

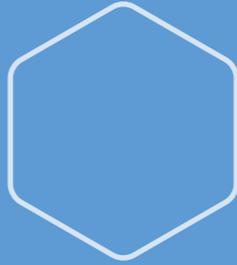
**INSTITUTE OF
HEALTHCARE ENGINEERING**



UCL



**ANNUAL
REPORT
2022**



WELCOME TO THE ANNUAL REPORT FOR 2021 TO 2022

This year has seen a very welcome return to in-person events. It has been wonderful to reconnect with colleagues, and for early-career researchers and students to have new opportunities to present their work and network.

This is something we're very big on – creating opportunities for the next generation of healthcare engineers. This year saw the second round of the Institute of Healthcare Engineering (IHE) Summer Studentship scheme, spearheaded by our Education delivery group, which allows undergraduate engineering students to spend eight weeks working on a research project inside a hospital.

In October 2022, we welcomed the third cohort to our IHE Impact Fellowship scheme, a year-long programme that trains UCL researchers in a range of engagement and impact topics, including co-production, policy engagement, media engage and science communication. Over the course of the scheme, Fellows develop their skills through personalised training, expert mentorship, and practical opportunities. Head to the 'Engagement' section to read about the impactful projects our alumni have already delivered!

We've continued to prioritise our work on technologies to support healthy ageing. From November 2021 to January 2022, we held 'Tomorrow's Home', an immersive installation at the Museum of the Home in Hoxton. The exhibition explored how our homes could be designed to help us live independently as we grow older, and also support our changing planet.

It's been two years since we launched our Age Innovation Hub – a digital platform that crowdsourced ideas and needs for technologies to support healthy ageing. The insights gathered from this project have fed into our healthy ageing strategy, making sure that we are focusing on delivering usable solutions to real problems.

This project directly shaped our Healthy Ageing Challenge Awards which launched this year. The awards provided four research projects with £10,000 each to develop healthcare engineering solutions to healthy ageing challenges. Along the way, the project teams will be supported by experts in co-production and responsible innovation, to ensure their innovative solutions are developed in collaboration with their intended end-users. At the end of the award period, the projects will take part in a Dragon's Den competition where the successful team will receive a further £50,000 – so watch this space!

Read on to find out all about these activities and more. If you are interested in learning more about our work, and being involved in IHE initiatives, please sign up to our newsletter; you can find the link on the homepage of our website, www.ucl.ac.uk/healthcare-engineering.

We hope you enjoy reading this report.

Best wishes,

Professor Rebecca Shipley

Director, UCL Institute of Healthcare Engineering

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ABOUT US

TRANSFORMING LIVES THROUGH DIGITAL AND MEDICAL TECHNOLOGIES

Healthcare engineering is the field of applying maths and science to solve healthcare problems. This covers an incredibly broad range of activities – from developing 3D-printing prosthetic limbs through to using artificial intelligence to predict cancer therapy response, to monitoring health and well-being from phone Apps. Our mission is to develop digital and medical technologies that transform lives across the globe.

For us, it's all about overcoming the big challenges – the ones that matter most. They drive our research and, quite frankly, get us to work every morning. We want to help patients with spinal injuries walk again. We want people to avoid stroke and paralysis. We want to hold back the visual deterioration that comes with age. We want to help cure cancer.

We support healthcare engineering research at UCL through activities like:

- Identifying priorities and supporting strategic funded research opportunities
- Creating networking opportunities and connecting researchers from across the university and our partner hospitals
- Facilitating meaningful knowledge exchange between academics, healthcare professionals, industry, patients and members of the public
- Providing training and development opportunities for students and early-career researchers
- Pump-priming projects
- Hosting events that develop interdisciplinary skills and knowledge
- Guiding researchers through UCL's research development pipeline, from foundational research to clinical practice

We have strong links to our affiliated hospitals and biomedical research centres, which help ensure our research focus is always on identifying and solving real clinical problems.

