogen and oxygen gases were devised **(Figure 3)** [4]. The photocatalyst panel produced a mixed gas of hydrogen and oxygen for approximately one year in the outdoor environment, with a peak STH efficiency of 0.76%, and transported the raw product gas to the gas-separation module smoothly. More than 70% of the produced hydrogen was recovered with a hydrogen purity of 94% from the raw product gas by using the gas-separation module.



Figure 3. *A 100 m^2 scale photocatalytic solar hydrogen production system.*

Establishing energy-efficient renewable solar hydrogen production systems

The ARPChem project demonstrated the feasibility of producing solar hydrogen via photocatalytic water splitting on an area scale of 100 m^2 and a time scale of one year. At the same time, it highlighted many technological issues for the practical application of this technology, including the development of photocatalysts and gas-separation membranes, reduction of system construction cost, and improvement of energy efficiency of water and gas processing. Safety and legal compliance of the system and process are also important aspects.

A follow-up project was launched in Japan in March 2022 with the aim of developing photocatalysts exhibiting an STH efficiency of 10% and one-hectare (10^4 m^2) scale panel reactors including gas-separation systems in 2030. Demonstration of such a working prototype of the entire system will stimulate research in various fields and promote the establishment of large-scale, cost-effective, and energy-efficient renewable solar hydrogen production systems.

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信州大学
SHINSHU UNIVERSITY

Kazunari Domen
Special Contract Professor
Shinshu University
Tel: +81 26 269 5225
domen@shinshu-u.ac.jp

EV battery research for transportation

Dave Howell, U.S. Department of Energy's Principal Deputy Director of the Manufacturing and Energy Supply Chains Office and Director of the Vehicle Technologies Office (VTO) highlights EV battery research for transportation

Transportation accounts for approximately 30% of U.S. energy needs and generates the largest share of the country's greenhouse gas (GHG) emissions. Decarbonizing the transportation sector is crucial to the Biden-Harris Administration's goal of a net-zero emissions economy by 2050. In August 2021, President Biden signed an Executive Order that set an ambitious target to make half of all new vehicles sold in 2030 zero-emission vehicles, including battery electric, plug-in hybrid electric or fuel cell electric vehicles.

To get there, lower-cost, durable, and safe advanced batteries to power electric vehicles (EVs) are needed. Advanced batteries power our daily lives, from consumer electronics to national defense, enabling electrification of the transportation sector and providing stationary grid storage vital to tomorrow's clean energy economy. The U.S. Department of Energy (DOE) is focusing on advanced battery research for EVs and stationary grid applications.

DOE's Vehicle Technologies Office is leading the charge on EV battery research

DOE's Vehicle Technologies Office (VTO) funds a broad portfolio of research, development, demonstration, and deployment (RDD&D) projects to develop affordable, efficient, and clean transportation options to tackle the climate crisis and accelerate development and widespread use of innovative transportation technologies. VTO's battery RDD&D has yielded breakthroughs in cost and performance over the past decade, reducing the cost of a battery pack 85% from around $1,000/kWh to $133/kWh while driving down weight and enhancing manufacturability. VTO's advanced battery research is aimed at new battery chemistries and cell technologies that cost even less ($60/kWh or lower) and go farther (range of 300 miles or more) while charging faster (charging time of 15 minutes or less).

Building a battery supply chain here at home

DOE recognizes that cost-effective advanced batteries need a domestic supply chain to back them up, so that we continue to see the growth of U.S. battery manufacturing jobs. Our efforts are leading the way to reduce U.S. dependence on critical materials such as lithium and cobalt by reducing the amount of these materials needed for battery production, developing substitute materials, and recycling materials already in use.

In response to President Biden's Executive Order on America's Supply Chains, last June DOE issued a 100-day review report of the large capacity battery supply chain, which recommended establishing domestic production and processing capabilities for critical materials to support a fully domestic end-to-end battery supply chain. The report underscored that both the public and private sectors play critical roles in strengthening our supply chains, the need for investment in R&D, and the importance of accelerating our ability to move innovations from the lab to the marketplace.

The Federal Consortium for Advanced Batteries (FCAB) is providing the framework for cooperation and coordination among federal agencies that have a stake in developing advanced battery technologies and establishing a domestic supply chain. DOE led the FCAB's efforts in releasing the National Blueprint for Lithium Batteries 2021-2030 that codifies the findings



Image: © Enanuchit | Dreamstime.com

of the 100-day battery supply chain review and details how federal investments will position the United States to lead an emerging advanced battery market. This February, DOE released a whole-of-government strategy to strengthen America's clean energy supply chain and 13 deep-dive assessments on technologies and topics critical to the clean energy transition.

The Bipartisan Infrastructure Law is investing in battery manufacturing

The Bipartisan Infrastructure Law provides a once-in-a-generation investment in America's infrastructure. It will invest over $7 billion to accelerate innovations and facilities across the battery supply chain, from materials refining and processing to recycling and second-life applications. On May 2nd, DOE announced two funding opportunities to invest $3.16 billion to strengthen the U.S. supply chain for advanced batteries and energy storage. The Battery Materials Processing and Battery Manufacturing funding opportunity will support the creation of new, retrofitted, and expanded commercial facilities and demonstrations that manufacture battery materials, cell components and batteries, along with battery recycling. The Electric Drive Vehicle Battery Recycling and Second Life Applications funding opportunity will support second-life applications for batteries once used to power EVs and new processes for recycling materials back into the battery supply chain.

The funding opportunities mark the first to be released as a collaboration between DOE's Office of Energy Efficiency and Renewable Energy and the new Office of Manufacturing and Supply Chains, created by DOE's organisational realignment to ensure that the Department has the structure needed to effectively implement the clean energy investments in the Bipartisan Infrastructure Law and the Energy Act of 2020.

Together, DOE's research, partnerships, and investments in advanced batteries are ensuring a strong and secure advanced battery supply chain in the United States in support of a clean energy future benefiting all Americans.

Dave Howell
Principal Deputy Director
Manufacturing and Energy Supply Chains Office and
Director of the Vehicle Technologies Office (VTO)
U.S. Department of Energy
www.energy.gov/eere/vehicles/vehicle-technologies-office
https://twitter.com/eeregov

Correlation of electrolyte properties, gas formation and heat generation by electrochemical-calorimetric methods

Dr Carlos Ziebert, leader of the group Batteries – Calorimetry and Safety, KIT, explains how electrochemical-calorimetric methods help to establish relevant correlations for improved batteries

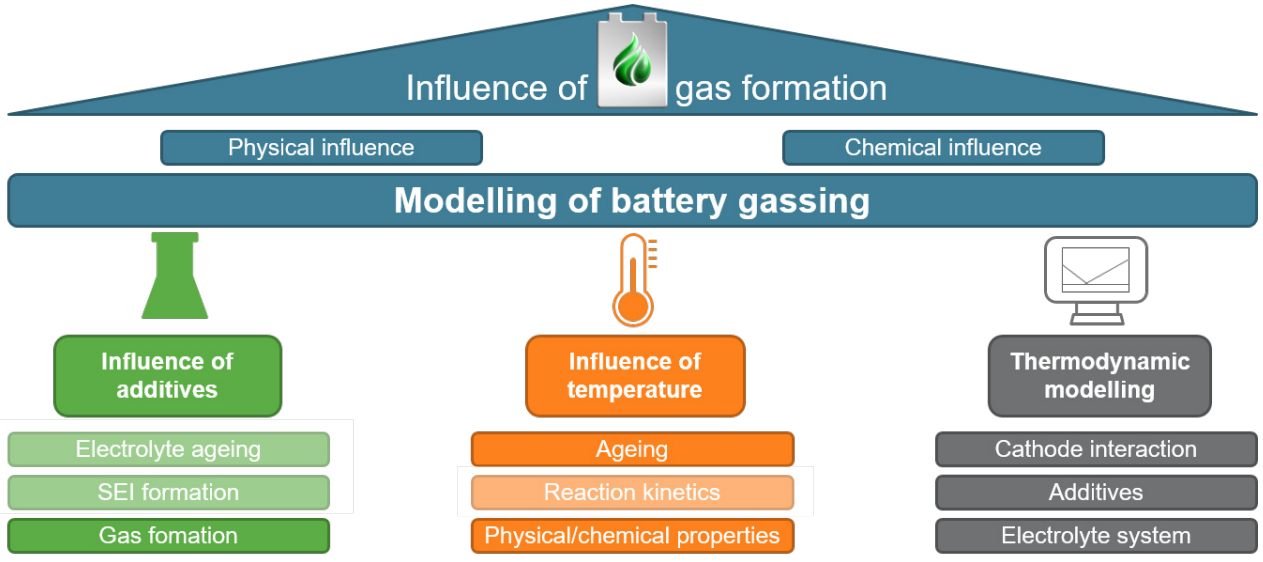


Figure 1: Connection of the different aspects of the work in the BatgasMod project.

In order to ensure a permanently high performance of lithium-ion batteries (LIB) in long-term operation the perfect interaction of the constituent components, such as electrodes, electrolyte, separator and current collectors is required. However, extensive material reactions occur during permanent charging and discharging, but also during the initial battery formation process, which can all negatively affect the behaviour of the LIB. Especially for cell aging and cell safety the reactions of the liquid electrolyte and the associated gas formation play a decisive role. Thus, these are in the focus of the BatgasMod (Modelling of Battery Gassing) project, which is funded by the German Federal Ministry of Education and Research (BMBF) and belongs to the new battery competence cluster Battery usage concepts (BattUse).

This competence cluster aims to foster our understanding of battery behaviour to determine when the second use of battery storage is preferable and has received funding of €20 million. The BatgasMod project started on 1st October 2020 and is coordinated by the Institute of Applied Materials – Applied Materials Physics (IAM-AWP) at Karlsruhe Institute of Technology (KIT). Other partners are the Institute for Power Electronics and Electrical Drives (ISEA) at RWTH Aachen University and the Münster Electrochemical Energy Technology (MEET) at the University of Münster.

Electrochemical-calorimetric measurements

The main aim of the project is to develop electrolyte aging models in combination with battery models for the early prediction of cell behaviour in the usage phase. Figure 1 illustrates the different aspects of the project. The work at the IAM-AWP is particularly highlighted here. It focuses on two areas. On the one side, electrochemical-calorimetric measurements are carried out on the active materials and the electrolytes as well as on the cells. This will ensure a consistent modelling in order to reveal the

decomposition mechanisms of the electrolyte and the simultaneous build-up of gas pressure during cell use. On the other side, the results of the calorimetric measurements are fed into a thermodynamic modelling of the electrolyte components, the additives and the electrode materials using CALPHAD (CALculation of PHAse Diagrams) methods provided by the Thermo-Calc software package. These methods are used to calculate phase diagrams and thermodynamic functions that will be finally implemented in the overall model provided by ISEA. Using this approach safety can be increased and the LIB can be operated much longer, thus enhancing their sustainability.

At first calorimetric investigations of the cell components were performed using highly sensitive Tian-Calvet calorimeters and differential scanning calorimeters. From these measurements, thermodynamic data of the electrolyte components ethylene carbonate (EC) and ethyl methyl carbonate (EMC) were modelled using the CALPHAD method.

At second pouch cells with a nominal capacity of 5 Ah were manufactured by the MEET battery production line and made available to KIT without a formation procedure. Three cell variants with different electrolyte compositions were produced, namely reference cells with a mixture of the organic solvents EC and EMC in a ratio of 3:7 (LP57) and LiPF6 as conductive salt and cells with 5 wt.-% vinylene carbonate (VC) or fluoroethylene carbonate (FEC) as an additive. Li(Ni0.6Mn0.2Co0.2)O2 (NMC 622) is used as cathode and graphite as anode. At third the pouch cells underwent a formation procedure at the

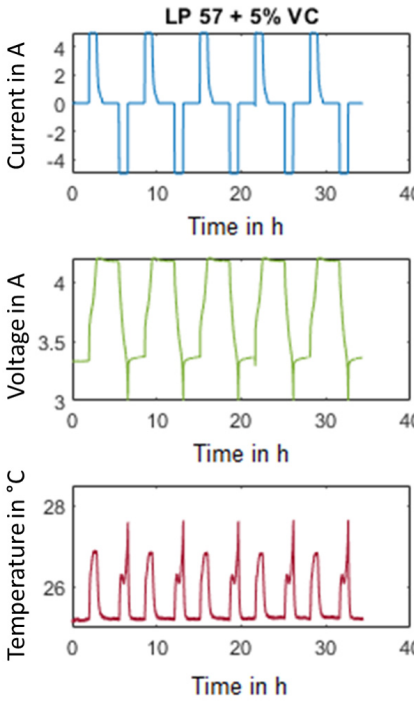


Figure 2: Current (blue curve), voltage (green curve) and temperature (red curve) during an Isothermal test on a cell with 5 % VC at 25 °C and a 1C charge/discharge rate.

IAM-AWP. It was found that the discharge capacity in the first cycle of the cells with additives was larger than that of the reference cells. This can be explained by the intended decomposition of the additives instead of the electrolyte. After formation, the cells were degassed and resealed to remove the gases that formed during formation from the pouch bag.

The gases were analysed qualitatively in a gas chromatography-mass spectrometer and typical decomposition products of the electrolyte or the additives such as CO, CO_2, methane, ethane and ethene could be found. After resealing an additional ten charge and discharge cycles, the heat capacity of selected cells was determined using highly sensitive heat flow sensors (HFX) that were attached to the centre of the pouch cell surface. To evaluate these measurements, an evaluation routine was developed using MATLAB software. Furthermore, isothermal tests were carried out. The cells were cycled in a climate chamber at 25°C with different C-rates (0.2C, 0.5C and 1C). During cycling the change in the surface temperature was measured by thermocouples. In addition, a heat flux sensor was attached to the cells to determine the generated heat. As an example, Fig. 2 shows the curves for an Isothermal test on a cell with 5 % VC at 25 °C and a 1C charge/discharge rate. First findings indicate that cells with VC additive produce more heat than cells with FEC. Now the different cells will undergo calendaric and cyclic ageing in order to study the influence of the ageing conditions on the gas formation and heat generation.

It is intended that both novel test methods that are developed in the course of the project and the complete model that includes electrolyte ageing and the related gas formation can be transfered to industrial partners afterwards. This serves both the mission of the cluster BattNutzung and the innovation pipeline of the BMBF umbrella concept for the German battery research factory.

Karlsruhe Institute of Technology

Dr Carlos Ziebert
Group Leader Batteries – Calorimetry and Safety
Head of Battery Calorimeter Center
Karlsruhe Institute of Technology
Institute of Applied Materials – Applied Materials Physics
Tel: +49 721/608 2919
http://www.iam.kit.edu/awp/

Sustainability, critical raw materials and batteries

Dumitru Fornea, Member of the European Economic and Social Committee, takes a look at sustainability, critical raw materials and batteries

The European Union, through the Paris Agreement, the European Green Deal and the Fit for 55 legislative package, has set ambitious and difficult-to-achieve targets for minimising the impact of human activities on the climate, and, specifically, reducing carbon emissions by 55% by 2030, and evolving towards a carbon-neutral economy by 2050.

Given the fact that energy and transport generate a large share of carbon emissions, technologically and ecologically viable solutions are being sought at European and global level to decarbonise these areas of activity. It is clear to everyone that energy and transport systems will have to be rethought both from the systemic perspective of infrastructure distribution and from the perspective of green technologies that will be used in the production and transmission of energy and in ensuring sustainable mobility.

Batteries and energy-storage systems play a key role in meeting the EU's carbon reduction timetable. Back-up systems in the field of energy, and electromobility in transport, are already integrating much more sophisticated and efficient batteries than those available up to now.

State-of-the-art batteries demand critical raw materials

The EU has a strong and innovative industrial and technological base for the production of state-of-the-art batteries, but the main problem is that the new batteries incorporate advanced materials, which are generating a very high global demand for new raw materials – some of which are already classified by the Commission as critical raw materials.

To better understand the impact of critical raw materials on European industries at the forefront of the decarbonisation efforts, the European Commission regularly assesses the state of supply chains and the evolution of mining production capacity in the world and in the EU. An important tool in this regard is the List of Critical Raw Materials. In 2017, there were 26 elements on this list (among them, heavy and light rare earths, borate, gallium, germanium, platinum group metals, etc.); in 2022, another 4 elements were added (bauxite, lithium, titanium and strontium).

Raw Materials Supply Group

Furthermore, following a proposal from stakeholders, as well as from the European Parliament and the European Economic and Social Committee (EESC), to facilitate cooperation on raw materials, in 2015, the Commission set up the European Institute of Innovation and Technology – Raw Materials; in 2017, it founded the European Battery Alliance; and at the end of 2020, it contributed to the establishment of the European Raw Materials Alliance.

All of these associative structures form a cluster of competencies, focused on research and development, and innovation for the production of new advanced materials and industrial and mining equipment updated to the new requirements, as well as on fostering a better understanding of some of the commercial aspects that are essential in setting up secure and reliable supply chains of critical and strategic raw materials for the EU.

The circular economy, substitution materials and innovative eco-design can make a significant contribution to reducing dependence on non-European raw material sources, but it will not be possible to completely eliminate critical raw materials from the innovative technological equipment that is absolutely necessary to achieve the climate goals. This



Dumitru Fornea
European Economic and Social Committee (EESC)

means that we will have to continue to strengthen the EU's production capacity through geological exploration and the development of new mining perimeters, and at the same time, we will have to do much more to identify new sources of secure supply outside Europe as alternatives to global supply chains monopolised by some states or multinational companies.

In short, the solutions identified by the experts participating in the meetings organised by the Commission in the framework of the "Raw Materials Supply Group" would be the following:

• Setting up European geological exploration capacity, maintaining an active mining industry in the EU, as well as industrial capacity for superior processing of the chemical elements extracted from European soil, and at the same time, capitalising on the significant stock of mining and industrial waste available in some Member States;

• Concluding mutually beneficial partnerships in the field of critical raw materials, brought about through EU companies' investments in the US, Canada, Australia, Latin America, Africa and Asian countries such as Vietnam and Myanmar. The Global Gateway and the EU's trade agreements with these states should facilitate the process of diversifying global supply chains, reducing dependence on states that use the monopoly on raw materials to pursue political and strategic objectives contrary to the interests of the EU and its allies.

• Exploring the exciting possibilities offered by the extraction and processing of polymetallic nodules and other elements that can be exploited from the bottom of the seas and oceans, given the enormous areas under the control of European States (France, the UK, Denmark, Norway, the Netherlands) and like-minded partners.

The EESC has been and will remain a committed partner and supporter of the EP and Commission's efforts to strengthen the security of supply of the raw materials essential for maintaining the competitiveness of European industries and the jobs of EU citizens.

Dumitru Fornea
Rapporteur for the EESC opinion on Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability
Member, European Economic and Social Committee (EESC), Workers' Group (Group II)
European Economic and Social Committee (EESC)
Tel: +32 (0)2 546 90 11
www.eesc.europa.eu
https://twitter.com/EU_EESC

Intercepting smuggled products to protect animal health

Will Wepsala, Public Affairs Specialist at the Animal and Plant Health Inspection Service, part of the U.S. Department of Agriculture, walks us through the work of intercepting smuggled products to protect animal health



An example of a smuggled product shipment seized by the U.S. Department of Agriculture and held at the warehouse pending destruction.

Photo courtesy of USDA

The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) plays a vital role in protecting America's agricultural and natural resources. Part of this role is ensuring that all imported agricultural products are safe and free of any pests or diseases. USDA regulates these products, and officials with the U.S. Department of Homeland Security's Customs and Border Protection (CBP) enforce these regulations at U.S. ports of entry. For nearly two decades, our strategic and essential partnership has protected U.S. agriculture, which contributes more than $1 trillion to the U.S. gross domestic product and supports more than 22 million jobs annually.

"Sometimes travelers or companies bring prohibited agricultural products into the United States," said Smuggling Interdiction and Trade Compliance (SITC) National Policy Manager Charles Citrone. "That's where APHIS' SITC comes in. The program works to detect and prevent the unlawful entry of agricultural products. Discovering these illicit products is crucial to fighting against the introduction and establishment of foreign plant and animal pests and diseases, and invasive species that they can carry."

Pork, chicken, and beef products that do not meet U.S. entry requirements can spread diseases like African

swine fever, classical swine fever, foot and mouth disease, and virulent Newcastle disease.

African swine fever (ASF)

The potential introduction of African swine fever (ASF) is one example of a threat that SITC works to prevent. "In recent years, ASF has spread throughout Asia and Europe," said Kristian Rondeau, SITC Operations Director. "It was also recently detected in Haiti and the Dominican Republic, the closest it has been to the United States in decades. Although ASF does not threaten human health, it is highly contagious and deadly to swine, with a mortality rate that can reach 100 percent. If it were to be introduced into the United States, it could devastate the U.S. pork producers and the communities that rely on them."


William Wepsala

"Regulating the importation of pork products is important, but we also need to stay vigilant to prevent those who are willing to smuggle prohibited products. USDA's robust efforts to keep ASF out of the country help protect U.S. livestock producers, their communities, and the economy that depends on them."

ASF is a particular concern because of its survivability. ASF can remain viable in frozen, fresh, or uncooked pork — as well as salted, dried pork products — for several weeks or months. Because of this, APHIS prohibits the entry of fresh or frozen pork from countries affected by ASF and only allows the importation of cooked pork under specific regulations.

"SITC is a vital component of the interlocking measures USDA has in place to prevent the introduction of ASF into the United States," said Rondeau.

Seizing prohibited agricultural items can protect animal health

SITC has recently seized a large volume of prohibited agricultural items. In 2021, the program seized 224,568 pounds of prohibited agricultural items valued at over $1.7 million. As of May, SITC has already made 692 seizures of animal products alone in 2022, totaling 46,455 pounds and valued at $669,153. CBP personnel at Port of Los Angeles Long Beach reported the seizure and destruction of 786,540 pounds of prohibited animal products in 2021, an 80 percent increase over 2020.

Regulating the importation of pork products is important, but we also need to stay vigilant to prevent those who are willing to smuggle prohibited products. USDA's robust efforts to keep ASF out of the country help protect U.S. livestock producers, their communities, and the economy that depends on them.

William Wepsala
Public Affairs Specialist
Animal and Plant Health Inspection Service (APHIS)
U.S. Department of Agriculture (USDA)
Tel: +1 844 820 2234
William.Wepsala@usda.gov
www.aphis.usda.gov
https://twitter.com/usda_aphis

The challenges of global food security – Part 2

Curtis R Youngs, Professor & M.E. Ensminger Endowed Chair of International Animal Agriculture, continues the discussion of the challenges of global food security

Societies are faced with unprecedented global food security challenges due to a myriad of factors such as rampant global inflation (9.2% in March 2022[1]), climate change that is adversely impacting agricultural productivity[2], and disruptions in the food supply chain caused by the Russian invasion of Ukraine.

Between 720 and 811 million people faced hunger during the year 2020[3], and an estimated 47 million additional people will face acute hunger in the 81 countries where the World Food Programme (WFP) operates - due solely to the Russian invasion of Ukraine[4]. When one considers citizens in countries where WFP does not operate, persons facing hunger could easily surpass 900 million (approximately one in every nine people globally).

Global food security programs and human consumption

A variety of different organisations, foundations, and governmental agencies has developed programs to address the massive societal problem of hunger. Those food security programs were designed to increase awareness of the problem, develop strategies to combat the issue, and implement specific action steps to reduce the number of people affected by hunger and malnutrition. Food insecurity knows no geographical boundaries. For example, 10.5% of all households (116.7 million people) in the United States were food insecure in 2020[5] – and this global food security crisis is only growing.

Although it is commonly believed that there is a sufficient quantity of food being produced at present to feed every man, woman and child on the planet, the figures on hunger tell a different story. Why does this apparent discrepancy between common belief and reality exist? Perhaps the reason lies in the massive volume of "wasted food".

Globally, one-third of food produced for human consumption is wasted (1.3 billion tons per year valued at $U.S. 1 trillion), and, if totally prevented, it would be enough food to feed two billion people[6]. Herein lies the connection between the belief that enough food exists to feed the world's population and the reality of hunger. If wasted food were a country, it would be the third-largest producer of carbon dioxide (a potent greenhouse gas that causes climate change) in the world - behind the U.S. and China[6].

Reducing wasted food

"Wasted food" is a term that the United States Environmental Protection Agency (EPA) has adopted in their systematic approach to developing a sustainable food management program. Their program seeks to reduce wasted food (and its associated impacts) over an entire life cycle – starting from the use of natural resources and continuing through manufacturing/processing, sales/distribution, consumption (at home and in restaurants), and disposal[7].

The EPA definition of wasted food is "food that was not used for its intended purpose", and the term "food waste" purposefully is avoided to encourage people to think more broadly about this problem. In 2015, EPA and the United States Department of Agriculture (USDA) joined forces with the goal of reducing wasted food in the U.S. by 50% before the year 2030. Most estimates indicate food wastage in the US at between 30 and 40% of the food supply.

Wasted food is generated through food loss from the agricultural sector (e.g., unharvested crops; loss of crops during harvest, transport, and storage; livestock death loss) and the consumer sector (e.g., unsold food from retail stores, food spoilage at home, uneaten meal portions). The U.S. EPA developed a "food recovery hierarchy" to identify actions that individuals and organisations can take to reduce wasted foods[8].

What is the food recovery hierarchy?

This inverse hierarchy (i.e., upside down triangle) has six categories. The five action categories are: 1) source reduction (reduce the volume of unused food generated), 2) feed hungry people (donate unneeded

food to food banks and shelters), 3) feed animals (divert food scraps to animal feed), 4) industrial uses (generation of fuels and energy), and 5) composting (creating a nutrient-rich soil amendment). The sixth and final part of the hierarchy is landfill/incineration (which should be considered a last resort). In 2020, methane emissions from landfills accounted for 15% of total US methane emissions[9]. The United Nations Environment Programme (UNEP) estimated that 8-10% of all global greenhouse gas emissions are associated with food that is not consumed[10].

The UNEP Food Waste Index Report 2021[10] is heralded as the most comprehensive data collection, analysis, and modelling of food waste to date. (In this report, food waste was defined as "food and the associated inedible parts removed from the human food supply chain in the retail, food service, and household sectors").

It also provides methodologies for countries to measure wasted food at the household, food service and retail levels and to track progress toward meeting sustainable development goal (SDG) target 12.3 (by 2030, to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses). This report revealed that the global average for wasted food is a whopping 74 kg per capita and was remarkably similar for lower-middle income countries and high-income countries. Food waste was generated 61% at the household level, 26% at the food service level, and 13% at the retail level.

So, what action steps can be taken immediately by citizens to reduce the problem of wasted food at the household, food service, and consumer levels?

Action steps to reduce wasted food include:

1. Pick one week to keep track of all food purchased and all food consumed. Attempt to quantify the amount of wasted food (either by weight or volume), the proportion of food wasted, and the associated cost of that wasted food. Set a goal for future weeks to reduce food waste.

2. Don't go grocery shopping while hungry to reduce the likelihood of overbuying – particularly for perishable items such as fruits, vegetables, meat, milk, and eggs.

3. Educate yourself regarding the dates on food packaging (i.e., "use by" or "best buy") and buy foods with a close "expiration date" if they can be consumed safely.

4. Consider working to pass laws that reduce legal liability for retailers and restaurants that donate food.

5. At restaurants, order smaller portion sizes (i.e., clean your plate) and/or take home any food you don't consume for later consumption (using your own recyclable food container, if permitted by local law).

If everyone takes some small steps to reduce food waste, the collective benefits will undoubtedly help feed the world.

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IOWA STATE UNIVERSITY

Curtis R Youngs
Professor & M.E. Ensminger Endowed Chair of International Animal Agriculture
Iowa State University
Tel: +1 515 294 5541
cryoungs@iastate.edu
www.ans.iastate.edu/people/curtis-youngs

Selecting for resilience and efficiency: The solution for European cattle farming

Nicolas Friggens at the French Research Institute for Agriculture, Food and Environment (INRAE) discusses cattle farming resilience and efficiency with genomics in breeding programmes

The arrival of genomics and its use in livestock farming has seen a step-change in breeding programmes. It has greatly improved selection accuracy and now offers many options for selecting more complex but appropriate traits like animal efficiency and resilience.

The use of genomics in livestock has been paralleled by the rapid expansion of Precision Livestock Farming (PLF), which includes using on-farm technology that enables cost-effective data collection and monitoring.

These technologies greatly help farmers' ability to phenotype a much wider range of traits in increasing detail and in larger populations. Over the last five years, the GenTORE EU project has successfully brought genomics and PLF together to provide on-farm management tools to sustainably improve efficiency using resilient animals.

Genomic sequencing is getting increasingly cheaper. When combined with more powerful computing and better statistical tools, we have seen a rapid uptake of genomics and increased selection intensity in the European dairy industry and, to some extent, in beef production.

GenTORE has developed a range of practical management tools that will help farmers focus on matching their animals to the options available to them. This will include identifying which animals to breed, crossbreed or cull, thus making cattle enterprises more economically efficient, more appropriate to current and future environments, and better fitting for what consumers demand.



"GenTORE has developed a range of practical management tools that will help farmers focus on matching their animals to the options available to them."

Tools to match cattle to their environment

Identifying which cattle genotype is best for current and future environments and sufficiently resilient requires finding the best blend of animal resilience and animal efficiency. However, these traits are generally poorly defined and so hard to measure. GenTORE scientists have developed a database combining regional topographic with climatic and farm types to aid in forecasting climate change effects on cattle production systems by region. They have also produced animal-level lifetime performance prediction models for dairy and beef using efficiency measurements and environmental impact. This will enable breeders and farmers to identify whether the local production environment is likely to challenge animals. Then, by ranking their animals in terms of resilience and production efficiency, farmers will be able to decide which ones will best suit local conditions as pure-breds or cross-breds or whether they should be sold.

This means the 'best' animals are selected for the local environment.

Improved Phenotyping for resilience and efficiency

Resilience and efficiency are complex and variable traits, and we lack practical references, on a large scale, for predicting which young animals will make good cows. Technologies currently used in precision livestock farming focus on monitoring and detecting specific events in individual cows like oestrus cycling. GenTORE had developed a multiple trait random regression model using this high-frequency data to measure efficiency. This allows the assessment of efficiency not just in fixed periods but at all time points throughout the lactation in dairy cows and the growth period in beef cattle. It has also developed a scoring system to assess a lifetime resilience score (LRS). The model will allow the farmer to evaluate the cow's 'ability to re-calve' and gives an estimate of its productive life. Farmers will be able to use on-farm information collection to calculate individual animals' LRS and rank all the cows in the herd, which will help them predict the LRS early in life to identify which cows to breed and keep. Farmers will be able to 'piggy-back' on technologies currently being used to monitor health or drones to collect data, making decisions on grazing. As this becomes cheaper and more commonly deployed, ranking and prediction will become more accurate.

Genomics Tools

There are four distinct ways genomic tools can provide solutions to the challenges facing farmers: genotype by environment interactions, systematic crossbreeding, identifying efficiency and resilience traits, and making the right management decisions. GenTORE has developed tools for the first two of these: tools and protocols that allow for the analysis of individual Single Nucleotide Polymorphism (SNP) effects and multi-breed genomic methods that allow joint evaluation of pure-breds, cross-breds, and admixed individuals.

These tools will lead to more efficient and resilient cattle systems through better utilization of and selection in crossbreeding systems, better selection within and across environments, and better management decisions.

Breeding Strategies for Mitigation

Genetic tools can be used to reduce emissions per kg product through improving productivity and efficiency, reducing wastage at the herd level, and reducing emissions by direct selection, when individual animal emissions are measurable. GenTORE has looked at several strategies that reduce management costs as well as emissions, including:

(i) Improved fertility: reducing calving intervals and inseminations would result in shorter dry/unproductive periods.

(ii) Improved longevity: reducing the number of growing replacement females required would produce less additional emissions and costs for the farmer;

(iii) Improved health: again, reducing unproductive periods or minimising production losses, as well as reducing involuntary culling, would provide both economic and environmental benefits;

(iv) Improved feed efficiency: for example, selection for improved residual feed intake would directly affect emissions, like animals that eat less for the same production level tend to produce fewer Green House Gases (GHGs). Also, indirectly, by reducing emissions associated with feed production;

(v) Improved resilience of cattle and farms: this could minimise production losses and enable animals to live longer, resulting in improved efficiency and reduced emissions.

GenTORE has made huge progress in the short period. Its research findings will be of great value to farmers and researchers wanting to refine future cattle genomics. If you want to learn more go to www.gentore.eu, where each of the four themes here presented is elaborated in greater detail, as well a full list of GenTORE results publications and a range of videos describing GenTORE are provided.

GenTORE has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 727213.

GENTORE

Nicolas Friggens
GenTORE Coordinator
INRAE
Tel: +33144081767
nicolas.friggens@agroparistech.fr
www.gentore.eu
https://twitter.com/gentore_h2020

Could technology and innovation in agriculture feed the world?

David Green, Executive Director at The U.S. Sustainability Alliance, argues that technology and innovation in agriculture can feed the world, but if only we let it

By the time you read this sentence, ten more people will have been added to our growing world population. [1] We are a mere 29 harvests away from producing more food than in the past 10,000 years if we are to meet the most basic human requirement – eating – for the expected world population of nearly 10 billion. [2] Add to that the pressure on land and natural resources and the threats posed by climate change, and the need for safe, trusted innovation in agriculture food supply is greater than ever.

In the United States, technology and innovation have increased agricultural output by 400% over the past 90 years with 10% less land and without an aggregate increase in required inputs. [3] However, modern agriculture is often feared rather than revered.

Past and more recent history are full of examples of innovative research, from artificial insemination to transgenic crops, struggling for acceptance once the outcomes were commercialised. Concerns about safety or monopolisation or upsetting the status quo can slow or stand in the way of much-needed technology.

Such misgivings raise the question of whether the risks and costs of not adopting innovative research outweigh the risks and costs of embracing it. Dealing with such a paradox will require a shift in societal thinking to minimise the view that innovation equals risk.

Safety first

Outsiders often portray Agriculture in the United States as large-scale and industrial, with farmers only too eager to grab the latest innovation. However, 98% of America's farms are family farms, and when these farmers do adopt new technology, it is only when they are convinced it is safe for them, their family and the land, and when they know it will make a positive difference to their operation.

For Nebraska farmer Brandon Hunnicutt, thirty years of innovations in drought and pest-resistant seed varieties and precision agriculture have enabled him to grow more with less impact. And, he says, such innovation is key to a sustainable future.

"I am struck by the essential task in front of all of us to unlock the next suite of innovations to ensure we continue to yield equal value for farmers and nature," he writes in [4] Agri-Pulse.

He believes that progress and ultimate success in solving the climate crisis lie in "learning together, mobilising more capital to support farmers in the transition, and pursuing solutions that create wins for farmers, business, society and the planet."

From the lab to the field

In line with Brandon Hunnicutt's vision, the U.S. Department of Agriculture (USDA) and its agencies fund ongoing research to support U.S. farmers while providing a wide range of advisory services to help translate this research into practical reality.

USDA's National Institute of Food and Agriculture (NIFA), for example, not only invests in research in areas as diverse as plant and animal breeding, genetics, biosecurity, and climate-smart practices. It also supports extension and advisory services that share the knowledge garnered from this research directly with the farmers who can put it into practice.

Technology innovation is high on NIFA's agenda, as reflected in its recent [5] investment of nearly $4 million



in two new 'Centers of Excellence' at universities which are part of the 1890 Land Grants Institutions National Program. [6] The funding will support projects to advance smart agriculture and promote its adoption among small and minority farmers, conserve and promote natural resources, and explore renewable energy. Other NIFA innovation programs range from [7] critical research into new crop varieties with better productivity, quality, and tolerance of environmental variability, to [8] research to better understand, diagnose, control, and prevent diseases in agricultural animals and aquaculture.

Consumer understanding – the missing piece

If we are to feed the world's growing population without depleting natural resources, research such as that funded by USDA and NIFA will be vital. But just as important is the need to advance consumer understanding of technology and why farmers use it. Speaking on the [9] This is U.S. Sustainability podcast, North Dakota soybean farmer Monte Peterson shared his theory that as generations go on, society has become further and further removed from the farm, which is how misunderstanding can creep in. "But I think it's important for each of us as consumers to follow sound science," he says, "to reach out to those that are in production agriculture, and ask questions, to learn about how our food is made today, and how it is done." The hope is that a greater understanding of farmers' practices will ease fears of what might be new but is definitely needed.

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David Green
Executive Director
The U.S. Sustainability Alliance
info@thesustainabilityalliance.us
https://thesustainabilityalliance.us/
www.linkedin.com/company/the-us-sustainability-alliance/
www.twitter.com/SustainableUSAg

The link between soil health and the survival of global agriculture

Here, we speak to Assistant Professor Christine Sprunger, who gives us expert insight on the universal need for soil health

When it comes to questions of climate change, food security is often one of the most well-discussed issues. In the wake of recent violence, global conversations are centering around access to certain crops.

It is common knowledge in some parts of the world that extreme weather systems directly shape the ability to grow food – but soil health is also at the heart of the issue. Soil can also function as a carbon sink, which makes it especially intriguing to scientists.

Firstly, do you think that the ongoing COVID-19 pandemic had a significant impact on agroecosystems?

"This is an important but complex question. In January 2021, we interviewed Ohio farmers and asked how covid was impacting their operations. About 90% of farmers said that COVID-19 had zero impact on their operations, with about 10% stating that they had started to see supply chain issues on their farm or difficulty accessing rental equipment for their farm.

"However, I want to stress that this was a small sample size in one region within the United States. Now that we are halfway through 2022, scholars around the world have been able to conduct extensive research on how COVID-19 has impacted agroecosystems worldwide. This is outside my area of research but many scholars including Baffoe-Bonnie et al., (2021) and Boerngen and Rickard, (2021) note that the COVID-19 pandemic has shed light on unequal access to the internet due to inadequate broadband availability in rural communities.

"Pre-covid, soil scientists, agronomists, and extension educators have relied on in-person conferences to communicate with farmers on emerging research within agriculture. The scholars mentioned above state that COVID-19 reduced communication and adult education opportunities for farmers in the United States due to inadequate broadband availability.

"More broadly, I think the delayed impact of COVID-19 on agroecosystems likely has to do with supply chain issues and market value but again this is not my area of expertise."

Secondly, when it comes to soil health and greenhouse gas emissions, you mention that you're working on improving carbon sink capacity. What can you tell us about that?

"Soil health and soil carbon are intricately linked. Soil carbon drives biological, chemical, and physical processes in the soil, and when enhanced, this directly benefits soil health. Additionally, soil has the capacity to store two times more carbon than the atmosphere. Thus, if carbon storage increases within a given soil, then there is less carbon in the atmosphere. For this reason, many soil scientists (including myself) are interested in quantifying soil health from the perspective of soil carbon sequestration and climate mitigation.

"One way that my lab examines soil carbon is by comparing carbon across a range of soil health promoting practices. Examples of soil health promoting practices according to the U.S. Natural Resource Conservation Service that 'soil health promoting practices are those that increase soil organic matter inputs, increase soil biota by diversifying plants in a rotation, extend year-round cover to prevent erosion, and consists of living root throughout the year.'

"In a recent publication in Agriculture and Environmental Letters (Sprunger et al 2020), we report results from a study that compared a series of soil health promoting practices including annuals grown in rotation with a cover crop, perennial monoculture systems, and perennial polyculture systems. We found that both perenniality and plant biodiversity are critical for increasing soil carbon. Perennial polycultures have an advantage to building soil C because of their extensive roots and more diverse soil food webs. Taken together, these mechanisms enhance soil C pools and promote soil carbon sequestration. Another noteworthy finding is that even amongst the annual systems, diversity played an important role.

"For instance, corn grown in rotation with soybeans + cover crops had

significantly greater carbon than those found in continuous corn systems. The take home message here is that soil health promoting practices including perenniality and plant diversity are critical for enhancing soil health and have implications for long-term soil carbon storage."

Third, reflecting on the connection between soil and the climate, what do you predict will happen to global agroecosystems if left alone?

"In the Upper Midwest, USA, we are already experiencing more frequent extreme weather events. In the spring and summer this means more intensive rainfall events that lead to major flooding followed by periods of drought during the summer. This more erratic weather is already a burden for farmers. It has been reported that flooding reduces crops yields by 34% compared to the long-term yield trend (Li et al., 2019). Moreover, in 2019, the Midwest, USA experienced the wettest growing season on record. This historic event caused massive delays in corn and soybean plantings and in many cases, row crops could not be planted at all due to continued standing water. In the end, 20 million acres went unplanted. This drastically beat the record of unplanted acreage which was previously ten million in 2017. If unchecked, climate change will continue to cause irregular and extreme weather patterns that will make farming more challenging.