2021-2022 IN NUMBERS

OUR TEAM

1 Director



2 Deputy-Directors

3 Professional Services
Team Members

9 Management
Board Members

SOCIAL MEDIA NETWORKS

560

LinkedIn Followers

3800

Twitter Followers

1700

Newsletter Subscribers

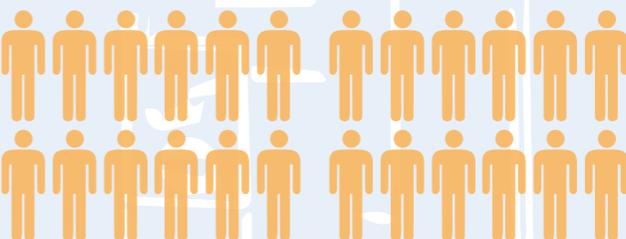
6 Delivery
Groups

40+ Delivery Group
Members from
Across UCL

EVENTS

6 In-Person
Events

3000



13 Webinars



1300
Event
Attendees

300



Symposium
Attendees
IHE Research Symposium
October 2022



10

ECR Travel Bursaries
Helping early-career researchers
present their work and reconnect
at conferences after the pandemic

18



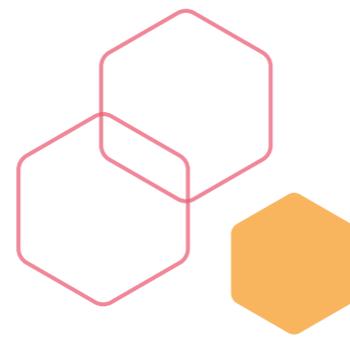
IHE Impact Fellows
Part of IHE Impact Fellowship scheme,
helping researchers develop impact and
engagement skills

2

RESEARCH



OUR RESEARCH PRIORITIES



These research priority areas reflect significant healthcare challenges currently faced around the world.

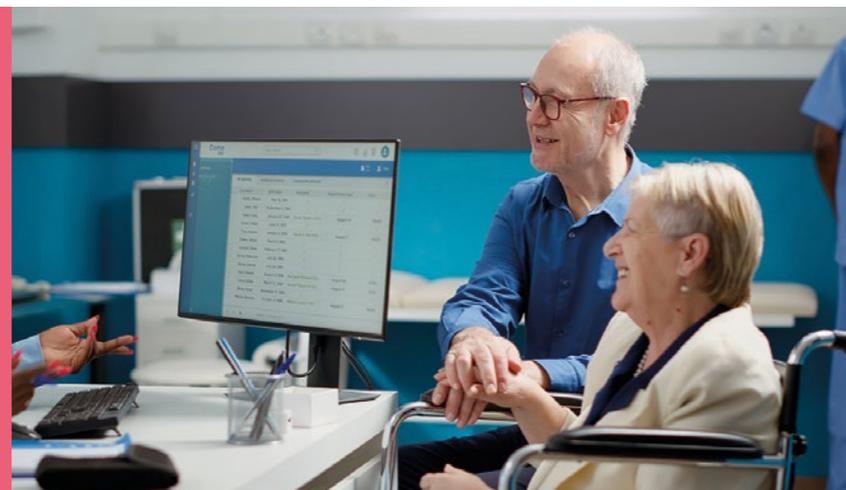
They are areas which interdisciplinary approaches in engineering are uniquely well placed to tackle and which we believe will take full advantage of the expertise available across UCL.

Our cross-cutting position in UCL's research community will allow us to bring knowledge and innovation from multiple disciplines to face these pressing challenges.

We aim to coalesce and grow research activity in these areas. We believe that each one identifies an opportunity for UCL's healthcare engineering community to be world-leading and to develop digital and medical technologies that truly transform lives across the globe.

SELF, SHARED, AND COMMUNITY CARE

Achieving healthcare's 'triple aim' of improved health outcomes, improved patient experience, and reduced costs requires patients to be fully engaged in their health and health care, and for services to be integrated, providing seamless care close to the patient's home. Achieving this has proven extremely challenging. This theme will explore how to use new technologies, including data science, machine learning, sensors, wearables and other digital technologies to enable people to adopt healthier lifestyles, actively engage with their health, taking their rightful place as an equal member of a multi-disciplinary healthcare team, and improve the quality and efficiency of service delivery across primary, community and social care.



TIMELY DETECTION, DIAGNOSTICS, AND INTERVENTION

Disease detection and diagnosis are at the heart of clinical decision making and patient monitoring. The development of improved tools to detect disease and to aid diagnosis is therefore a substantial component of healthcare engineering activity, with engineering-led examples including improved imaging technologies, sensor design, and machine learning applied to diverse and rich signals. Successful activity in this area will lead to detection and diagnostic developments that have clear value to patients and healthcare systems, in terms of accurate, affordable, and relevant diagnosis. The relevance of disease detection is heavily dependent on when it occurs; detection that is too late may mean treatment opportunities are lost, whereas detection that is too early may lead to wasted resources.

Both scenarios may lead to unnecessary patient anxiety. We are therefore prioritising not only innovation in detection and diagnosis, but also those innovations that provide the right information at the right time to patients and healthcare practitioners.



Timely diagnosis ultimately enables intervention at the right time. Engineering technologies underpin the development of most healthcare therapies and interventions, and we aim to pioneer advancements in this field. Focus will range from regenerative therapies and tissue engineering to simulations that help clinicians prepare for surgical procedures or predict the efficacy of drug delivery, to the application of nano-engineering, robotics, medical imaging and augmented reality to enable surgeons to intervene with ever greater precision.



HEALTHY AGEING AND MULTI-MORBIDITY THROUGH THE LIFE COURSE

Healthy ageing is a national and international strategic priority. For example, the UK Industrial Strategy Grand Challenge mission (2019) aims to “Ensure that people can enjoy at least 5 extra healthy, independent years of life by 2035”. There are many opportunities for medical and digital health technologies that address this challenge across the life course, from healthy conception and growth through to older age where many people are managing multiple long-term conditions.

Technologies range from apps that facilitate behaviour change for improved health through to advanced diagnostic and therapeutic technologies that support the delivery of highly individualised care. Future technologies are likely to exploit data on genetic, social and environmental determinants of health and support the integration of care across multi-morbidities. They will support and coordinate the expertise of specialist and generalist health professionals as well as patients and carers, to address the complexity of health management, exploiting advances in medical device developments, data analytics, and user-centred design.

COST-EFFECTIVE AND EFFECTIVE HEALTHCARE TECHNOLOGIES

The need for healthcare technologies that are both effective and cost-effective has never been more pertinent.

Globally, the world faces an expanding and ageing population with an increasing set of complex needs and health issues and an increasing inequity of access to affordable healthcare.

Effective and cost-effective healthcare technologies can tackle this gap.

From technology that turns portable mobile and wearable devices into accessible monitoring and diagnostic tools, to low-cost manufacturing processes for medicines, to using big data and AI to find more effective workflows, and to digital apps that encourage preventative lifestyle choices – there is significant opportunity for impact.

A growing shift towards precision medicine should reduce the likelihood of inappropriate treatment and avoid associated costs. Reducing unnecessary workload and improving the efficiency of clinical workflow will also impact patient experience and the mental health of healthcare professionals.

Close collaboration with international partners will offer us opportunities for bi-directional learning, will allow us to understand what the real challenges are in each region and what is needed to make technologies translatable and usable in low-resource settings. Crucially, the need for effective and cost-effective healthcare technologies is also felt keenly in countries like the UK. As the NHS faces increasing resource constraints, this need has become particularly pressing. Incorporating a frugal mindset into our research offers the potential to save the NHS significant resources, which could then be directed toward patient care instead. As sustainability becomes increasingly important, we aim to develop technologies that have longevity and usability for many years.



RESEARCH HIGHLIGHTS

BRIGHTEST EVER X-RAY SHOWS LUNG VESSELS ALTERED BY COVID-19

The damage caused by Covid-19 to the lungs’ smallest blood vessels has been intricately captured using high-energy X-rays emitted by a special type of particle accelerator.

Scientists from UCL and the European Synchrotron Research Facility (ESRF) used a new revolutionary imaging technology called Hierarchical Phase-Contrast Tomography (HiP-CT), to scan donated human organs, including lungs from a Covid-19 donor.

HiP-CT enables 3D mapping across a range of scales, allowing clinicians to view the whole organ as never before by imaging it as a whole and then zooming down to cellular level.

The technique uses X-rays supplied by the European Synchrotron (a particle accelerator) in Grenoble, France, which following its recent Extremely Brilliant Source upgrade (ESRF-EBS), now provides the brightest source of X-rays in the world at 100 billion times brighter than a hospital X-ray.

Due to this intense brilliance, researchers can view blood vessels five microns in diameter (a tenth of the diameter of a hair) in an intact human lung. A clinical CT scan only resolves blood vessels that are about 100 times larger, around 1mm in diameter.



Dr Claire Walsh presents an image of a COVID-affected lung

Dr Claire Walsh (UCL Mechanical Engineering) said: “The ability to see organs across scales like this will really be revolutionary for medical imaging. As we start to link our HiP-CT images to clinical images through AI techniques, we will - for the first time - be able to highly accurately validate ambiguous findings in clinical images. For understanding human anatomy this is also a very exciting technique, being able to see tiny organ structures in 3D in their correct spatial context is key to understanding how our bodies are structured and how they therefore function.”