"In regards to soil biogeochemical processes and climate change, this is something that many are still working to understand. Research has shown the elevated CO_2 and soil warming can alter soil biogeochemical cycles, leading to more loss of CO_2 from soils into the atmosphere. Our lab group is currently assessing how things like flooding and drought impact soil health, and even more specifically, soil biota."

Finally, what did you discover about farmer perceptions of global climate change? Are there any insights you believe would be beneficial for climate strategists, policy-makers and scientists?

"We generally don't directly ask farmers about perceptions of climate change, more so, we ask them how extreme weather events impact their soil management and farm operations. 50% of the farmers we talk to generally say they are not impacted too badly, and their strategy is to wait to plant until weather conditions improve. The other 50% say that extreme weather events are making them reconsider soil health promoting practices like cover crops and more diverse crop rotations. However, many followed this statement with a question, 'if I incorporate cover crops will this help alleviate excess moisture?'

"This question is important because there is still a lot of research that needs to be conducted in this space. My colleague Alex Lindsey and I are conducting a project on this very question. We are working to see which cover crops are most effective at alleviating excess moisture prior to corn planting. The message to policy makers is that it is important that agencies continue to fund research in soil health and climate change so that we can address important scientific questions that have practical implications for farmers."

Why are nematodes so important in the soil health framework?

"My lab has recognised an important need in developing nematodes as a potential soil health indicator. In general, most soil biological health indicators reflect the activity of the microbial communities but do not directly measure soil organisms. This is problematic given how instrumental soil biota are at influencing soil health. In recent years, my lab has proposed incorporating beneficial nematodes into the soil health framework. Beneficial nematodes serve as important organisms within the soil food web due to the variety of feeding types, those that feed on bacteria, fungi, plant roots, and carnivores that feed on each other. Nematode indices, developed by famous nematologists, Ferris et al., (2001) are derived from nematode identification and can provide important inferences to nutrient cycling, ecosystem disturbance, decomposition pathways, and community complexity. Despite the important information that can be collected, nematode indices have largely been excluded from the soil health framework because of the specialisation required for identification through microscopy.

"Our group has made important advances in nematology by working to assess how nematodes are related to other soil biological health indicators (see Martin et al., 2022)."



Christine Sprunger
Assistant Professor of Soil Health
Michigan State University
Tel: +1 (330) 263-3916
sprunge5@msu.edu
www.sprungerlab.com
@Sprunger_PhD

The consequences of farm policy and regulations on America's food supply

Peter Bachmann, Vice President, Policy & Government Affairs at USA Rice, sheds light on the consequences of farm policy and regulations on America's food supply

The U.S. rice industry has a long and storied history as one of the oldest crops to be domestically cultivated in America. For America's food supply, it is primarily a regional crop, grown from as far north as Illinois and following the Mississippi River south, through Arkansas, Louisiana, Missouri, Mississippi, and parts of Texas along with the Sacramento Valley in California.

Half of the rice grown in the U.S. every year is shipped to more than 120 countries around the world, making the United States the fifth largest exporter. And while U.S. production is typically around 3 million acres, that figure tends to oscillate depending on a number of economic, weather, and regulatory factors.

Most U.S. legislators and regulators try to write programmes and regulations in a way that is agnostic and doesn't give advantages to growing one commodity over another.

Secondary factors leading to changes in commodity production

Specifically, U.S. farm policy is carefully drafted to ensure that farm safety net payments are not tied to plantings for that specific year, referred to as 'decoupled' payments, to stay compliant with World Trade Organization commitments. While these support payments don't encourage or discourage the planting of certain crops, secondary factors can lead to drastic swings in commodity production.

A recent example of those secondary factors at play is the Russian invasion and war against Ukraine. As significant grain producers and exporters, knocking them out of the global market has had a dramatic impact on commodity prices, especially corn, soybeans, and wheat. And just in time for the American planting season.



Peter Bachmann
Vice President, Policy & Government Affairs, USA Rice

Many factors influence what a farmer will plant each year, ranging from their soil type, marketability of their crops, cost of production, and one of the most evident – the price they think they can get for their crop after harvest. When rice farmers across the middle South states, Arkansas, parts of Louisiana, Mississippi, and Missouri are planning for their upcoming cropping season, most have several options: corn; soybeans; cotton; or rice.

Unfortunately, rice has the highest cost of production on that list because of the fertiliser and other inputs required. To make matters worse, prior to the war in Ukraine, there was already a global fertiliser shortage stemming from pandemic-related backups, further exacerbated by a combination of export bans and import sanctions on Russian fertiliser. Rice also has a relatively low market price compared with other commodities.

International matters affecting America's food supply

Because rice is not a staple in Russia and Ukraine, there was no proportional price spike after the invasion, but the same cannot be said for the price of other grains. The United Nations' Food and Agriculture



Rice field in Texas

Image: © Nat693 | Dreamstime.com

Organization's price index for cereal grains jumped 17.1% between February and March [1], while the price index for rice remained stagnant, 10% lower than it was a year ago.

The global fertiliser shortage and price spikes have taken their toll on input-heavy crops like rice, except in markets like India, where the government has committed more than $20 billion U.S. dollars to insulate their farmers from fertiliser price increases.

Meanwhile, U.S. farmers are looking to crops with promises of larger margins and reported to the U.S. Department of Agriculture (USDA) that they intend to plant 3% fewer rice acres in 2022 than they did in 2021. Except there's one problem. Most of those surveys were completed before the impacts of Russia's invasion of Ukraine were realised. They were also carried out before California, the second-largest rice-producing state, had completed 2022 water allocations – which all have an effect on America's food supply.

While farmers in California confront drought-related decisions, the decision for farmers in the South is a little trickier. Those farmers know they will have sufficient water all summer, but their net profits could look vastly different depending on which crop they choose to plant once they account for the cost of production and take a gamble on what the market prices will look like down the road.

Was the 3% decrease in rice acres too small a prediction?

USDA's projected 3% drop in 2022 rice acres is likely an understatement for the reality of what gets planted. U.S. rice farmers are in a quandary this year; market prices are high enough that they will not receive farm safety net payments, but they are low enough that their increased input costs are not covered by their income.

While U.S. legislators worked to create a fair farm safety net, the programmes are failing to actually help producers during the most critical production years.

Luckily, rice farmers are hardy, and weather conditions are never predictable, nor is legislation. They know they have to make hard decisions some years to stay in business for the long haul. Perhaps even more importantly, many of these farmers are fourth, fifth, and even sixth-generation rice farmers. They grow rice because it's their lifestyle; it's not just a job or a stream of income. They work as a family on the farm and grow a crop that will feed their community and the world.

The hope is that the U.S. rice industry's resilience will hold its own, the infrastructure will arm itself for more challenges in the future, and the United States can continue to provide the world with its bounty of high-quality rice for many generations to come.

1. FAO Food Price Index posts significant leap in March

Peter Bachmann
Vice President, Policy & Government Affairs, USA Rice
Member of the U.S. Sustainability Alliance
Tel: +1 703 236 1478
pbachmann@usarice.com
www.usarice.com
https://thinkrice.com
https://twitter.com/Think_Rice
https://twitter.com/usaricenews

A decade after the most important gene of fragrance rice uncovered

Professor Dr Apichart Vanavichit, Director of the Rice Science Center, reflects on the decade since the most important gene of fragrance rice was uncovered

Fragrant rice is much sought after worldwide and as such, sells for higher prices than non-fragrant rice. There are two popular fragrant rice classes in the global market, soft-cooked long grain Jasmine rice and fluffy-cooked long grain Basmati rice. In Asia, soft-cooked fragrant rice is more prevalent among middle and wealthy-income populations. Developing new fragrant rice varieties is a strategic goal in rice-consuming countries.

Characteristics of rice fragrance

Cooked rice aroma possesses around 200 volatile compounds, including hydrocarbons, alcohols, aldehydes, ketones, acids, esters, phenols, pyridines, pyrazines and other compounds. In 1983, scientists identified the potent aromatic compound in rice known as 2-acetyl-1-pyrroline (2AP). Fragrant rice accumulated much higher levels of 2AP compared to non-fragrant rice. However, the detection of 2AP requires laborious analytical methods not suitable for rice breeding programmes. Using aroma-specific DNA markers, breeders can select better fragrant plants with more robust throughput. For the first time, the most important gene was cloned from Thai Hom Mali Rice, the world-renown fragrant rice, in 2004. The knockout mutation was identified for precision breeding of fragrant rice.

Function & diversity of the fragrant gene in rice

The gene involved in making rice fragrance is a dysfunction of amino aldehyde dehydrogenase (AMADH), the specific enzyme converting 4-amino butanol to 4-amino butyric acid (GABA) found in non-fragrant rice. Consequently, the building-up of the toxic butanol is converted into 2AP in fragrant rice [(1)]. Is such a biochemical pathway unique for the Thai Hom Mali rice?

A genetic survey concerning four classes of fragrant rice, Basmati (Central Asia), Paw San Hmwe (Myanmar), Jasmine (Southeast Asia), and Japonica (East Asia) showed a similar dysfunctional enzyme AMADH knock-out by specific mutations.

Precision breeding of fragrant rice

Gene sequences of inactivated mutations were used for designing specific DNA markers for precision breeding. Since 2008, many rice-consuming countries have released newly improved fragrant rice varieties. More than 50 new fragrant rice varieties in Thailand were improved for resistance to biotic and abiotic stresses. In India, 18 new Basmati rice varieties have been released since 2008. Also, improving high yielding and early maturity fragrant rice has been the major goal In Vietnamese rice.

Discovering fragrant genes in other plants & microbes

The rice fragrance was also detected in other plant species. It is interesting to know if they also carried similar genetic dysfunction of AMADH as rice. The AMADH-like genes from 12 fragrant plant species were analysed for genetic similarity, including rice, bread flour, pandan, vegetable soybean, sorghum, mung bean, taro, spinach, cucumber, ridge gourd, sponge gourd and winter melon. The result revealed different inactivated mutations that did not express the AMADH-like genes yet created 2AP. In addition, a similar genetic mechanism was also responsible for 2AP biosynthesis in bacteria and fungi such as *Bacillus cereus* and Bakers' yeast. These results led us to conclude that 2AP-producing fragrant plant and microbial species shared similar evolutionary paths.

Innovative technology to generate new fragrant plants

Besides precision breeding, molecular inactivation of specific AMADH can generate new fragrant plant and microbial variants. The initial invention utilised RNA interference technology (RNAi) to convert Nipponbare, a non-fragrant japonica rice, to fragrant rice [(2,3)]. Genome editing is the latest technology that precisely creates a specific double DNA strand break at a target genomic site. Gene editing of



native AMADH-like genes by utilising TALEN [4] and CRISPR- CAS9 [5, 6] generated innovative 2AP-producing plants.

Recent & future research challenges

Fragrant rice landraces are narrowly adaptable to their specific niche environments; otherwise, low productivity in modern cultural practices. High-yielding fragrant rice varieties do not guarantee strong grain aroma because environmental conditions substantially impact grain aroma. Under salinity, cold, and drought stresses, grain-2AP is enhanced, but grain yield is reduced. Moreover, the overall productivity of RNAi-derived fragrant rice was affected compared to the wild type[3]. Therefore, grain yield and strong aroma seem to require the opposite environmental conditions. To overcome such problem, rice farmers need to add innovative steps, including alternating wetting and drying during the vegetative stage [7], exogenous applications of NaCl [8], GABA [9], Silicon [10], and Copper [11] applied during the vegetative and early reproductive stages. These new cultivation practices enhanced grain-2AP at least 1.5-2.0 times compared to the control. Therefore, after a decade of aromatic gene discovery has strong impacts on breeding-by-design and precision agriculture to significantly improve fragrance rice productivity in modern agriculture.

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ExcelRice

Professor Dr Apichart Vanavichit
Director
Rice Science Center
Tel: +66 (81) 527 4070
vanavichit@gmail.com
dna.kps.ku.ac.th



How to improve biological control agents for soil and pest management

Aarthi JanakiRaman, Research Director, Chemicals and Advanced Materials at TechVision, explains the need for an integrated approach to improve adoption of biological control agents for soil and pest management

The United Nations Sustainable Goals, highlight the need for food production to rise exponentially till the year 2050 to meet the ever- rising demands of the growing global population. On the other hand, the world is facing challenges concerning biodiversity loss and greenhouse gas emissions due to the rising burden placed in soil ecosystems while stakeholders strive to address the growing demand for food security.

To mitigate biodiversity losses, there is a push towards sustainable agricultural practices; plant protection practices being one of the key applications. Following this, stakeholders have been testing and are open to gradually replace synthetically derived plant protection chemicals with biocontrol (biological control) agents (BCA).

Utilizing biological control agents

Biological control broadly refers to use of any biological agent that can help in crop, disease and pest management. It is an environmentally safer alternative and sustainable in nature. While the concept of biological control itself is not new and was integral in traditional agrian practices, its use in commercial scale is being revived, mainly due to concerns regarding soil degradation and sustainability. Increasing focus towards biological methods can improve commercial adoption, making it economically viable and further continued research and commercial adoption.

> "For effective utilization of biocontrol agents, it is important to understand the relationships of various BCA to provide a holistic and effective crop and soil protection strategy."

Biological control agents are proven to be advantageous as they can target a specific group of disease-causing pathogens, which can minimize potential adverse effects in the soil ecosystem as in the case of some broad spectrum pesticides, have a more sustained effect on soil without additional intervention and can work with other biological aids without creating adverse effects. It can also help in conservation of host immune responses so that plants can channelize the energy towards desired traits.

However, for effective utilization of biocontrol agents, it is important to understand the relationships of various BCA to provide a holistic and effective crop and soil protection strategy. Also, as the efficiency of BCA is dependent on various biotic and abiotic factors and hence, overall understanding of the inter relationships of the entire soil ecosystem and plant growth is needed to derive the maximum potential from biological control agents.

"Rising focus on sustainable practices methods are leading to interest in the use of biological control methods for improving and maintaining soil health and pest management."

Many BCAs used currently to improve plant immunity or as an aid to combat disease and infestation and research studies are underway to develop BCA that can provide long term benefits taking into account the adaptation of pathogens to them. Focus is also on evaluating and fine tuning the mechanism of action and functionalities to increase their adoption across geographies and plant varieties. A key requirement to optimize its potential is to integrate its use with other plant and soil protection agents, making it a part of integrated soil and pest management approaches.

Genetic engineering and design to increase BCA effectiveness

Using BCA along with other technologies can not only improve commercial adoption, but also help in developing more effective agents. At present, biocontrol methods are being used along with chemical methods to achieve longer lasting effects. However, combining them with other tools and technologies can help in achieving better value. Genetic engineering and design, digital and analytical methods and forecasting tools are some of the technologies that can be integrated with BCA to increase effectiveness. For example, modeling and simulation tools for plant phenotyping and genotyping can help in developing targeted BCA formulations that are active over longer period of times, help to overcome potential resistance and develop aids that are active under various environmental conditions. Use of modeling tools and genetic tools can also help in developing BCA that can be effective in various environmental conditions and reduce the dependence in chemical agents and encourage a shift towards independent of biological soil and pest management practices.

As BCA take a longer period of time to attach itself to the plant's rhizome when compared to chemical agents, disease forecasting tools and models to analyze and predict pathogen incidence can help in devising a schedule for application to obtain maximum benefits over extended periods of time. Geographical models can provide an accurate assessment of ecological impact and also devise strategies to prevent invasion of foreign species and preserve the natural ecosystem.

Integrated soil and pest management

The goal for an integrated soil and pest management is to leverage various biological control agents such as biofertilizers, microbial cocktails (including bacterial, phages, algae etc.) that can act as plant growth promoters and soil nourishing agents ably supported by microbial and genetic engineering techniques and digital tools. Numerous lab-based efficacy trials have established the effectiveness of such combinational approaches. More experimental field trials involving the farmers and getting real time validation in terms of boost in productivity and yield, combating plant diseases and improving soil health can increase technology availability and commercial adoption.

Rising focus on sustainable practices methods are leading to interest in the use of biological control methods for improving and maintaining soil health and pest management. Continued access to funding for boost research activities, involving stakeholders from various technology areas, conducting field trials can not only provide wider product choices but also position biological control methods as a choice for intervention and mitigation strategies by the agricultural communities.

Aarthi JanakiRaman
Research Director, Chemicals and Advanced Materials
TechVision, Frost & Sullivan
Tel: +91 44 6681 4102
aarthij@frost.com
ww2.frost.com
www.twitter.com/Frost_Sullivan

The city FEEDS the city and FERTILIZES the countryside: sustainable food production

The circular and sustainable food production system of the future is already here.
FaaS - Farming as a Service has been launched in Sweden through ICA Maxi in Sundsvall.

Modern technology makes it possible to grow vegetables and fish in closed systems. This means that production can get closer to consumers. We now have the ability to share energy and take advantage of residual flows that were previously classified as waste and were a problem. Food production in closed circular and sustainable food production systems in urban environments has the opportunity to utilize heat and power resources from adjacent businesses. The surplus of, for example, heat that previously cost money to ventilate away, is today an important resource in a circular production model. Urban water and sewerage systems, which are often strained and have problems separating nutrients, which can lead to eutrophication of our seas and watercourses, are now becoming a source of extraction and production of recycled fertilizers. We can in the long run get rid of the use of the unsustainable production of mineral fertilizers. Through controlled and predictable production with the help of AI technology, much of the overproduction that is the source of food waste can be avoided. The city can not only FEED itself with vegetables and fish but can FERTILIZE grain and outdoor food production in the countryside.

Make the transition to sustainable food production possible

GreenFood, together with Agtira, is making a major joint investment in urban farming with vertical farms in Sweden. The basis for this sustainable development is innovative FoodTech companies as JUMO, SentianAI, Solserv and Ekobalans. Technologies for producing fish and vegetables safely and sustainably in closed systems, as well as taking advantage of and refining valuable residual flows in our cities.

GreenFood

We absolutely love healthy food. To make it tastier. Easier. Better. More affordable. It is the passion that drives us at Greenfood.

The passion for healthy food has made Greenfood one of the Nordic region's leading food groups in fresh healthy food, with a history that spans over 50 years. Green convenience today, for a greener tomorrow is our guiding principle. For us, it is not more difficult than that. Everything we stand for and everything we do depends on a healthy planet, and a healthy planet is completely dependent on us. Our decisions should lead to a more sustainable society - not because we are forced to because of rules and expectations, but because we think it is important to contribute to a better world. Greenfood's range is at the forefront of sustainable food with the base in fruit and vegetables.
https://www.greenfood.se/en

Agtira

We redefine the concept of locally grown - by developing food production systems for vertical and indoor food production in urban environments - we create opportunities for food production in, or in direct connection to grocery stores.

With our smart systems and Ai, we redefine the concept of locally grown. Our ambition is to be a world leader in food production systems for vegetables and fish in urban environments and constantly develop both food production methods and software support. The circular and sustainable food production system of the future is already here.
https://www.agtira.com/

Solserv

Packaging and composting solutions

Solserv has many years of experience in machines and service for creative and sustainable packaging technology. We deliver complete solutions for machinery, training, maintenance, and service for large and small customers in the international market.

Thoughtful waste management
For space-saving and efficient production, a well-thought-out management of waste is required. Our environmentally friendly composting solutions cover all needs - from 5 to 1400 kg per day. We also have facilities with a capacity of 5-100 tonnes per day with subsequent processing into recycled fertilizers. A fully automated system with heat and microorganisms breaks down food residues and other compostable organic waste into usable compost soil. Thanks to the active process of controlled heat and microorganisms, the process takes no more than 24 hours.
https://solserv.se/

EkoBalans

The future is circular and EkoBalans has the technology
Circular economy is the opposite of the toil and waste society. In a circular economy, we use the resources that already exist in society instead of new raw materials. For EkoBalans, circular economy means benefiting from residual flows from agriculture, treatment plants and industry. If we had to decide, all residual flows, which contain phosphorus, nitrogen and substances that contribute to an improvement in the properties of the soil, would be called resource flows.

We at EkoBalans want society's organic residual flows to be used sustainably with completed cycles for plant nutrients such as nitrogen and phosphorus. That is why we deliver solutions for recycling plant nutrients and sustainable management of residual flows from treatment plants, biogas plants, the food industry and agriculture. We then refine the residual flows into high-quality fertilizers and soil improvement products.
https://ekobalans.se/

Jumo

Your partner for sensor and automation solutions
JUMO is a leading global component and system supplier for individual sensor and automation solutions. In addition to components in temperature, fluid analysis, pressure, level, flow rate and humidity, the focus is also on automation challenges such as registration and monitoring, regulation and automation.

Measurement provides knowledge
Temperature, humidity, pH / conductivity, CO_2 and light intensity all affect the growth climate in the greenhouse. Accurate measurement and control of these measured values is therefore very important. JUMO offers a wide range of sensors for measuring temperature, humidity, pH / conductivity and CO_2 where you can choose between wired, wireless, analog and digital versions.
https://en.jumo.se/

Sentian

We at Sentian believe in the power of artificial intelligence and machine learning to drive innovation and transform processes. We help industrial companies to improve their operations by using cutting-edge AI and ML technology, to take them to the next level.
Our Machine Learning powered control solution helps minimize energy costs and reduce emissions. Our innovative AI learns your process from your historical operational data, finds the best parameter settings through real-time simulation and keeps on adapting even as process, equipment and goals change. As a result, it can more accurately and responsibly control your energy usage than APCs and expert operators.
https://www.sentian.ai/

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We are improving the world. SLU is a top-class international university with research, education and environmental analysis in the sciences for sustainable living.

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https://www.slu.se/en/

Bengt Fellbe
Program Leader
SSEC, Swedish Surplus Energy Collaboration
Tel: +46 709 585 019
bengt.fellbe@gmail.com
https://sse-c.se

Research & innovation for bio-based industries in Europe

Philippe Mengal, Executive Director at CBE JU - Circular Bio-based Europe Joint Undertaking, charts the priorities for a strategic research & innovation agenda for competitive bio-based industries in Europe

Becoming the world's first climate-neutral continent by 2050 is a once-in-a-lifetime opportunity to modernise the EU's economy and society, and re-orient them towards a just and sustainable future through bio-based industries in Europe. Research and innovation will play a central role in accelerating and navigating this transition; deploying, demonstrating and de-risking sustainable solutions; and engaging citizens in social innovation.

Within the EU's long-term budget, the framework programme for research and innovation, Horizon Europe, is called upon to play a very strong role in supporting the EU's sustainable growth. A key tool in implementing this ambitious research agenda is that of European Partnerships, which have successfully proven their ability to significantly contribute to achieving the EU's political priorities.

The Circular Bio-based Europe Joint Undertaking (CBE JU) is one such European Partnership, which brings the private (Bio-based Industries Consortium – BIC) and public (European Union, represented by the European Commission - EC) partners together in pursuit of advancing competitive circular bio-based industries in Europe. By producing renewable bio-based products and materials from waste and biomass in an innovative, sustainable and circular way, these industries can contribute significantly to the climate neutrality target by 2050 while creating jobs and economic growth in regions across Europe.

This €2 billion Public-Private Partnership will build on the success of its predecessor, the Bio-based Industries Joint Undertaking (BBI JU) - which has demonstrated the added value of a competitive circular bio-based economy in Europe and has contributed to reducing the fragmentation of the sector. Established on 30th November 2021, the new partnership will fund projects which support the shift from non-renewable fossil resources with waste and sustainably sourced biomass to produce industrial and consumer goods in a more sustainable and circular way.

Strategic Research and Innovation Agenda (SRIA)

A pivotal aspect of European Partnerships is the setting of strategic research and innovation priorities required to achieve their general objectives. As with any public-private partnership, it is essential to align the "public" and "private" interests, goals and commitments to ensure the realisation of the different perspectives.

The founding partners of CBE JU, EC and BIC, have drafted a Strategic Research and Innovation Agenda (SRIA) in collaboration with the CBE JU Programme Office and in consultation with the partnership's advisory bodies. The document describes the targeted impact of the partnership, foreseen portfolio of activities and measurable expected outcomes. It is adopted by the CBE JU Governing Board. This is an important novelty to stress, as the SRIA of CBE JU now becomes a legally binding strategic priority document for the new partnership.

CBE JU priorities going forward

The SRIA will operationalise the objectives of CBE JU as agreed by the partners, who see the partnership as a platform for coordinating a broad scope of activities by all stakeholders of the European bio-based industries.

The agreed strategic priorities will deliver tangible and increasingly ambitious environmental, social and economic benefits by 2031. Such strategic priorities include ensuring the availability and quality of

sustainable bio-based feedstock; development of innovative production systems in the bio-based industry and innovative bio-based products; as well as stimulating research activities in countries and regions with underdeveloped R&I capacity for bio-based systems.

"Becoming the world's first climate-neutral continent by 2050 is a once-in-a-lifetime opportunity to modernise the EU's economy and society, and re-orient them towards a just and sustainable future. Research and innovation will play a central role in accelerating and navigating this transition; deploying, demonstrating and de-risking sustainable solutions; and engaging citizens in social innovation."

Furthermore, it will also aim to scale up production and market uptake of innovative bio-based solutions; improve the investment risk profile of bio-based projects; as well as setting effective and robust environmental sustainability and circularity criteria for bio-based systems; and facilitating social acceptance of bio-based applications.

CBE JU will implement these strategic priorities via competitive calls for project proposals. The partnership will fund projects focussed on research and innovation, as well as coordination and support. Among them, Flagships will deploy the first-of-its-kind innovation in the European market.

Transparent checks & balances

The Scientific Committee and the states' representatives group (SRG) are the two advisory bodies of CBE JU whose role is to provide advice on the strategic priorities to be addressed in the CBE JU's annual work programmes in line with the SRIA and Horizon Europe strategic planning. The advisory bodies will help highlight scientific achievements of the programme, suggest corrective measures for the programme implementation when necessary, and provide independent scientific and strategic advice on specific issues at the request of the Governing Board.

The Scientific Committee plays a key role in ensuring that the CBE JU programme is implemented successfully and confirms that the key strategic and programming documents include all relevant scientific



Philippe Mengal

and multidisciplinary considerations, incorporates breakthrough-promising technologies and contributes to positive societal impacts, while ensuring a sustainable and efficient management of natural renewable resources.

Members of the Scientific Committee and states' representatives group also act as CBE JU ambassadors, helping to increase the visibility of the programme and to reach out to key bioeconomy actors across, and beyond, the EU.

Since their establishment, the CBE JU Scientific Committee, comprising of 15 members of which 47% are women, and the states' representatives group, composed of 31 members and 29 alternates from 27 countries, have already undertaken an active role in providing feedback on the draft SRIA and its strategic priorities, as well as the work programme implementing the SRIA, prior to the opening of the partnership's first call for project proposals.

Philippe Mengal
Executive Director
CBE JU - Circular Bio-based Europe Joint Undertaking
info@cbe.europa.eu
www.cbe.europa.eu
https://twitter.com/cbe_ju

Valorisation of industrial CO2 side streams and BIOCON-CO_2 H2020

Montse Bosch, Area Manager at Leitat Technological Center, discusses the BIOCON-CO_2 H2020 project and its transformation of raw CO2 waste into everyday products

Carbon Capture and Utilisation (CCU) is a diverse set of technologies that allow for the capture and use of carbon dioxide (CO_2) as a carbon feedstock for making everyday products such as fuels, chemicals and building materials that are currently predominantly derived from fossil resources. These are the aims of the BIOCON-CO_2 H2020 project.

CCU provides a major opportunity for climate mitigation, energy transition and industry redeployment, for the benefit of all.

BIOCON-CO_2 is a Horizon 2020 funded project coordinated by Leitat which aims to develop and validate in industrially relevant environment a flexible strategy to biologically transform raw CO_2 waste from the iron, steel, cement and electric power industries into added-value chemicals and plastics (www.biocon-co$_2$[1]). The proposed platform is based on three main stages:

i) solubilization technologies
ii) bioprocess development
iii) downstream technologies.

CO_2 solubilization technologies

The use of carbonic anhydrase (CA) has been one of the strategies for increasing CO_2 solubility investigated in BIOCON-CO_2. CA is the fastest known enzymes able to convert $CO_2$to bicarbonate ions, being therefore a potent biological catalyst for CO_2 capture. Despite the higher rate of catalysis, its industrial uses are restricted due to its poor reusability and low stability. During BIOCON-CO_2, the human carbonic anhydrase enzyme isoform II (hCAII) has been successfully cloned, overexpressed and purified. The enzyme has been characterized and its low overtime stability has been targeted. A couple of the obtained mutants display better activity and thermostability than wild type enzyme, proposing them as suitable candidates to increase CO_2 bioavailability.

Another strategy investigated in BIOCON-CO_2 was the design of a trickled bed reactor (TBR) and the selection of the most suitable materials for cell adhesion and CO_2 solubilization. TBR main advantages compared to conventional reactors are better gas-liquid mass transfer, easy product recovery, and low cost of production and operation. In BIOCON-CO_2 H2020, the packing material act as a support for microorganisms where they attach and form biofilm. The results show that our TBR system improved 2-fold the CO_2 solubilization starting from 5 minutes.

In addition, by immobilizing the new CA mutant with increased activity and thermostability onto the packing materials of the TBR systems, both strategies could be combined as an innovative approach to overcome gas-liquid mass transfer limitations.

Bioprocess development

During BIOCON-CO_2 four microbial cell factories (MCFs) had been developed using anaerobic microorganisms (*Clostridium spp.* for C3-C6 alcohols), aerobic microorganisms (*Cupriavidus necator* for polyhydroxyalkanoates) and enzymes (formate dehydrogenase for formic acid and multienzymatic system for lactic acid production), thus proving high flexibility and versatility to the BIOCON-CO_2 platform. In each MCF different strategies to increase tolerance to impurities and to enhance their productivity applying genetic improvement tools have been investigated.

In addition, innovative strategies to develop less energy intensive processes have been applied. Fermentation is a biological process characterized by a lower energy uptake by bacteria, compared to aerobic/anoxic metabolism, and consequently by a lower bacterial growth and a higher product yield. Electro-fermentation (EF) is considered as a potential technology reducing the energy consumption of a conventional fermentation, while maintaining (or even enhancing) its productivity. The EF is defined as an electrochemical process to control fermentation path-



Leitat's headquarters at Terrassa (Barcelona)

ways using current. In the frame of BIOCON-CO_2 project, EF has been employed to increase the butanol production using a strain of Clostridium beijerinckii by fine tuning the cathode potential.

Downstream technologies

The main goal of the BIOCON-CO_2 approach for the downstream processes is to create an integrated tool for extracting and purifying the different building blocks based on their differential properties of the products compared to those of the media they are in. An automated tailored statistical tool, called DS-Opti-DoE (DSODE), able to optimize downstream strategies has been developed and it is available under request. The main challenge has been the low concentration of the target molecules. While liquid external products (C3-C6 alcohols, lactic and formic acids) are present at quite low concentrations, while intracellular products (PHB) have high concentrations within the cells, however when they are released their concentrations in the media become low. The strategies assessed have been based on pressure- and thermal-driven membrane and non-energy-intensive concentration techniques.

In conclusion, during these last 4 years, cutting-edge technologies and strategies have been developed for each stage that can be combined as "puzzle pieces" depending on the target chemical and the used biological system. These tools could be transferred to other bioproducts produced from CO_2, which is the main contribution of BIOCON-CO_2 to the European CCU strategy.

CCUs a key tool for the mandatory decarbonization

CCUs will play a key role in decarbonizing industry and energy sectors. It is crucial that CCUs are deployed during this 2020 decade to support the EU's decarbonization trajectory towards net zero greenhouse gases (GHG) emissions by 2050, as well as to comply with climate targets for 2030 (50% GHG emission reduction compared to 1990). The CCUS SET-Plan intends to move forward the actions from a technological, policy, regulatory and funding perspective across the whole value chain. Reality is that the new incentives are delivering unprecedent momentum for CCUS implementation. In a recent report by the International Energy Agency, it has been highlighted the increase of commercial CCUs facilities already operating and the increasing number of those under development. In this thrilling scenario, Leitat has extended their activities in the CCU field by exploring the use of microorganisms as catalysts for converting CO_2 into added value products. Currently, Leitat is participating in GAIA[2] and REGENERA projects, in which bioprocesses, based on bioelectrochemistry to produce methane and hytane from CO_2 are explored.

1 This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 761042 (BIOCON-CO2). This output reflects the views only of the author and the European Union cannot be held responsible for any use which may be made of the information contained therein.

2 The GAIA project has been financed within the framework of the call "R&D&I Projects in Strategic Lines 2021" financed by the Spanish Ministry of Science and Innovation (MCIN) and the State Innovation Agency (AEI) (code of project 10.13039/501100011033). It has also been financed by the Next Generation EU/PRTR European funds.



BIOCON-CO_2 has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 761042

LEITAT
managing technologies

Montse Bosch
Area Manager
Leitat Technological Center
Tel: +34 93 788 23 00
mbosch@leitat.org
www.leitat.org
https://twitter.com/Leitat

Eduard Borràs
Principal Researcher
Co-author

IRODDI: New strategies for a sustainable development

Olga Gómez de Miranda, Scientific researcher from TECNALIA illustrates the innovative technologies and strategies in place to improve sustainable development

How bioeconomy and circular economy boost European development

The transition from current industrial petrochemical models to new sustainable ones encourages to redefine manufacturing activities to orient them towards new bio-based and circular economy strategies. These two concepts drive societies to a more efficient development. Reducing the dependency on fossil-based resources promotes healthy and secure production and supply of materials. The European Green Deal has marked as a priority area of development by the implementation of sustainable and optimized processes based on rational consumption of natural resources. [1]

One of the key aspects of the circular economy is the waste reduction, it keeps materials in use, and promotes the claim of doing more with less. Therefore, there is scope for business opportunities to implement circular economy projects which consider residues as potential raw materials that can be re-introduced into the value chain giving benefits. [2]

The refining processes of vegetable oils and fats, as well as the oleochemical industries, are also involved in this new perspective. World vegetable oil production amounted to more than 210 million metric tons last year. [3] Oilseeds processing and refining to obtain edible oils, and the further modifications to convert them into oleochemicals, produce a variety of waste products.

Industrial residues as new raw material resources

Soapstocks and deodorizer distillates are the major by-products from vegetable oil refining. They have little commercial value and are sold at a fraction of the oil cost. [4] These residual materials may result harmful for the environment, but at the same time they have potential value for different applications. Moreover, it is necessary to consider that as the human population increase, the consumption of edible oils is also expected to increase, thereby generating more by-products.

Deodorizer distillates (DODs) are obtained in the deodorization process, the last stage of the refining of vegetable oils and fats. It normally consists of steam distillation at elevated temperature under reduced pressure. Its purpose is to remove all those glyceridic and non-glyceridic volatile compounds that are detrimental to the flavour, colour, stability or safety of the refined oils. [5]

The principal commercial value of DODs lies in their tocopherol, squalene and sterol content which are different depending on the origin of the DODs (physical or chemical). [6] Moreover, DODs contain important amounts of free fatty acids (FFAs), which are mostly used for biodiesel production. DODs are a cheaper source than vegetable oils and they are readily available at an industrial scale. These two factors contribute to increasing the profitability of the oleo chemistry production chain, and more importantly, they do not compete with agro-food resources.

Innovative technologies to valorise deodorization distillates

To convert oil processing residual materials into commercial valuable products it is necessary to develop economically efficient separation/isolation processes and chemical/enzymatic modifications to transform them into derivatives of interest. The development of sustainable technologies is essential for a rational evolution of societies.

IRODDI (Innovative Refining process for valOrization of vegetable Oil Deodorizer DIstillates) is an ambitious initiative funded by the Bio Based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 887407, which aims to develop new biobased products using FFAs contained in DODs, as well as develop innovative technologies for isolation of valuable oil minor compounds (tocopherols and squalene) also contained in them

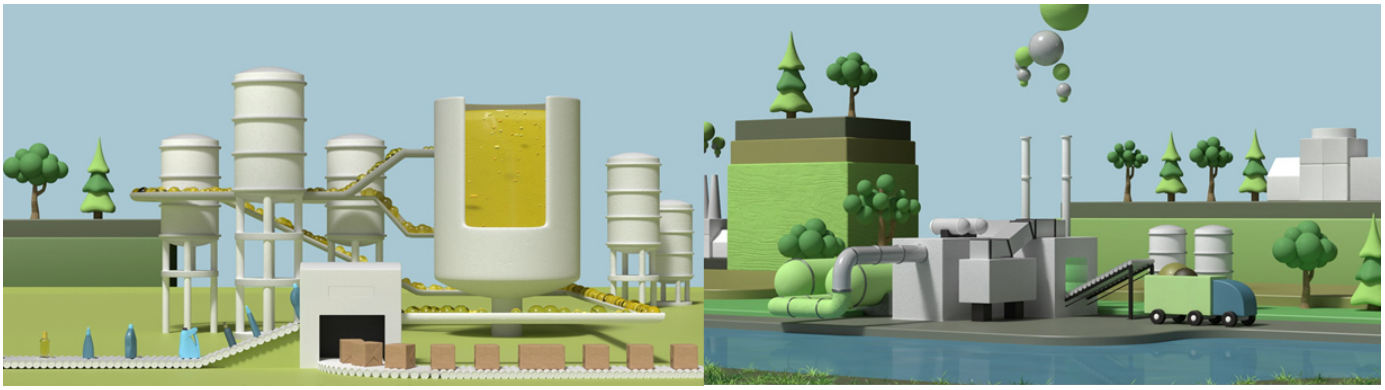


Figure 1. Images of Biorefineries based on the IRODDI concept. Capture of IRODDI's promotional video

using softer operational conditions than those employed at industrial level.

Three new bio-based products are obtained from the residual DODs:

- Eco-friendly surfactants with increased water solubility. Here, FFAs contained in the DODs are neutralized with benign ionic liquids (ILs) to give surfactants with good detergency characteristics, good wetting power, stable over time, low surface tension, low critical micellar concentration (cmc) and high solubility in water at low temperatures.
- Biodegradable base-oils that can be directly used in the formulation of biolubricants. They are obtained by enzymatic esterification of two residual streams derived from vegetable oils: DODs and glycerol, sub-product of biodiesel processing.
- Bio-based polyols for polyurethane formulation. They are oriented to the production of greener adhesives, more acceptable from the customer point of view.

Two innovative extraction technologies are developed for isolation of oil minor valuable compounds present in DODs:

- Supercritical carbon dioxide ($scCO_2$), used as an inert, non-toxic and high volatile solvent, permits the operation at low temperatures to preserve the products to be extracted, in particular squalene for cosmetic applications.
- Highly stable and recyclable ILs are used to extract tocopherols from DODs. This technology substitutes other energetically intensive processes as distillation, which is expensive and responsible for quality losses in the products.

Sustainable development: the transition to oil biorefinery

IRODDI supports the transition to an oil biorefinery model that can provide substitutes to fossil-based products. The use of biomass as raw material offers more environmentally friendly products, in accordance with sustainable development. Moreover, IRODDI fosters a circular economy approach that does not exhaust the available resources.

More information: www.iroddi.eu

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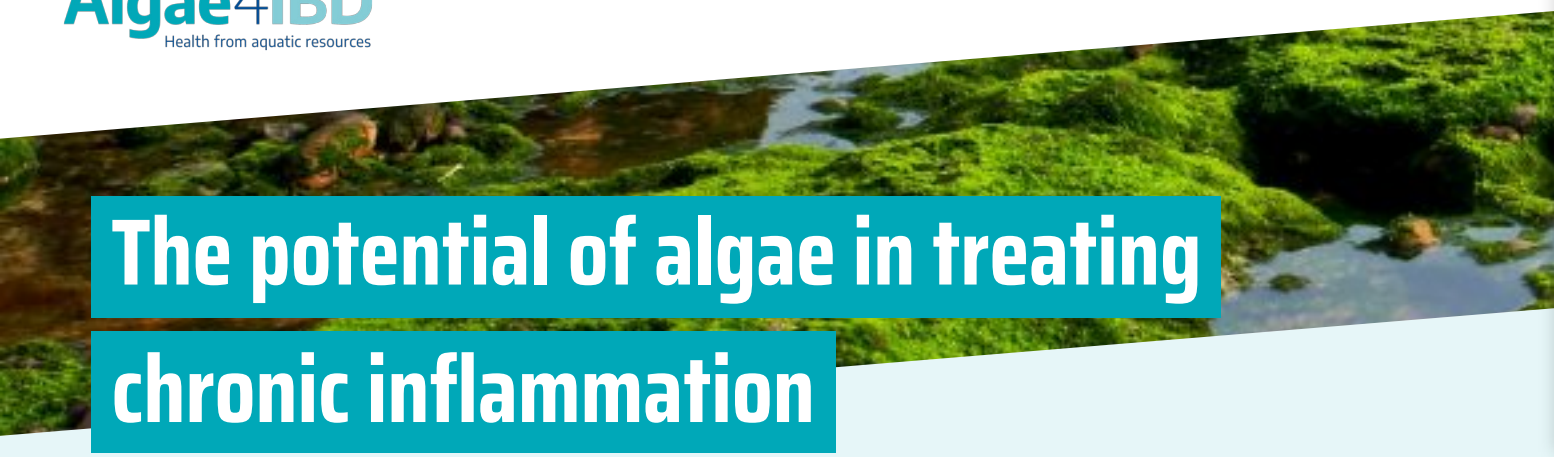
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This project has received funding from the European Union's HORIZON 2020 Research & Innovation programme under the Grant Agreement no.887407.