Using HiP-CT, the research team, which includes clinicians in Germany and France, have seen how severe Covid-19 infection ‘shunts’ blood between the two separate systems – the capillaries which oxygenate the blood and those which feed the lung tissue itself. Such cross-linking stops the patient’s blood from being properly oxygenated, which was previously hypothesised but not proven.



Shortly after the beginning of the global pandemic we demonstrated that Covid-19 is a systemic vascular disease using histopathological (optical imaging of tissue) and molecular methods. However, these techniques did not adequately address the extent of the changes and clotting in fine blood vessels of whole lungs. ”

Maximilian Ackermann MD (University Medical Center Mainz), clinical user of the technique



By combining our molecular methods with the HiP-CT multiscale imaging in lungs affected by COVID-19 pneumonia, we gained a new understanding how shunting between blood vessels in a lung’s two vascular systems occurs in Covid-19 injured lungs, and the impact it has on oxygen levels in our circulatory system. ”

Danny Jonigk, Professor of Thoracic Pathology, (Hannover Medical School, Germany)



The idea to develop this new HiP-CT technique came after the beginning of the global pandemic, by combining several techniques that were used at the ESRF to image large fossils, and using the increased sensitivity of the new Extremely Brilliant Source at the ESRF, ESRF-EBS. This allows us to see in 3D the incredibly small vessels within a complete human organ, enabling us to distinguish in 3D a blood vessel from the surrounding tissue, and even to observe some specific cells.

This is a real breakthrough, as human organs have low contrast and so are very difficult to image in detail with the current available techniques. ESRF-EBS has allowed us to go from deciphering the secrets of fossils to seeing the human body as never before. ”

Dr Paul Tafforeau, lead scientist at ESRF

USING HIP-CT TO CREATE THE HUMAN ORGAN ATLAS

With support from the Chan Zuckerberg Initiative (CZI), the UCL-led team are using HiP-CT to produce a Human Organ Atlas. This will display six donated control organs: brain, lung, heart, two kidneys and a spleen, and the lung of a patient who died of Covid-19. There will also be a control lung biopsy and a Covid-19 lung biopsy. The Atlas will be available online for surgeons, clinicians and the interested public.

The Atlas spans a previously poorly explored scale in our understanding of human anatomy, which is the centimetre to micron scale in intact organs. Clinical CT and MRI scans can resolve down to just below a millimetre, whilst histology (studying cells / biopsy slices under a microscope), electron microscopy (which uses an electron beam to generate images) and other similar techniques resolve structures with sub-micron accuracy, but only on small biopsies of tissue from an organ. HiP-CT bridges these scales in 3D, imaging whole organs to provide new insights into our biological makeup.

– Project lead Professor Peter Lee (UCL Mechanical Engineering)

INSIGHTS FOR OTHER DISEASES AND CONDITIONS

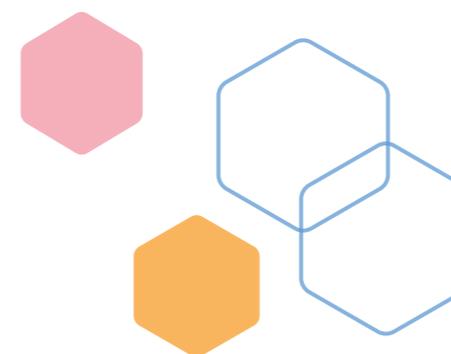
The researchers are confident that the scale-bridging imaging from whole organ down to cellular level could provide additional insights into many diseases such as cancer or Alzheimer’s Disease.

HiP-CT is filling a vast imaging gap in human medicine: clinical imaging provides 3D data of the body and organs but is limited to a gross scale; histopathology on the other hand provides detailed images of tissues and cells derived from small pieces of organs. It is generally limited to a small field and two dimensions. HiP-CT is bridging the organ to tissue scale, tightly linking the clinical disciplines of radiology and pathology and providing never before seen structural data of 3D tissue architecture and disease patterns.

– Clinician Willi Wagner, Radiologist at University Hospital in Heidelberg

The authors hope the Human Organ Atlas will eventually contain a library of diseases that affect organs on a range of scales, from 1 to 100s of microns to entire organs, helping clinicians as they diagnose and treat a wide range of diseases. The team also hope to use machine learning and artificial intelligence to calibrate clinical CT and MRI scans, enhancing the understanding of clinical imaging and enabling faster and more accurate diagnosis.

The work was supported by the Chan Zuckerberg Initiative, the ESRF, the UK-MRC and the Royal Academy of Engineering. Additional support was from the German Centre for Lung Research (DZL, BREATH), the ERC, the German Registry of COVID-19 autopsies (DeRegCOVID), INSERM, University of Grenoble Alpes, Kidney Research UK, Rosetrees Trust, the Wellcome Trust, GOSH and the German Registry of COVID-19 Autopsies.