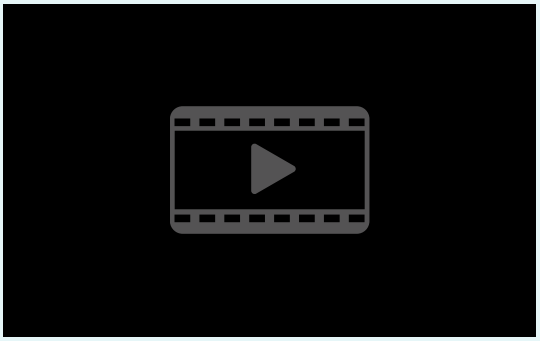
Olga Gómez de Miranda
scientific coordinator of the IRODDI project
TECNALIA
Tel: (+34) 671 728 565
olga.gomez@tecnalia.com
https://www.tecnalia.com/

Algae4IBD
Health from aquatic resources



The potential of algae in treating chronic inflammation

Algae has become a hot topic, however there is a knowledge gap that's resulting in an underused resource that could offer new solutions for the treatment of pain, inflammation, and inflammatory bowel disease (IBD)



The industrial and overall potential of algae is increasingly understood, but most algae are still under-studied, and there is an abundance of unknown species yet to be discovered.

It seems as if no problem exists that cannot be solved with the aid of algae. The compounds they produce can be refined into biodiesel, turned into biodegradable packaging, substitute meat, or enrich our diets with supplements.

Algae produce these valuable compounds at low economic and environmental costs. Their inexpensive lifestyle requires light, CO_2, and some nutrients. The cost-effective potential of algae has driven their use in the fuel, plastics, food, and cosmetics industry and it could in the future reach other sectors.

The potential of algae: new medicines for inflammatory bowel disease

IBD is a set of diseases which cause chronic inflammation in the bowel, the most common being Crohn's disease and ulcerative colitis. In all forms of this illness, its resulting bowel injury impairs organ functions and leads to severe pain, fatigue, depression and in some cases colon cancer. These symptoms impair the lives of more than 6.8 million people worldwide and according to estimates this illness is going to affect 8 million people by 2025.

Currently no cure exists, so available therapies focus on mitigating the inflammation and its symptoms. Some of the available treatments also cause side effects. Steroid-based medication leads to sleeping problems and increased appetite. Not every patient responds to treatment, making removal of the affected organ parts their only option for a life with controlled IBD.

What if the solution for a chronic disease lies in our ocean, rivers, or lakes? The EU-funded Algae4IBD project will help answer this question.

Some of the algal compounds can be beneficial for our health. The anti-inflammatory compounds of Chlorella, among other things, make these algae a preferred source for food supplements. Consuming such products could help reduce chronic inflammation. The anti-inflammatory compounds can also serve as a good starting point to develop new therapies against chronic inflammatory diseases.

Scientists expect more algae species to have similar health effects. Dr. Dorit Avni,Algae4IBD coordinator, an expert for immune modulation at the MIGAL Galilee Research Institute in Israel, is one of these scientists. "I think we just started to scratch the huge world of algae," she says. "We know about some, but algae are a huge untapped reservoir with an infinite opportunity to find novel compounds."

The hidden medical potential of algae could be used to prevent and treat IBD as Dr. Avni found in her own research. "We found interesting anti-inflammatory compounds from algae that could have higher therapeutic activity than current standard [IBD] treatments."

"We will address as much as we can because we have a list of bioactivities that could be effective in this disease, the microbiome, inflammation, and pain," says Dr. Avni about the EU-funded research project, Algae4IBD, she leads. Together with her partners across Europe, she is trying to harness the health potential of algae and develop novel medicines for the treatment of IBD.

Algae4IBD's goals



Algae4IBD consortium is made up of academic and research institutes, hospitals, as well as companies with expertise in algae cultivation and extraction, food development and pharmaceuticals. It has 21 partners spread over 11 countries, with MIGAL from Israel as the coordinator. The researchers, companies and hospitals involved in the different stages of the project will use the biodiversity of algae, both micro and macro, as a wide source for bioactive compounds using state-of-the-art cultivation and extraction technologies for obtaining bio-active molecules.

Algae4IBD Consortium Map - Click here to enlarge



Algae enriched food to prevent IBD

Aside from developing new IBD medicines, the researchers from the Algae4IBD project are developing "smart food based on the compounds coming from algae. For example, bread that will be enriched with these relieving compounds," explains Dr. Avni. "With joint forces for four years, we definitely can provide the research base that will bring us either novel treatment through pharma or functional food."

Juices with added vitamin C or iron and other trace elements might be the most known enriched food. They are eaten both for a more wholesome diet and to prevent deficiencies. Similarly, scientists hope that consuming foods containing anti-inflammatory compounds help prevent inflammation and IBD which is increasing worldwide.

New, cost-effective health products and medication are important to improve patient's well-being but also to counteract healthcare costs for IBD, which are going to rise with the increasing disease incidence.

For prevalent Crohns' disease and ulcerative colitis, today's annual healthcare costs per patient can surpass U$7000 in Europe, $13500 in North America and $1500 in Asia. Thereby, costs for medication make up the largest part.

The scientists of the Algae4IBD project connected these dots in harnessing the cost-effective health potential of algae to prevent and treat IBD. By mid-2025, they want to deliver their algae-based smart food and medicines.

Algae4IBD proposes innovative solutions to sustainably use algae-based products with improved nutritional quality to positively impact IBD patients.

If successful, this EU-funded project might cause other players in the sector to look for novel therapies in algae, improving the knowledge on this untapped resource. Dr. Bar-Gil from Yemoja ltd, also involved in the project, agrees: "There is a big potential in algae, and I believe that if this project is successful, many countries around the world will start encouraging investment in startups like Yemoja, and better understand the potential that can be found in this industry. Moreover, it will open new business opportunities for algae companies such as Necton , Algaia and Gopsis".

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 101000501

Dr. Dorit Avni
Migal Galilee Research Institute
dorita@migal.org.il
Tel: +972 54-9815556

Hyperspectral camera imaging promotes research of the seas and space

Mikko Mäkelä, Research Professor at VTT, discusess the possibilities of a hyperspectral camera – a device that can see things which the human eye cannot

"The human eye sees colours and is able to tell apples from pears based on their colour and shape. A hyperspectral camera, on the other hand, shows what condition the fruit is in and when it will go bad", explains Research Professor Mikko Mäkelä.

In the 90s, a NASA scientist by the name of John Bolton moved to Finland together with his wife. He had an idea to create a hyperspectral camera that could be used to survey the condition of forests. The VTT team in Oulu jumped at the opportunity to get on board:

"Before the aeroplane project, I had to develop a simple and compact spectrometer structure that could be attached to a fibre optic cable. This structure in fact enabled the development of a new kind of simple imaging spectrometer, which was then patented in the early 90s. It was very jolly to see how the very first prototypes for the imaging spectrometer worked as they should. We saw that there was demand for this technology, so a spin-off company, Specim, was set up in 1995 to work on commercialising it. Specim is now racing ahead at a dizzying pace, and its imaging spectrometers are well known throughout the world," recounts long-time researcher Mauri Aikio, who has been working with hyperspectral imaging for more than 30 years.

This technology is certainly not threatened by obsolescence – quite to the contrary, enthusiastic researchers such as Mäkelä still use it in their research, and it continues to be harnessed in world-changing endeavours.

Mäkelä goes on to explain what makes hyperspectral camera imaging so special. Let's compare it, for example, to the everyday digital camera that is familiar to us all. A digital camera measures the intensity of light using three wavelengths of visible light: red, green and blue. The human eye itself is able to distinguish these colours. A hyperspectral camera, on the other hand, measures as many as several hundred different wavelengths from both the visible spectrum and beyond. The images produced contain information on things such as the object's chemical properties.

The result is therefore a kind of machine vision – a device that can see things which the human eye cannot.

Reaching beneath the surface

Researcher Heikki Saari has also been working at VTT since the beginnings of the hyperspectral imaging journey, and his varied work has included development of a device for diagnosing skin cancer.

"Hyperspectral imaging was getting attention already in the 90s as part of efforts to measure the ozone layer. Our technology has also been launched into space aboard a number of different satellites – including projects carried out with NASA. I have also invented a hyperspectral camera imaging method, using a unique MEMS technology that enables the cheap manufacture of small-scale hyperspectral cameras that in the future could be integrated into phones. Our job is to get this technology integrated into mobile phones. After that, the different applications for it will emerge as people creatively make use of it," Saari explains.

Hyperspectral imaging is used in many different ways – and there are not doubt more applications still to be discovered. Cameras are installed, for example, on satellites and then sent into space to analyse the atmosphere, or they are attached to drones for surveying the condition of forests. In the coming years, they will also be used to separate out different textile materials from waste flows. Hyperspectral cameras are also part of an ambitious project in Mumbia, India, to



clear out plastic waste from one of the world's most polluted rivers. In this project, the cameras help to identify plastic floating on the surface.

Ultimately, hyperspectral imaging is something that fits perfectly with the essence of digitalisation. The measurements are extremely fast compared to the alternative of laborious and expensive laboratory work. There basically isn't any sample preparation required, yet we can still get a huge amount of data quickly and easily.

"I used to do experiments in the laboratory for three weeks and then spend a day or two afterwards chewing over the data. Now it has flipped around the other way – I spend a day imaging and then a month crunching the code."

"I haven't yet come up with any other method which can gather so much data in such a short time. Within the research itself, the images and the physics involved combine with chemistry and applied mathematics. Through machine learning, chemistry is transformed into visual and quantitative data", says Mäkelä.

And how does the future look to Mäkelä? Part of his work currently involves textiles, and he hopes that in the future hyperspectral imaging could be used to digitalise the manufacture of new and more uniform materials for different applications. New possibilities are constantly emerging, however, so time will tell where the technology ultimately brings the biggest change.

Read more about the possibilities of imaging technologies at www.vttresearch.com

Mikko Mäkelä
Research Professor
VTT
mikko.makela@vtt.fi

Oceans and the circular economy

Open Access Government charts the priorities of Virginijus Sinkevičius, European Commissioner for Environment, Oceans and Fisheries, particularly concerning the role of oceans and the circular economy

Commissioner for the Environment, Oceans and Fisheries, Virginijus Sinkevičius' responsibilities include ensuring the environment, oceans and fisheries remain at the core of the European Green Deal; Leading on a Circular Economy Action Plan; and promoting plastic-free oceans and proper implementation of legislation on plastics, particularly microplastics. Now, he looks toward the link between oceans and the circular economy.

In April, at the Our Ocean Conference in Palau, the EU renewed its pledge towards international ocean governance with a list of 44 commitments for 2020-2022 worth a combined total of almost €1 billion.

The commitments cover all the themes of the international conference: marine protected areas; tackling marine pollution; confronting the ocean-climate crisis; creating sustainable blue economics; advancing sustainable, small-scale fisheries and aquaculture; and achieving a safe, just and secure ocean.

Flagship commitments include almost almost €500 million over the period 2021-2023 for research, development and innovation in seed funding for the Horizon Mission Restore our Ocean and Waters by 2030.

The "Mission Ocean" will address the ocean and waters as one and play a key role in achieving climate neutrality and restoring nature. It will help achieve the EU objectives of protecting 30% of member states' sea area, as well as restore marine ecosystems, prevent and eliminate pollution by reducing plastic litter at sea, nutrient losses and use of chemical pesticides and helping the further development of sustainable oceans and the circular economy.

The EU has introduced a commitment tracking tool to allow citizens to follow the progress of implementation.

Speaking at the conference, Sinkevičius said: "The sum the EU is committing today is significant, but not as significant as the role that the ocean plays for our very existence. It provides us clean air, regulates the climate, hosts a large part of biodiversity on Earth and is key for our economy. The ocean is bringing all these benefits to us and we need to protect it. Our future depends upon it."

Ukraine war: Help for the aquaculture sectors

April also saw the Commission propose an amendment to the European Maritime & Fisheries Fund 2014-2020 (EMFF), which would allow additional crisis measures to support the EU fishery and aquaculture sectors in light of Russia's invasion of Ukraine.

Following the first package of measures announced in March, it comprises financial compensation for additional costs, lost income and aid for the storage of products, as well as for the temporary cessation of fishing activities due to safety concerns.

Sinkevičius said: "The fishery and aquaculture sectors are heavily impact by the war in Ukraine. There are still financial resources available under the EMFF. With this



proposal, we give the possibility to member states to reallocate them to specific measures mitigating the socio-economic impact of the crisis."

Circular Economy Action Plan

March saw the Commission adopt a new Circular Economy Action Plan which, as part of the European Green Deal, aims to strengthen economic competitiveness while protecting the environment and giving new rights to consumers.

The plan presents measures to:

- **Make sustainable products the norm in the EU.** The Commission will propose legislation on Sustainable Product Policy to ensure that products placed on the EU market are designed to last longer, are easier to reuse, repair and recycle, and incorporate as much as possible recycled material instead of primary raw material. Single-use will be restricted, premature obsolescence tackled and the destruction of unsold durable goods banned.

- **Empower consumers.** Consumers will have access to reliable information on issues such as the reparability and durability of products to help them make environmentally sustainable choices. Consumers will benefit from a true 'Right to Repair'.

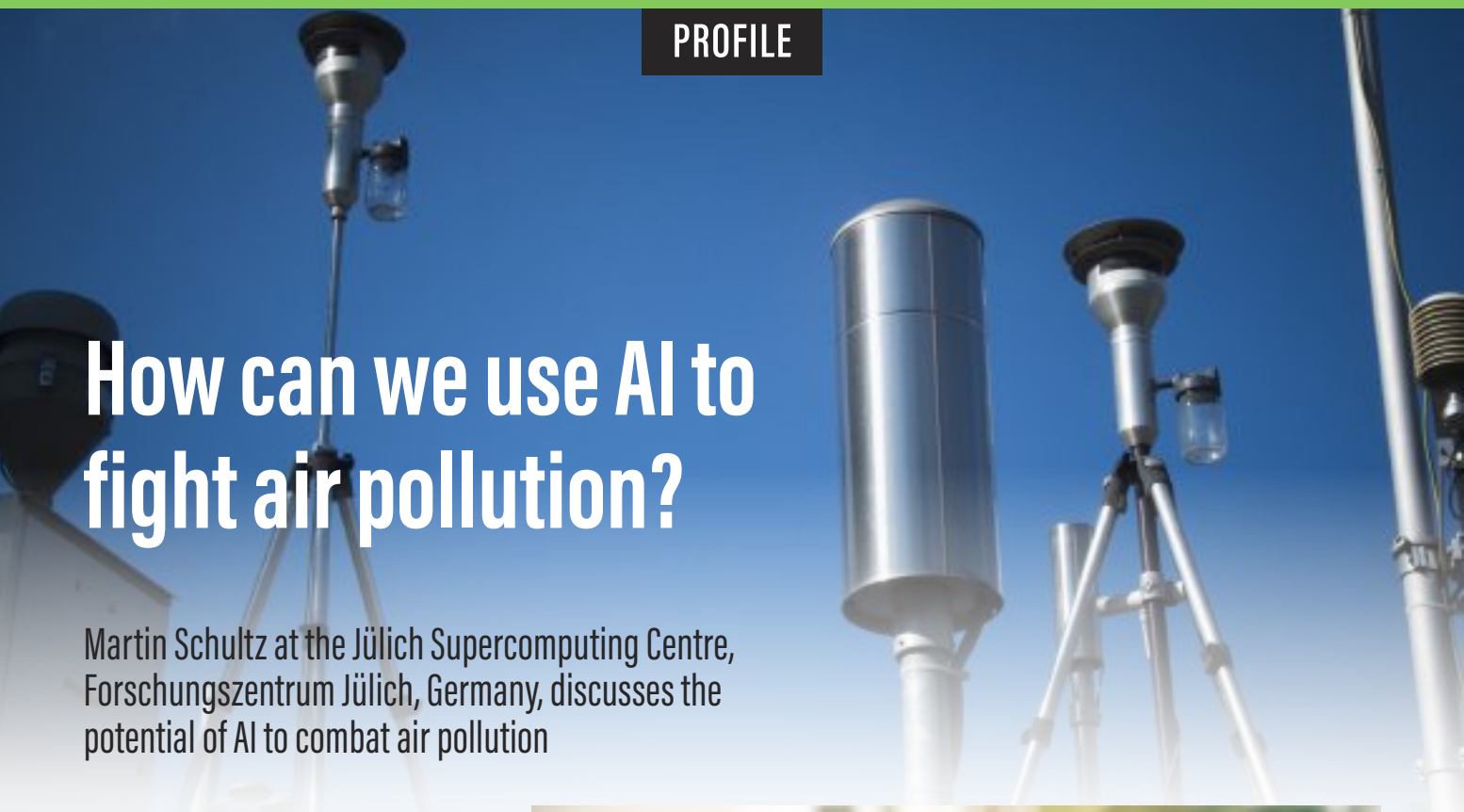
- **Focus on the sectors that use the most resources and where the potential for circularity is high.** The Commission will launch concrete actions on electronics, batteries and vehicles, packaging, plastics, textiles, construction and buildings, and food services.

- **Ensure less waste.** The focus will be on avoiding waste altogether and transforming it into high-quality secondary resources that benefit from a well-functioning market for secondary raw materials. The Commission will explore setting an EU-wide, harmonised model for the separate collection of waste and labelling. The Action Plan also puts forward a series of actions to minimise EU exports of waste and tackle illegal shipments.

Sinkevičius said: "We only have one Planet Earth, and yet by 2050 we will be consuming as if we had three. The new plan will make circularity the mainstream in our lives and speed up the green transition of our economy. We offer decisive action to change the top of the sustainability chain – product design. Future-oriented actions will create business and job opportunities, give new rights to European consumers, harness innovation and digitalisation and, just like nature, make sure that nothing is wasted."

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How can we use AI to fight air pollution?

Martin Schultz at the Jülich Supercomputing Centre, Forschungszentrum Jülich, Germany, discusses the potential of AI to combat air pollution

Air pollution is still a problem almost everywhere, so researchers investigate using AI to fight air pollution.



Although other environmental topics such as global warming, loss of biodiversity, soil degradation and unsustainable use of freshwater resources have become more prominent in recent years, air pollution has remained an issue which deserves our attention and action.

According to the World Health Organisation, between 3 and 8 million people die prematurely every year, because the air they breathe frequently contains harmful substances which may affect the respiratory system, lead to inflammatory diseases or impact the human immune system.

Despite several regulations that aim to reduce emissions of air pollutants and put limits on the levels of ambient air pollutant concentrations, measurements across Europe still regularly exhibit concentration levels beyond the threshold values that are deemed safe for human health and food production.

Other world regions face even larger problems; sometimes the pollution in the megacities of Southern and Eastern Asia, Africa and South America is so severe that it is almost impossible for people to go about their work or navigate through the streets.

We are therefore advised to continue and even expand the monitoring of air pollution and further develop the tools we need to analyse these measurements and make predictions of air pollutants so that vulnerable people can be warned and counter measures can be taken. In this article we will see how we can use AI to fight air pollution.

We have a lot and yet too little data about global air pollution

Artificial intelligence is data-hungry and for building good AI tools it is necessary to understand what data is available and what information this data contains. Since the 1980s, several world regions established air pollution monitoring networks including fixed stations and mobile platforms.

The database of the Tropospheric Ozone Assessment Report (TOAR) hosted at Forschungszentrum Jülich in Germany contains data from over 14,000 air pollution measurement sites around the world. The data from

these stations are supplemented with information obtained from satellites. While this description of the global air pollution monitoring network would suggest that we have rather complete information about air pollution in the world, this impression is misleading.

Satellite instruments, although they have global coverage, don't measure frequently enough and have limited precision for measurements near the Earth's surface where humans breathe the air. Many world regions have hardly any air quality monitoring stations and even in Europe, where the station network is relatively dense, there are usually some ten if not hundred kilometres distance between neighbouring sites.

AI can play a role in expanding the global air pollution monitoring network, for example as a means to interpret the measurement signals obtained from modern low cost sensor devices. Such devices may be used to fill monitoring gaps if they are used in context with measurements from traditional stations.

AI can help analysing and predicting air pollution

Interpretation and forecasting of air pollution currently requires complex numerical models (so-called chemistry transport models) which simulate weather and air pollution chemistry with computer codes encompassing many thousand lines and running on the world's largest supercomputers.

Using AI for these purposes poses a number of challenges that differ from the issues commonly seen in other AI applications. AI methods have first been tested in the context of local air quality forecasts in the 1990s. At the time, the machine learning algorithms and computational capacity were



about a million times less powerful than today and so machine learning results were only marginally better than results obtained with classical statistical methods if at all.

After 2012 when so-called convolutional neural networks led to breakthroughs in typical AI tasks such as image recognition, atmospheric scientists also became again interested in AI. Since 2018 several studies have appeared which clearly demonstrate that advanced machine learning techniques can indeed generate good-quality air pollution forecasts locally.

Machine learning models will soon also provide alternative and computationally much cheaper solutions to forecast air pollution over a region. Our own research in the framework of the ERC project IntelliAQ indicates that such systems might work best in a hybrid approach where the weather information is taken from traditional numerical simulations (i.e. weather forecasts), while air quality information is brought in from measurements.

Chances and risks of AI in air pollution management

The combination of low cost air pollution sensors with AI and hybrid models might offer the potential for much more detailed air pollution maps and therefore much better targeted mitigation measures compared to what is affordable today.

In combination with physiological sensors and medical information systems AI-based pollution monitoring may eventually allow for direct measurements of inhaled pollutant doses which could help vulnerable persons to better plan their outdoor activities and avoid hazardous environments. Indeed, several companies in Europe and elsewhere are already advertising AI-based air quality information.

However, at this point, the quality of such systems is often questionable and there is little information available how well they work in practice. As in other application areas, the greatest danger of AI solutions arises when they are blindly trusted. It is thus important that we develop a good understanding of the capabilities and limitations of AI-based air quality monitoring systems and that we remain in control about our actions.

This project has received funding from the European Union's HORIZON 2020 Research programme under the Grant Agreement no. 787576

JÜLICH Forschungszentrum

Martin Schultz
Senior Researcher and Team Lead
Jülich Supercomputing Centre,
Forschungszentrum Jülich GmbH
Tel: +49 2461 6196870
m.schultz@fz-juelich.de
https://go.fzj.de/martinschultz
https://twitter.com/MGS_DataScience

Water infrastructure and planning in a climate-changing world

Maria Alina Rădulescu, Wim Leendertse and Jos Arts, from the Centre for Agroecology, Water and Resilience (CAWR), look towards water infrastructure to plan for better stakeholder engagement

Water runs across territories and administrative boundaries, hangs in the air as vapour, rain, hail, snow, flows underground and rests on the surface, trickles in streams into lakes, surges from rivers into seas and oceans. We drink it, wash in it, play in it, fish in it, use it in industry, religious celebration and for irrigation – water infrastructure is necessary to life.

In July 2021, while Western Europe experienced a series of severe flooding events, severe drought pushed Madagascar to brink of the world's first climate change famine.

Climate change planning is increasingly necessary

As climate change increasingly causes more frequent and intense weather events, spatial and water infrastructure planning becomes more difficult. Planning approaches need to be more nuanced than either top-down – based on the global character of climate impacts, or bottom-up – based on the trends of decentralisation and citizen participation that aim to improve adaptive capacity on the local scale.

Essentially, we need to ditch our silos in favour of new planning approaches that simultaneously enable localisation and contextualisation, interaction and coordination and express an explicit appreciation for complexity, uncertainty, flexibility, dialogue and adaptive capacity.



One option could be a *Living Lab*. Defined as "user-centred, open innovation ecosystems based on a systematic user co-creation approach integrating research and innovation processes in real life communities and settings" (European Network of Living Labs, 2015), Living Labs are increasingly being recognised as a way of engaging and integrating a plurality of knowledges to address complex social-ecological issues.

They have been successfully used in the private sector for some time in open innovation and user-oriented innovation. By bringing together different insights, types of knowledge (expert and experiential), organisational and working cultures, and resources, Living Labs not only have the potential to make a spatial and water infrastructure planning project more inclusive and resilient, but can also ensure broader support from affected communities.

A case study of water infrastructure projects

A case study investigation of this approach to support collaborative decision-making in The Netherlands, undertaken as part of the RECOMS project, concluded that a Living Lab can contribute to the transformation of a spatial and water infrastructure planning project into an engine for the sustainable development of an area (Radulescu 2021).

Living Labs, alike many other co-creative stakeholder engagement processes, can bring real benefits, but there are also potential challenges to be aware of.



The following *recommendations* are offered in support of creating – and sustaining – the foundations for such a process to flourish. Whilst they have primarily been drawn from the research undertaken on the use of Living Labs, their relevance extends to a much wider array of resource and place-based stakeholder engagement processes:

- **Carefully plan the co-creative and collaborative process, but remain flexible** – clearly define the goals, identify key resources and responsibilities, and set aside sufficient time to create a good management and communication system, but remain flexible and sensitive to new information, novel insights and feedback from stakeholders.

- **Involve a diversity of viewpoints** – map all potential stakeholders early to identify all those affected or with an interest. Remember to balance inclusivity with the need for a manageable number of participants.

- **Clearly explain the nature and context of the Living Lab from the beginning** – the initiator must clearly introduce the problem at stake, the goals of the Living Lab, its position and scope within the planning process and potential limitations (e.g. In terms of budget and time).

- **Connect local, regional and national actors, issues and goals** – given the complex nature of 'wicked' challenges and the fluid, interconnected character of water, a Living Lab needs to connect and raise awareness of the different actors, issues and goals to promote understanding, synergies and coordination.



Photo by: Geoffrey Whiteway

- **Create space and time for exchange of knowledge, expertise and experience** – be adaptable in terms of setting, language, timing, pace, focus, facilitation, tone, perspectives, needs and outputs. Be prepared to bring in experts form other fields to respond to an identified need not originally envisaged. Be willing to learn from the experience of a Living Lab in a different context or region, but be prepared also to adapt it to the specifics of your own case.

- **Be prepared to limit focus, boundaries and establish a mandate** – Narrowing down the scale, focus and scope can prove crucial to success. Keeping ambitions realistic can help provide focus and make it possible to implement ideas in practice.

- **Don't be afraid of uncertainty or failure** – even when a Living Lab does not succeed in fostering innovative ideas, or ideas that are implemented, it still represents a source of shared learning, community building and problem ownership. It may be the starting point for longer term collaboration.

- **Monitor and reflect back to track progress and ideas** – Conventional management tools often fall short in monitoring the complex multi-stakeholder collaboration that a Living Lab usually is. Be attentive to the process and the outcome.

These findings will be shared as part of RECOMS contribution to the festival of the New European Bauhaus in Brussels in June 9-12.

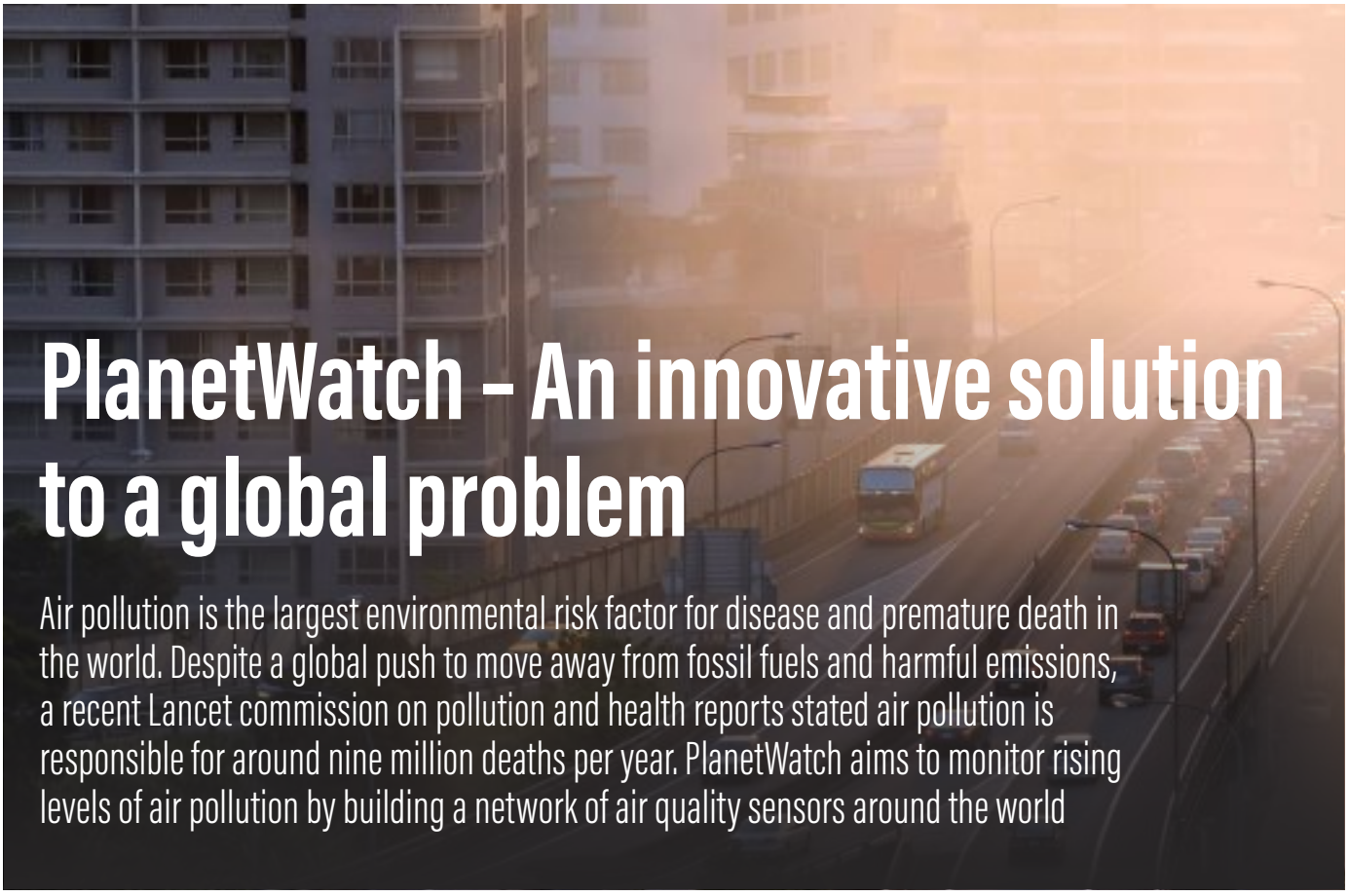
The lead authors of this article are Maria Alina Rădulescu, Wim Leendertse and Jos Arts. The article is derived from a policy brief which also forms part of the RECOMS Project and includes editorial input from Tsveti Bandakova, Lindy Greaves and Alex Franklin.

This project has received funding from the European Union's HORIZON 2020 Research programme under the Marie Sklodowska-Curie grant agreement No 765389.

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

RECOMS

Centre for Agroecology, Water and Resilience (CAWR)
Coventry University
m.a.radulescu@rug.nl
wim.leendertse@rws.nl
https://twitter.com/RECOMS_ITN



PlanetWatch – An innovative solution to a global problem

Air pollution is the largest environmental risk factor for disease and premature death in the world. Despite a global push to move away from fossil fuels and harmful emissions, a recent Lancet commission on pollution and health reports stated air pollution is responsible for around nine million deaths per year. PlanetWatch aims to monitor rising levels of air pollution by building a network of air quality sensors around the world

This staggering figure incorporates both indoor and outdoor exposure and has remained roughly the same since 2015. Industrialised and traffic-heavy cities are the largest pollution hotspots globally, yet data from the World Health Organisation (WHO) shows that 99% of the world's population is exposed to air which exceeds guidelines for pollution limits.

The scale of this problem highlights the size of the task ahead. Before air pollution can be tackled in an efficient and impactful way, widespread and accurate air quality monitoring is needed to provide the agents of change with accurate data to tackle issues with targeted measures.

The air quality monitoring network of the future

One innovative solution to provide accurate air quality monitoring on a global scale is PlanetWatch. Founded as a spinoff from the European Organization for Nuclear Research, widely known as CERN, and with offices located very close to CERN, PlanetWatch is leading the way by building a hyper-local and near-real- time network of air quality sensors, all over the world.

The project was founded by Dr Claudio Parrinello together with other seasoned entrepreneurs and researchers. While occupying leadership roles at CERN, Claudio recognised the enor- mous potential of citizen science for real-world, data-intensive projects. This was further developed with the evolution of blockchain technology, and how this could improve global air quality monitoring through its speed, efficiency, transparency and decen- tralised nature.

Claudio and co-founders set up PlanetWatch in late 2019. Since then, PlanetWatch has grown to become a community-driven network of over 70,000 sensors, with large sensor rollouts in European and US cities currently underway. Unlike traditional air quality monitoring networks, PlanetWatch uses reliable yet afforable and easy-to-install sensors. This makes the project uniquely scalable while providing accurate and up-to- date local data.

How hyperlocal monitoring can lead to change

Current monitoring networks are not dense enough to detect localised pollution hotspots, especially in inner cities. High-density networks delivering hyperlocal data are essential in order to timely identify hotspots and analyse in detail the correlation between air quality and potential pollution triggers.

Unlike most current air quality monitoring networks which rely largely on data interpolation on the basis of a few, isolated sensors, PlanetWatch's network is reliable and dense, delivering hyperlocal data.

Readings are taken on a rolling basis, allowing for a near real-time stream of information. This is particularly useful for identifying pollution caused by traffic, which can vary heavily during a normal working week. It can also provide information on the impact of other variables, such as weather conditions on air pollution.

This combination of hyper-local and near real-time information is crucial in filling knowledge gaps for local, regional, and national authorities, allowing them to take targeted action where it is most needed. For example, this can take the form of improved traffic management or targeted emission taxation for polluting businesses. It can also aid city planners in deciding where to locate public spaces and how to protect schools, hospitals, and other civic facilities from increased pollution levels.

Citizen science in action

Air pollution is a problem which affects everyone. As such, providing individuals and communities with the tools and the agency to make a differ- ence is a powerful way to generate change from the ground up. This is why PlanetWatch is proud to operate a community-driven air quality monitoring network. Data is stored on the Algorand blockchain, which is renowned for its sustainable profile, creating a transparent, speedy, and decentralised ledger of air quality information, the first of its kind.

In exchange for sharing sensor data, users earn rewards in the form of PLANETS tokens, which can be collected and redeemed for products and services, including the planting of a tree in a sustainable forest. This incentive scheme encourages the growth of PlanetWatch's network while rewarding its users and empowering them to make a positive difference to their environment.

> "The information provided by accurate air quality monitoring networks can provide national leaders, lawmakers, and individuals with a clear picture of what measures must be taken in order to tackle this global challenge."

This 'citizen' science approach is a vital part of PlanetWatch's ethos. Yes, government action is important and desperately needed, but when allied with community and individual agency, measures can be taken more quickly and with added impetus.

Following the PlanetWatch roadmap

While major cities in the developing world tend to experience the highest pollution levels, recent data shows that areas in Central and Eastern Europe, as well as hotspots in Northern Italy, are showing dangerous levels of air pollution, especially particulate matter (PM10 and PM2.5) and nitrogen oxide (NO2), all of which are highly damaging to physical and neurological health.

Some of PlanetWatch's earliest projects took place in Italy, where recently published figures led to an EU court ruling that the country's air quality levels breached air pollution laws. PlanetWatch analysed over 6.5 million data streams from the pollution hotspots of Milan and Taranto, providing an excellent blueprint for future city-wide projects.

PlanetWatch is also currently establishing a strong presence in several other European cities, including Barcelona, Munich, Berlin, Madrid, Brussels, and Budapest, while a partnership with the City of Miami announced in late 2021 will result in a large-scale rollout of sensors across this Florida metropolis.

The ambition for PlanetWatch is to expand rapidly and provide a truly global network of impactful hyper- local data, which can empower citizens to look after the air they breathe. The information provided by accurate air quality monitoring networks can provide national leaders, lawmakers, and individuals with a clear picture of what measures must be taken in order to tackle this global challenge.

PlanetWatch
Your planet needs you

Claudio Parrinello
Chief Executive Officer (CEO) &
Founder of PlanetWatch
PlanetWatch
business@planetwatch.io
https://www.planetwatch.io/
Twitter account:
https://twitter.com/PlanetWatchsas
https://www.linkedin.com/company/planetwatch
https://www.facebook.com/PlanetWatch-106206814422901/
https://www.instagram.com/planetwatchsas/
https://medium.com/planet-watch

Research priorities for sustainability science

With the position paper "Research priorities for sustainability science" the German Committee Future Earth (Deutsches Komitee für Nachhaltigkeitsforschung in Future Earth, DKN) highlights pertinent research gaps and suggests forthcoming fields of research in the field of sustainability science.

We live in a world of multiple global crises. Unsustainable ways of living are leading to increasing loss of biodiversity, climate warming, health threats, social inequalities, and political instabilities, and ultimately, to great environmental and societal challenges. Urgent action is required to tackle these challenges. In order to support these actions, it is crucial to identify what research is needed.



"Research priorities for sustainability science" combines insights from global environmental change research and the environmental social sciences and humanities. The aim is to foster exchange and networking that can facilitate research that will sustainably transform society.

Concepts and trajectories

The paper covers different areas of sustainability science and identifies open research questions. It discusses conceptual approaches and goals of sustainability research and different trajectories regarding how to attain sustainable development. It also discusses challenges regarding spatial, temporal and functional scales as cross-cutting topics and treats inter-linkages, synergies and trade-offs between extreme events, societal resilience, individual health and well-being, and social cohesion for design-



ing pathways towards the Sustainable Development Goals. Also linkages between biodiversity, food production, human nutrition, dietary behaviour and health are discussed.

From this review of pertinent research topics that need to be tackled in the field of sustainability science, the following conclusions are drawn:

1. Key sustainability concepts require constant reflection and probing and it must be asked to what extent they are conditioned by political motivation and cultural background.
2. Questions of justice (transgenerational, transnational etc.), now considered to be a key challenge of transitions towards sustainability, must be debated.
3. Sustainability sciences at large should engage in both evaluation of existing theories and the development of new concepts at the same time. This effort must be addressed by international interdisciplinary consortia engaging scientists from the natural sciences, the social sciences, and the humanities, arguing simultaneously from vantage points in different spatio-cultural settings.
4. To find out how cross-scalar linkages can be addressed in empirical research and political action is still a key task of the sciences.
5. In-depth interdisciplinary understanding of the socio-ecological processes underlying transitions from extreme events to crises and catastrophes and of the conditions of resilience is needed.
6. Changes in food systems and dietary transformations are of crucial significance to address anthropogenic perturbations, steep biodiversity declines and global health.

Interdisciplinary and transdisciplinary

Research programmes and projects on these topics are necessarily interdisciplinary. They need to involve scientists from different epistemic communities. They also need to be transdisciplinary and participatory, involving decision-makers and civil society from the early phases to the reflection upon resulting theories.

With this paper, the DKN aims to promote the discussion on the manifold epistemological, theoretical, and methodological challenges of current sustainability research and, moreover, aims to motivate scientists to engage across disciplinary boundaries to actively shape the transformation towards a sustainable society.

The German Committee Future Earth (Deutsches Komitee für Nachhaltigkeitsforschung in Future Earth, DKN) is an independent scientific advisory body of the German Research Foundation (DFG) and national contact point and platform for developments and activities within the international research program for global sustainability "Future Earth" and the "World Climate Research Programme" (WCRP). The DKN fosters interdisciplinary, integrative sustainability research in both a national and international context and thus promotes cooperation between the disciplines. Since 2019, the DKN is chaired by Daniela Jacob and the DKN Secretariat is hosted at the Climate Service Center Germany (GERICS).

Authors

Sebastian Sonntag, sebastian.sonntag@hereon.de

Daniela Jacob, d.jacob@hereon.de

Helmholtz-Zentrum hereon

GERICS Climate Service Center Germany

An institution of Helmholtz-Zentrum **Hereon**

Goerl, Knut
Scientific Assistant
GERICS Climate Service Center Germany
Tel : +49 40 227 338 417
knut.goerl@hereon.de
www.gerics.de
https://twitter.com/GERICS_Germany

Uncertainty in sea-level rise & how can we use it as a tool

Sandy Avrutin, Ocean and Earth Science Postgraduate Researcher, National Oceanography Centre at the University of Southampton, describes the uncertainty in sea-level rise, what it is & how we can use it as a tool

Sea-level rise is a major impact of climate change, threatening coastal communities, infrastructure and ecosystems. To compound the issue, a significant proportion of the UK's population are centred around coastlines – making them vulnerable to changing seas. Because of this, it is difficult to understate the importance of being able to predict how sea levels will change in the future. Furthermore, uncertainty in sea-level rise and its lack of predictability means that it is essential to begin to reduce our emissions even if there are some gaps in our knowledge – a fact that not all policymakers are grasping.

To project sea-level rise, we must understand the different processes that contribute towards it. There are processes that physically add to the volume of water in the ocean (these act to change sea-level on a global scale) and change our coastlines, which change sea level on a local scale. In the first category, we have ice melt and thermal expansion (warmer water takes up more space than colder water because it is less dense). In the second category, we have vertical land motion or erosion.

Part of being able to predict the amount of sea-level rise from these sources by a particular year is knowing what timescales they act on. For example, it takes time for extra heat to make its way from the atmosphere to the bottom of the ocean. This means that the sea-level rise we get from thermal expansion happens slowly – in fact, we haven't yet experienced the full extent of sea-level rise we can expect from the warming we have already caused. This is termed "committed sea-level rise": the amount of sea-level rise we can expect in the long- term from the emissions we have already released. This 'committed sea-level rise' is a key point in favour of rapid and significant reduction of carbon emissions, alongside solid adaptation planning. Policymakers need to understand that even though there is possible variation in the exact outcomes of sea-level rise, we as scientists are certain that damage will be done, and delaying the transition to zero emissions until the 'exact' outcomes are known could lead to catastrophic amounts of sea-level rise.

Because of the number of processes that contribute to sea-level rise, each with their own timescale, scientists can never fully represent the intricacies of interactions at play. To represent this, future sea-level rise will always be presented as a range of possibilities for a given amount of warming, rather than one single figure. For example, the most recent prediction from the IPCC is 0.63-1.01 metres of sea-level rise by the year 2100 following the highest-emission scenario, and the most optimistic prediction is 0.28-0.55m. Note that in the most optimistic case, scientists assume that warming will stabilise and eventually decrease – but sea-level rise is still predicted to continue, due to the lag in response of sea level to warming.

This range of potential sea-level rise is referred to as 'uncertainty'. This conveys that there is variation in the earth system that we can never fully represent in models, because it is impossible to know exactly how all the different parts of the complex earth system will interact. However, it is perhaps an unfortunate choice of phrasing because it can create the impression that we don't understand the system or that we can't be sure whether these predictions are correct. While scientists readily understand the phrase as simply a little room for manoeuvre (we don't have a crystal ball, after all), politicians and policymakers like to use it as an excuse to avoid putting climate change measures at the top of their agenda. Paying upfront to avoid catastrophic (and much more expensive) damage in the future should be a no-brainer.

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Of course, limitations to our understanding do exist. To refer to these, the IPCC reports use the term 'confidence' in projections. To give a simple example of how these two terms are used together: I ask a group of people to guess my friend's exact age and their guesses range between 15 and 50. There is high uncertainty in that range (35 years), but I trust the judgement of these people as a collective and we can be quite confident that my friend's actual age is somewhere in that range. For a more in-depth explanation on confidence and uncertainty, the IPCC issues guidance on it. The sea-level projections from the latest IPCC report are given with medium confidence, indicating that there is some disagreement between studies, or that we could use more evidence. While it is always possible that we can improve our representation and understanding, we already have enough knowledge of the system to know that predictions have meaning and point towards a realistic future.

"While we wait, we are letting warming continue, and increasing the amount of sea-level rise we are committed to."

So, the range of these predictions can absolutely be used as a tool for scaling our adaptation efforts on a local basis. Policymakers should take the opportunity to prepare for the lower end of the predictions and prioritise spending and development towards preparing for other hazards, which may be the approach favoured by areas that are not set to experience much sea-level rise. Ideally, they can prepare for the higher end of the predictions and know that this covers almost any eventuality, which is useful for low-lying, at-risk areas such as the Netherlands.

What we have no reason to do, however, is wait for a time when predictions have little to no uncertainty to them before we act to reduce emissions. Not only is this an unrealistic expectation, but while we wait, we are letting warming continue, and increasing the amount of sea-level rise we are committed to. This is a particularly pertinent point in the case for socially just climate change policies, due to the unequal amounts of sea-level rise occurring worldwide. As the effects of sea-level rise will inevitably be to affect how and where we as humans can live, it is absolutely essential that policymakers cease to wait for increased 'certainty' of scientific predictions, and instead work with urgency to protect those that they represent.

Case study: Environmental science in the U.S.

National Oceanic and Atmospheric Administration (NOAA), an agency within the U.S. Department of Commerce, in essence, makes life richer through their environmental science work. Indeed, NOAA's work encompasses "the surface of the sun to the depths of the ocean floor" and as such, they strive to keep the public up-to-date about the changing environment. (1)

Part of NOAA's Mission concerns predicting and understanding changes in the ocean and coasts, as well as climate plus weather. Another is to do with managing and conserving coastal and marine ecosystems plus resources. (2)

It is, therefore, interesting to note that the Office of Protected Resources, a part of NOAA, seeks to work "to conserve, protect, and recover marine species and their habitats," we read online. For example, the Marine Mammal Conservation and Management aspect of their work concerns responsibility "for the conservation, management, and protection of whales, dolphins, porpoises, seals, and sea lions under the Marine Mammal Protection Act (MMPA)." (3,4)

Sharing the knowledge of the environment referred to earlier with others is, therefore, a key part of NOAA's Mission: to benefit communities, businesses, communities and people's daily lives in the United States.

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Sandy Avrutin
Ocean and Earth Science Postgraduate Researcher
National Oceanography Centre at the University of Southampton
Tel: +44 (0)23 8059 5000
www.southampton.ac.uk/oes/postgraduate/research_students/ala1e19.page?
https://twitter.com/NOCnews
https://twitter.com/unisouthampton
https://twitter.com/AvrutinS

Minimising impacts of coastal construction on bottlenose dolphins

Ann Weaver PhD, Dolphin Behaviourist and Biostatistician, offers insight into minimising the impacts of coastal construction projects, ensuring the quality of coastal life such as dolphins



Coastlines are the most endangered habitats on earth. 70% of the human population clambers to colonise them. With the human population projected to reach 9.9 billion by 2050, noise pollution and environmental disruption must be monitored and minimised to ensure the quality of future life.

A major source of environmental disruption is the range of activities related to coastal construction. Seawalls are built to contain the soil and create new land. Incalculable pilings are pounded into the seafloor for moorings. Inestimable tonnes of sea floor are dredged. Land masses are moved and shaped to create arenas, airports, and shipping yards on the water.

Replacing ageing maritime infrastructures is essential

A widespread form of coastal construction is replacing ageing maritime infrastructures such as bridges. I am the principal investigator of an intensive, ongoing 18-year NOAA-based study to document changes in free-ranging bottlenose dolphins before, during and after a five-year bridge replacement project in prime dolphin habitat. My study's results give direction to minimising the impacts of future coastal construction projects.

To document impacts, I collected three measures of dolphin behaviour in the immediate construction zone before, during and after bridge replacement on 1219 surveys across 11 years. One, dolphin presence and absence was documented to see how often dolphins occurred in the area before construction to compare to during and after construction. Two, when dolphins were present, they were counted to see if their numbers before construction changed during and after construction. Three, dolphins' use of the area was documented to see if any main behaviours before construction changed during and after construction.

Statistical results of logistic and negative binomial regression analyses revealed these findings. During and after construction:

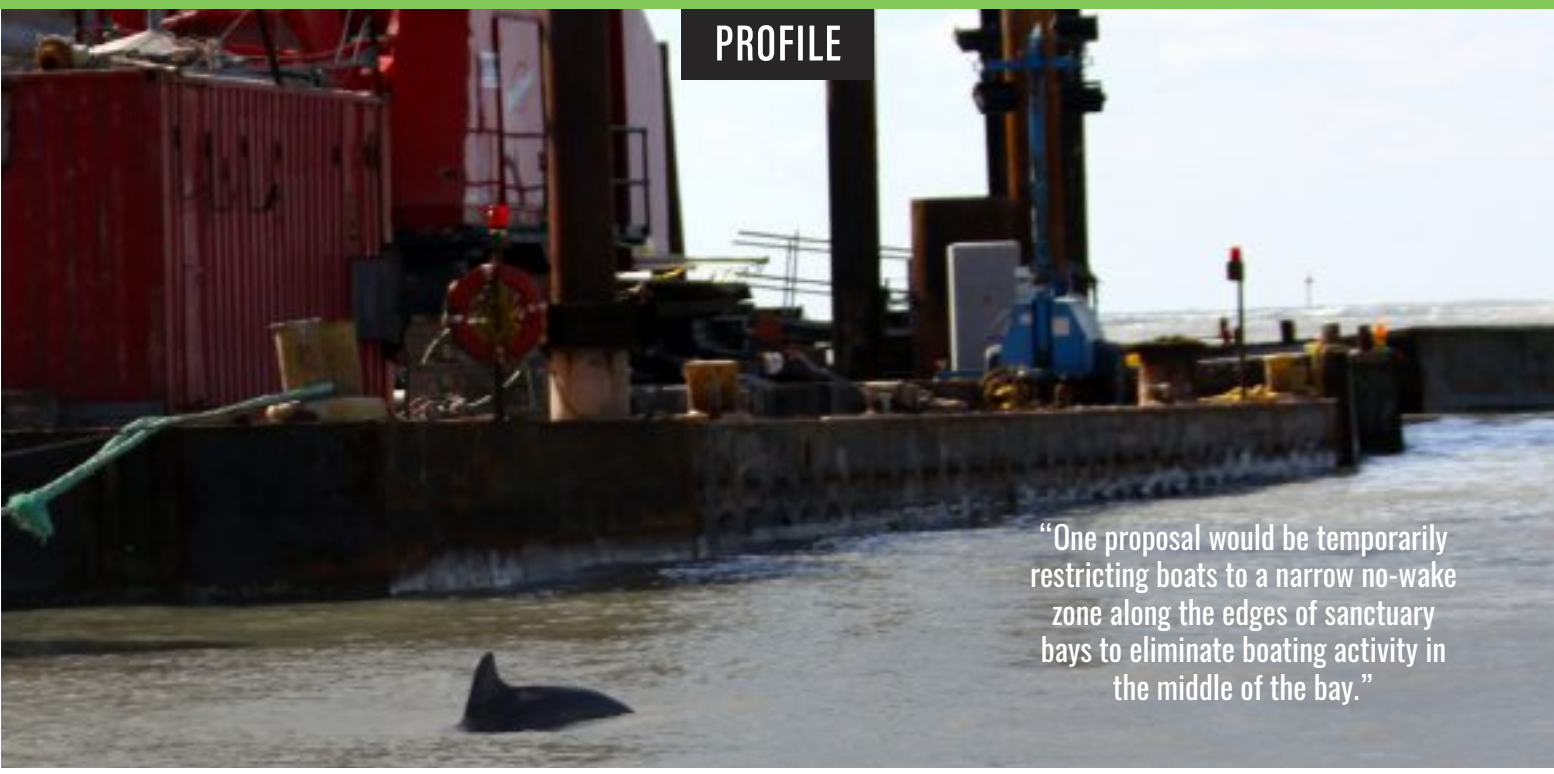
- Dolphins were present significantly less often.
- Dolphin numbers were significantly lower.
- Females were present significantly less often.
- Feeding was significantly less frequent.

Alternatively, dolphin social behaviour did not change across construction but shifted to later in the day when construction activities were at an ebb.

Interpretation of findings on coastal construction

My interpretation of these findings relates to the fact that construction occurred in two 2.5-year phases: Removing and replacing the west lane, then the east lane. Both involved the same series of activities: above and below water demolition, dredging, debris removal, and replacement. Dolphins' first-phase behaviour was wholly disrupted but second-phase behaviour increasingly resembled baseline. My interpretation is that the two-phased nature of construction may have given the dolphins the chance to learn and adapt by showing them what to expect even as they resisted changing their habitual use of prime dolphin habitat.

These results led to two conclusions. Firstly, coastal construction shows no signs of abating. However, if construction projects are designed to be completed in two phases to give coastal dolphins a chance to adapt, maybe they will adapt. Secondly, 11 years of data suggested that dolphins will only change what anthropogenic environmental disruption forces them to change, shifting different behaviours in different ways. Therefore, dolphin presence in construc-



"One proposal would be temporarily restricting boats to a narrow no-wake zone along the edges of sanctuary bays to eliminate boating activity in the middle of the bay."

tion-degraded habitats does not mean that anthropogenic activities were neutral.

Monitoring and mitigation of all coastal construction projects should be mandatory, funded by ear-marked governmental and construction company monies as part of construction costs.

Key parts of an ideal research effort

The ideal research effort has five key parts. Species at the apex of the food pyramid, such as dolphins, are key informants of environmental conditions. One key part is an animal behaviourist who monitors dolphins in and beyond the construction zone. Free-ranging coastal dolphins are relatively easy to study scientifically during small-boat surveys. The more detailed the documentation of how dolphin behaviour changes across construction, the more valuable the study.

Two is an ichthyologist who monitors middle and lower trophic levels. Fish are also sensitive sentinels of environmental quality, the crucial 'canary in a coalmine' because apex marine species depend on fish to eat. My study shows that coastal construction activities destroy fish populations, an important impact to mitigate for dolphins and humans alike.

Three is an acoustician who monitors the acoustic scene with hydrophone arrays. In the construction zone, noise pollution, boat traffic, and the disturbed acoustic scene of dolphins, fish, and invertebrates can be measured and compared to the undisturbed acoustic scene beyond it.

Four is a popular science writer whose regular updates from the field can educate and entertain the public, soliciting citizen cooperation as they bond with local wildlife on a first-name basis. People have an uncanny attraction to dolphins. My study shows that the public appreciates being informed, based on enthusiastic responses to my 15 years of publishing weekly popular science articles to introduce the public to their 400 local dolphins.

Five is minimising exposure to horrific construction noise pollution by establishing temporary sanctuary bays for the duration of construction to provide acoustic shelter. One proposal would be temporarily restricting boats to a narrow no-wake zone along the edges of sanctuary bays to eliminate boating activity in the middle of the bay. Local tax collector offices maintain lists of registered boaters, who can be emailed about boating restrictions in sanctuary bays. Passive economical monitoring systems for violators in sanctuary bays could be solar-powered cameras mounted on channel marker pilings. Fines can be used to augment monies earmarked to fund research efforts.

Most of all, monitoring and minimisation before, during and after every coastal construction project must be mandatory to ensure the quality of coastal life.

Ann Weaver, PhD
Dolphin Behaviourist and Biostatistician
Good-natured Statistics Consulting
Tel: 01-727.642.2890
annstats54@gmail.com
DolphinsDigital.org



Shellfish poisoning: A neurotoxic consequence of global warming

Jeremy MacMahon, Yi-Hua Tsai, and Pamela Lein from the Department of Molecular Biosciences, UC Davis School of Veterinary Medicine, explore how shellfish poisoning is affecting human and animal health

Over a month-long period in 1987, more than 150 people across Canada unknowingly consumed large quantities of contaminated mussels from Prince Edward Island in what turned out to be the largest documented case of human amnesic shellfish poisoning (ASP) to date. Acute symptoms included vomiting, diarrhoea, headaches, and amnesia, while severely intoxicated individuals developed seizures and/or went into a coma. Those who did not die took up to 3 weeks or even longer to recover.

The Canadian outbreak of ASP was precipitated by ingestion of the marine toxin, domoic acid (DA) in contaminated shellfish. DA is produced by diverse algae species that grow around the world. Very high levels of DA are associated with red algae blooms, which are large masses of the diatom *Pseudo-nitzschia*. Some species are capable of producing DA, and shellfish that feed on toxic *Pseudo-nitzschia* blooms sequester DA in their tissue for as long as three months after exposure. DA is a neurotoxic chemical that can cause permanent short-term memory loss (or amnesia), brain damage and death in severe cases. The shape of DA resembles that of neurotransmitters that would normally bind to and activate kainate receptors in the brain. By mimicking these neurotransmitters, DA activates kainate receptors, which increases excitatory signalling in the brain. At high enough concentrations, DA causes an imbalance in excitatory to inhibitory signalling in the brain, which results in excitotoxicity, literally, the death of neurons due to over-excitation.

The dangers of shellfish poisoning to native animal populations

DA not only harms humans who consume contaminated shellfish, but also native animal populations, most notably marine mammals, such as dolphins and sea lions, and birds, especially gulls, living along the West Coast of the United States. California sea lions have become an important model species in studies of DA neurotoxicity because the route of exposure to DA, consumption of contaminated shellfish, and symptoms of intoxication are comparable to humans.

"DA causes an imbalance in excitatory to inhibitory signalling in the brain, which results in excitotoxicity, literally, the death of neurons due to over-excitation."

Currently, there is no known antidote for ASP, and neither cooking nor freezing contaminated shellfish eliminates DA toxicity. This has prompted research to identify "safe" levels of DA for human consumption and the mechanisms by which DA causes neurotoxicity. Currently, the regulatory limits for DA in shellfish are based on

a recommendation from the United States Food and Drug Administration that no more than 20 µg DA/g tissue in fish tissues (30 µg DA/g tissue in crab tissues) is safe for human consumption. The United States and Canada monitor DA levels by collecting sentinel species (typically clams and crabs) in areas where harmful algal blooms are a concern. If levels exceed the recommended regulatory limit, public health officials have the authority to prohibit the harvest of shellfish from affected areas. In the spring of 2015, a massive harmful algal bloom of the toxin-producing *Pseudo-nitzschia* occurred on the U.S. West Coast, causing closures of shellfish fisheries that extended into 2016, generating an economic shock for coastal fishing communities. Economic hardships extended beyond fishing-related operations to include other sectors, particularly the hospitality industry, and long-held traditions surrounding crab and shellfish harvest and consumption were disrupted, threatening the cultural identities of the affected communities.

Is human health being protected?

Many scientists question whether the current regulatory limit is sufficiently protective of human health. This concern is based in part on emerging research focused on how DA impacts the developing nervous system. Several studies have demonstrated that young animals exposed during early development to low levels of DA that do not cause shellfish poisoning have an increased likelihood of developing epilepsy or behaviours relevant to schizophrenia or related neuropsychiatric disorders as they mature. The implications of these findings are sobering given regulatory limits on DA in shellfish are currently based on levels that cause acute toxicity in adults.

> "Additional factors implicated in increased harmful algal blooms include changes in pH and CO_2, and increased concentrations of nutrients (mostly phosphorus and nitrogen) in the ocean, which are also consequences of global climate change."

The complications associated with regulating DA and treating individuals poisoned by DA underscore the pressing need to identify factors driving harmful algal blooms. Algal blooms are natural phenomena that happen regularly. However, harmful algal blooms, a term that refers to either the overgrowth of nontoxic algae that deplete oxygen levels in the water causing fish die-offs or the blooms of toxin-producing algae, are increasing in frequency and size. Warmer ocean water temperatures from global climate change are considered a significant factor in the increase in toxin-producing harmful algal blooms. A 2017 study led by scientists at Oregon State University and the United States National Oceanic and Atmospheric Administration (NOAA) reported that the occurrence of high-level DA is closely linked to warm phases of the Pacific Ocean. Additional factors implicated in increased harmful algal blooms include changes in pH and CO_2, and increased concentrations of nutrients (mostly phosphorus and nitrogen) in the ocean, which are also consequences of global climate change.

Managing future algae issues

To better manage and prevent future acute high-level DA exposures that cause ASP, it will be essential to tackle this issue on multiple fronts. We need tools that will enable better prediction of the timing and "hotspots" of harmful algal blooms to issue early warnings to potentially impacted communities, industries, and consumers. We will also need to develop internationally coordinated environmental interventions to address the root cause of harmful algal blooms, which is global climate change. Investment in the resources needed to realize these goals will have significant positive impacts not only on public health, but also on ecological diversity and the economic and cultural stability of communities that rely on shellfish.

UCDAVIS VETERINARY MEDICINE
Lein Laboratory

Jeremy MacMahon
PhD Graduate Student
University of California, Davis
Tel: +1 925 324 8021
jamacmahon@ucdavis.edu
https://leinlab.vetmed.ucdavis.edu/

Yi-Hua Tsai, Ph.D.
Postdoctoral Scholar
University of California, Davis
Tel: +1 530 979 4104
yihtsai@ucdavis.edu
https://leinlab.vetmed.ucdavis.edu/

Pamela J. Lein, Ph.D.
Professor
University of California, Davis
Tel: +1 530 752 1970
pjlein@ucdavis.edu
https://leinlab.vetmed.ucdavis.edu/

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THE HISTORICAL SIGNIFICANCE OF TOXICOLOGY:
(IN)FAMOUS POISONINGS THROUGHOUT HUMAN HISTORY

Poisons have figured prominently throughout human history, with recorded evidence of domestic poisonings as early as 331 BC, and frequent references to poisoning in the Bible, Shakespeare's works, and fairy tales or myths of diverse cultures…Poisons have also been wielded as tools of assassination or intimidation in quests for political and/or financial gain and crimes of passion. Here, we provide a brief review of (in)famous poisonings from ancient to modern human history.

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THE HISTORICAL SIGNIFICANCE OF TOXICOLOGY:
(IN)FAMOUS POISONINGS THROUGHOUT HUMAN HISTORY



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Pamela J. Lein, PhD
Professor of Neurotoxicology
School of Veterinary Medicine
University of California, Davis
Tel: 1-530-752-1970
pjlein@ucdavis.edu
https://leinlab.vetmed.ucdavis.edu/

Unlocking the potential of cities in Europe

Alex Ryan, Urban Design and Transport Expert at PA Consulting, delves into unlocking the potential of cities in Europe

Cities in Europe are hotbeds for testing, trying and executing game-changing resilience - let's make sure they can access generous European funds.

Cities are hubs for innovation, and their governments can be forces for urban advances, with huge demand to create resilient and connected systems within them – something which has never been more crucial following the profound shock and fall out of the pandemic. A resilient system can absorb and adapt to these shocks and stresses, without disrupting the actors and stakeholders embedded within them, whilst also allowing such stakeholders to thrive.

The European Union is backing the Member States through a range of generous funds to help ensure this and to realise the immense potential of human ingenuity. However, municipal governments often struggle to influence and access European funds as current structures mean national governments play a far more important role in defining where the money goes and on what it is spent. For example, for the Member States to access some of the €800 billion from Next Generation EU, each had to develop a National Resilience Recovery Plan (NRRP), which were almost fully dictated by national governments, meaning municipal governments were not able to strongly influence the plans.

Are cities central to the comeback?

As of 2020, approximately 75% of EU Residents live in urban areas, significantly higher than the global average. Logic, therefore, suggests that any fund looking to maximise return on investment (economic, social, environmental) should tap into city networks and help remove barriers to effective capital deployment direct to municipalities and their local system partners.

Furthermore, during times of shock and disruption, progressive and innovative policies are fundamental to not just recovery but building a better society; and the local knowledge of municipal governments must be drawn upon to understand where positive impacts will be most felt and who is best placed to deliver inclusive policy and projects. Such projects need to be held to standards, such as the urban resilience standard ISO 22371 or the British Standard BS 67000 for City Resilience published in 2019.


Alex Ryan

Solutions for cities

Coordination between supranational, national and municipal governments is tough: different actors, different agendas, different ideas. Trust is crucial; those holding the purse strings need to trust those with the local context and have the ability to implement spending where it will make a difference – for digital infrastructure, usable spaces, health and education.

There are examples of better coordination between the different levels of governance, including the upcoming National Resilience Strategy for the UK, which embraces a "whole of society approach" to resilience, delivering on the need for more joined-up thinking and partnerships across industry, academia, government and communities.

Eurocities insight into social care systems

At the Eurocities Social Affairs Forum in May this year, insights on the challenges faced by social care systems were shared, as well as committing to investing in inclusive services. "Care is an important work as it sustains life as it involves childcare, elderly care, education, healthcare, social and domestic services," Nicolas Schmit, European Commissioner for Jobs and Social Rights comments. "And all of these have a strong local dimension."

Cities in Europe have adapted their care systems at great speed and established plans to settle and welcome refugees from Ukraine. The Eurocities caring cities statement insists that more support and measures should be put in place for all refugees and cities. Indeed, many cities have gone down the path of local social care reforms. Other cities engage in national debates about reforming social welfare policies, for example, Stuttgart adopted a 'Pact for Integration', spending €77 million from municipal budget annually for social integration measures to welcome refugees.

The last word goes to Bianca Faragau-Tavares, Policy Advisor at Eurocities who provides a compelling insight on social inclusion in the cities in Europe: "Cities' actions have reached the hearts and minds of EU leaders, standing as a clear example of commitment, inspiring national policy reforms and providing the needed impetus to push social rights forward. Social inclusion starting with children is an antidote against attacks to our social system and cohesion – and cities are fundamental."

https://eurocities.eu/latest/cities-working-towards-inclusive-care-systems-for-all/

Non-funding organisations have a role to play too. The private sector is famously agile, inventive and adaptive, and utilising these traits will allow for the effective delivery of robust, inclusive and resilient outcomes.

Mechanisms are needed to allow for similar levels of engagement between the private sector and municipal governments as already exists between the private sector and national governments. These could be in the form of joint tenders, put out by supranational organisations and municipalities, which allow for project financing and delivery models akin to those between the private sector and national governments.

City networks and NGOs are also critical, they have a deep knowledge of urban issues and the solutions to such challenges. Organisations such as Resilient Cities Network, C40, ICLEI, Rebuild by Design and MCR2030 are well connected within municipal governments, the private sector and supranational organisations and can act as the glue between stakeholders to deliver resilient and inclusive policy and projects.

A great example of this is the collaborative work seen in Rotterdam in efforts to incorporate water into public spaces. A delivery consortium from different levels of government, private sector and NGOs combined to deliver Benthemplein, a multi-use plaza that, when dry, is a meeting space and used for sports and events, but when wet can be used as a reservoir with three basins retaining water from surrounding land and buildings, stopping floodwater rampaging through dense residential neighbourhoods.

Trust cities, they know what to do

Cities' ambitious and inclusive nature means they are well placed to meet the European Commission's recovery effort. The urban-rural population balance continues to tilt in favour of city dwellers, which provides an opportunity for European institutions to realise far greater benefits and economies of scale for each Euro invested – political leaders and funders have the opportunity to put their trust in cities and enable them to be building blocks for positive change.

Alex Ryan
Urban Design and Transport Expert
PA Consulting
www.paconsulting.com
https://twitter.com/PA_Consulting
www.linkedin.com/company/pa-consulting

eMOTIONAL Cities: Mapping cities through the senses of those who make them

Funded by the European Commission's Horizon 2020 Framework Programme, eMOTIONAL Cities is a 48-month project, with a total budget of nearly €5 million, that is designed to fully characterise the intensity and complexity of urban health challenges and inequalities

What if we were able to know how, how much and exactly what in the urban environment where we live and work affects our feelings and emotions, and how it affects our mental wellbeing?

Urban planners and health professionals have so far failed to demonstrate with scientific evidence this interrelation between urban living and mental health and wellbeing. Urban health, and particularly mental health, has been often forgotten in urban planning and city design, even though there seems to be common agreement that the built and natural environment in which we live affects our physical and mental health.

In the eMOTIONAL Cities, we want to create scientific evidence on how the built environment affect's our mental wellbeing.

What is the purpose of investigating the relationship between mental wellbeing and the built environment?

We are convinced that through our project, the following specific objectives will be reached:

I. Identify policy-relevant research questions and develop a "eMOTIONAL Cities conceptual framework" for linking urban environment, neuroscience and physical/mental health and wellbeing. The goal is to extend current knowledge



with new, systematic evidence from case studies, as well as real-world experiments and, by collaborating with relevant stakeholders, achieve a better translation of science to policies.

II. Apply geospatial analytics, through quantitative and qualitative methodologies, to four different urban case studies, across two continents (three in Europe and one in the US), to determine critical urban area characteristics, as well as to map physical environments, socio-economic features, mobility patterns and real-time geo-social media determinants of health. This will capture the perceived emotions and identify the driving factors affecting the perceptions of the urban environment.

III. Combine controlled laboratory experiments with field ecological research by directly capturing people's physiological and neurobiological responses while interacting with specific urban artefacts. We aim to identify how the brain regions responsible for processing the emotional valence and arousal that influence individual decisions adapt to or buffer environmental influences, so that we could better predict when such mechanisms could be dysfunctional or not able to compensate. We expect to achieve this by taking advantage of virtual reality, as well as mobile sensing devices and platforms; and through the integration of neurophysiological (high-density and wireless electroencephalography – EEG) and neuroimaging (functional magnetic resonance imaging – fMRI) brain activity.

IV. Collect and analyse both geospatial and neuroscience data paying specific attention to vulnerable groups, age and gender aspects in order to identify barriers and facilitators of urban spaces that are truly inclusive. The approach is designed to consider a multidimensional gender perspective – by going beyond binary views and accounting for intersectional aspects (such as age, race/ethnicity, income, place of residence etc). We will be focus on providing important evidence for vulnerable elderly people at risk of developing dementia on how urban characteristics may impede functional performance.

V. Create an open spatial data infrastructure (SDI) capable of integrating multisource heterogeneous geospatial and neuroscience datasets and time series information. We aim to share and provide spatio-temporal query and answering capa-

bilities for city emotional places within and beyond the eMOTIONAL Cities stakeholders' community.

VI. Integrate statistical data and geospatial descriptions with contextual neuroscience information to generate evidence-based knowledge on how the natural and built environment, as well as the social fabric, affect cognitive and affective wellbeing. This will be achieved by comparing urban realities from different countries, considering their contrasts and similarities. This will be critical to validate a set of universal cognitive and emotional indicators and models that could be used for measuring and predicting urban health, quality of life, environmental risk-assessment and sustainability.

VII. Provide insights and policy-related recommendations to improve the physical and mental health and wellbeing in cities by leveraging the project's evidence-based knowledge with machine learning-based scenario discovery. Linking research to practical need, our project will develop fundamental methodologies to support decision making in terms of scenario discovery and showcase covering different dimensions of the duality in urban environment – mental health and wellbeing.

VIII. Raise awareness on how the built environments relate with human senses and shape emotions and health, fostering citizens to act and request for better policies that address wellbeing. Through a targeted dissemination and communication strategy, relevant stakeholders will be made aware of eMOTIONAL Cities and encouraged to be involved in the project, notably through several tools including workshop preparation for the outdoor experiments, the project website, in-hand dissemination materials and other online tools.

IX. Ensure project sustainability after its conclusion. eMOTIONAL Cities aims to be a sustainable project by developing an exploitation and business plan that includes specific actions to ensure the long-term impact of the main outputs. It is focused on the exploitation of scientific and industrial outcomes. The business plan will focus on assessing the commercial value of the innovative health data and knowledge produced by the project towards urban planning solutions that promote urban health in the long term.

One of six projects in the European Urban Health Cluster

eMOTIONAL Cities is one of six projects that comprise the European Urban Health Cluster resulting from the Horizon 2020 topic SC1-BHC-29-2020 Innovative actions for improving urban health and wellbeing – addressing environment, climate and socioeconomic factors, with the aim to promote urban health in the European Urban Agenda and to optimise synergies, and avoid overlaps between the projects selected from funding on the above mention call.

The eMOTIONAL Cities consortium is led by the Institute of Geography & Spatial Planning (IGOT) with the co-coordination of the Faculty of Medicine (FMUL) of the University of Lisbon. It comprises 10 other members from academia and industry.

In the brain will be the answer.

In the public space and the built environment, we will find the solutions.

Contributing authors: Paulo Morgado (IGOT), Bruno Miranda (FMUL) e Ana Bonifácio (IGOT)

This project has received funding from the European Union's HORIZON 2020 Research & Innovation Programme under the Grant Agreement no. 945307.

The eMOTIONAL Cities project is a consortium of 12 partners from different geographies.

UNIVERSITY OF LISBON
Portugal

INSTITUTO DE GEOGRAFIA E ORDENAMENTO DO TERRITÓRIO
www.igot.ulisboa.pt

FACULDADE DE MEDICINA
https://www.medicina.ulisboa.pt

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https://www.spi.pt

eMOTIONAL Cities

Dr Paulo Morgado
Institute of Geography and Spatial Planning of the University of Lisbon
Tel: +351 21 044 2957
paulo@campus.ul.pt
https://ceg.ulisboa.pt/investigacao/pessoas/paulo-morgado/?lang=en
https://twitter.com/MorgadoPaulo9

Artificial Intelligence: The different approaches to solve complex problems even without data

Here Jose M. Peña Director at Lurtis LTD explores the ways to address AI problems beyond using Machine Learning

The term Artificial Intelligence (AI) has recently become a hot topic, however, there are currently some misunderstandings about this term, for instance, it has been used as a synonym for **Machine Learning** (ML), however, ML is only a part of the whole AI.

There are two main reasons to explain this, the first one is the fact that ML is the best known of all techniques, and the second one is because of the similarities between learning and "intelligent behaviour". Machine Learning is the ability of training a computer system to perform a task by giving as input either data or, alternatively, an equivalent source of information that allows it to automatically associate, segment and/or classify said data. In other words, the computer can learn something in a certain way and therefore, act with "intelligence".

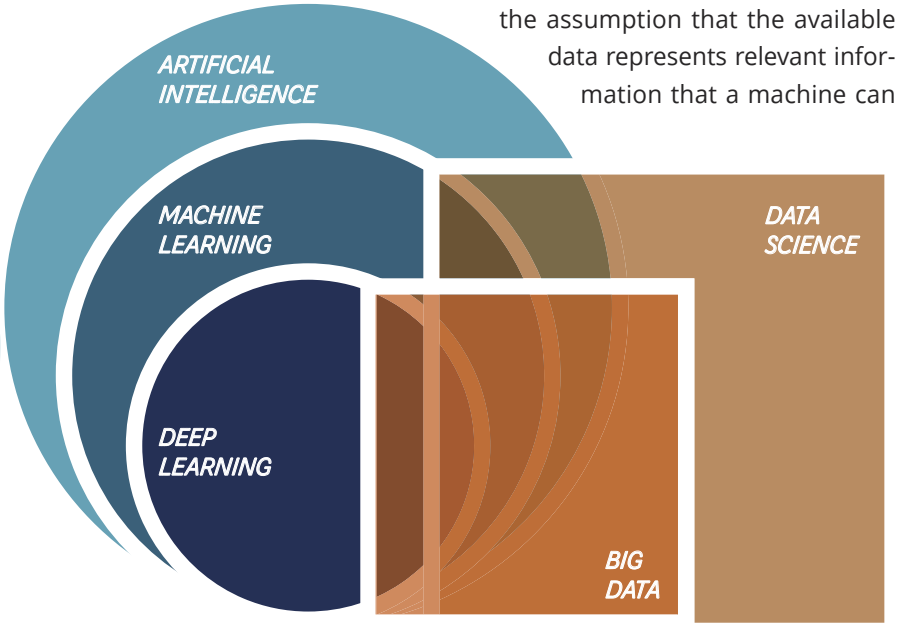
Moreover, ML is not a synonym of AI, because AI does not only focus on learning, AI has more factors to be able to operate autonomously in new and uncertain environments and adapt to them accordingly.

Different approaches of AI

Nonetheless, AI comes in many different flavours, and not all of them require vast (or even any) amounts of data. Here we can see three major approaches of AI:

Data-driven AI

This approach has its paramount representative in ML. It works under the assumption that the available data represents relevant information that a machine can learn from to perform specific tasks such as prediction, classification, characterisation or even synthetic generation. A lot of information of this topic is widely covered in the specialised literature, or even general media, but the following approaches are less known, and it is worth analysing in more detail, in particular, for sectors such as engineering, industrial design, and construction/ architecture.



Knowledge-driven AI

This second approach relies on methodologies that allow expert knowledge to be translated, in order to be interpreted and applied by a series of algorithms to address complex tasks. Traditional AI approaches of this type are expert systems, ontologies, logic programming, or case-based reasoning. So, the computer system can use structures of information that come from the experience, obtained from interviewing experts, extracted from well-documented cases, or explicitly programmed as rules by a computer scientist.

There are problems, such as logistics and planning that are based on perfectly defined rules, but when the interfering factors or the dependencies grow, it can become so difficult to solve them, so the expert needs an automatic mechanism to handle it.



For instance, suppose you want to optimise a supply chain or a project planning, in that case, you need a search mechanism that iterates on the rules and alternatives and assists the user in the best course of action based on these predefined constraints and dependencies.

Problem-driven AI

This third approach refers to when the AI is based on different quality criteria as the measurement of how good/bad a solution is. For instance, to solve a structural problem it is necessary to simulate different solutions by finite element simulations (such as ABAQUS) until the solution reaches the best possible values for the evaluation of some predefined criteria, such as minimising weight, and resist a benchmark of mechanical loads. Another example is to train a robot how to resolve a task, e.g., avoiding obstacles.

Combination of AI approaches

We have just defined three different approaches, but we do not really need to apply them separately, we can combine them to develop some technology that requires them, as we can see in the following examples.

Knowledge-driven AI can be combined with data-driven (ML) when part of the ruleset results from analysing data (learning patterns from the data) as actionable rules for the rest of the system. An example of this hybrid approach is RegURBIS (under development by Lurtis and supported by Innovative UK), a tool that extracts normative values for different stakeholders in the building sector to design a building in a specific location. This technology uses a **Natural Language Processing (NLP)** tool trained with building regulation documents that combines **expert knowledge** in the form of semantic rules and ontologies representing architecture and construction project terms.

Similarly to the previous case, **problem-driven AI may use data-driven** approaches when the quality criteria uses ML model. For example, in computer vision it is necessary to optimise some parameters to let the machine learn how to extract some information from the images.

For these combinations, Lurtis has developed a flexible framework for numerical optimisation applied, for instance, to different generative design problems in aeronautics, material design, and energy efficiency. This framework is called Lurtis EOE (Engineering Optimisation Engine), which can optimise solutions for any simulation software (such as computational fluid dynamics, thermodynamics, or solid mechanics) by combining metaheuristics (problem-driven AI), the knowledge of the expert (knowledge-driven AI), and ML (data-driven AI) to assist in computer-based design scenarios. Lurtis EOE is the foundation of many different generative design solutions provided by the company.

In conclusion, **Artificial Intelligence is a versatile toolkit for engineering and sciences**, and it can solve many different problems by properly selecting fundamentals and technology even if there is no available raw data. Structured and unstructured expert knowledge, computational simulations, and know-how are valuable inputs we can use to design revolutionary AI solutions.

LURTIS RULES

Jose M. Peña
Director Lurtis LTD
Lurtis Limited
Tel: (+44)(0)1865 546416
jm.penya@lurtis.com
www.lurtis.com
https://twitter.com/lurtisrules

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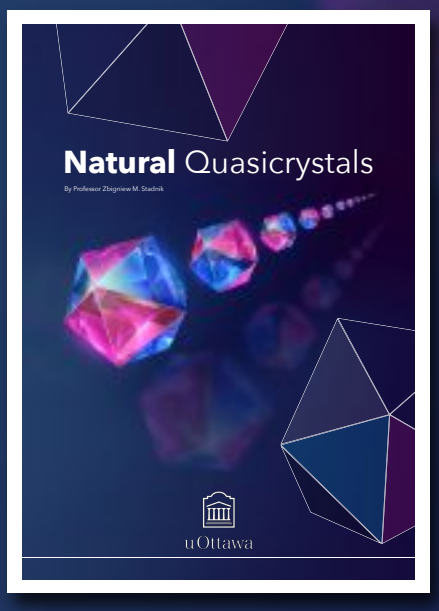
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