SCENT-DELIVERY DEVICES COULD SUPPORT PEOPLE LIVING WITH PARKINSON'S DISEASE

Researchers from UCL are developing scent-delivery devices which could provide 'smell training' to people living with Parkinson's disease.

Parkinson's disease is a neurodegenerative condition that affects around 145,000 people in the UK. The condition can cause a range of symptoms, ranging from body tremors to mental health problems. One of the earliest and common non-motor symptom is scent impairment – or loss of smell. This can have an immeasurable impact on a person's quality of life, as their enjoyment of food and drink is limited.

In recent years, there has been an increasing interest in digital technology to improve outcomes for people with Parkinson's disease, but up until now, this has largely focused on reducing the impact of motor symptoms.

In a pilot study published in Digital Health, the researchers did a focus group with

people living with Parkinson's disease to explore their feelings on whether a scent-delivery device and associated mobile app could help them manage their condition and improve their wellbeing.

This type of research falls into the field of human-computer interaction, or HCI; the study of how computer technology influences human lives and focuses on user-centred design to make interactions as easy as possible. The scent-delivery device being developed would connect with a user-friendly app that allows people to track their progress and preferences.

Through conducting a focus group with people living with Parkinson's disease, the researchers wanted to understand whether this type of technology would be received positively by end-users, and how they would make use of it. The pilot study was carried out by Prof Mine Orlu (UCL School of Pharmacy), Professor Marianna Obrist (UCLIC and IHE's Deputy Director, Digital), Dr Emanuela Maggioni (UCLIC), and Dr Neel Desai (UCL School of Pharmacy).

All the participants had expressed concern about their loss of scent to healthcare professionals and felt they had been dismissed:

I did feel the doctor dismissed it when I said I couldn't scent anything 10 years ago and didn't really explore or explain any other possibilities.

The participants expressed the sentiment that they 'would try to do anything that may bring some of the memories back' and were open to doing scent training as often as possible to achieve this.

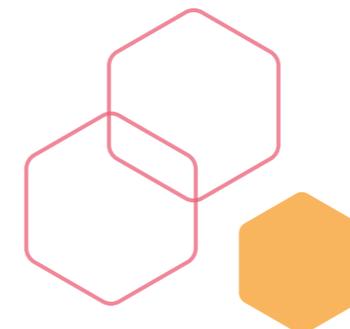
Based on the positive feedback, the group's next steps will be continuing to develop their technology and extending the applications to include other neurodegenerative conditions such as Alzheimer's disease.

Experiencing sensory dysfunctions (e.g., smell loss), even if only temporary, can have negative effects on a person's health and wellbeing.

This article emphasises the importance of developing novel olfactory interfaces in the context of Parkinson's disease, where smell dysfunction is an early biomarker for the development of the disease.

Collaborating across disciplines and applying a user-centered approach is key for digital innovation and more important long-term adoption and impact.

– Dr Emanuela Maggioni



“ Scent impairment in Parkinson's disease can occur up to four years prior to the onset of motor signs and symptoms and has a significant impact on quality of life for Parkinson's disease patients.

By leveraging our knowledge of human computer interaction and pharmaceutical science, we have begun to assess the use of scent delivery devices as part of regular scent training to map changes in smell function over the course of Parkinson's disease. We thank our wonderful focus group whom were critical in defining their current problems and end-user needs and to Parkinson's UK for their help in facilitating access to these participants.

Neel Desai

An interdisciplinary approach is instrumental in achieving better outcomes in healthcare. Blending our understanding in human computer interaction and pharmaceuticals sciences has inspired us to start exploring the potential of scent delivery devices in improving quality of life of patients with altered sense of smell. We are very grateful to participants of this focus group study for enabling us to better understand the importance of the needs of end-users of healthcare engineering technologies.

– Prof Mine Orlu

The authors would like to thank Parkinson's UK for access to their Research Support Network and assistance in focus group invitation distribution to that network. The work was supported by EPSRC and the European Research Council.

Read the full research paper here: ['Scent-delivery devices as a digital healthcare tool for olfactory training: A pilot focus group study in Parkinson's disease patients'](#)



“ The multisensory world we live in is increasingly transformed through technological advances like novel multisensory devices and interfaces. Such multisensory technologies not only stimulate our eyes (think of screens) and ears (and audio systems), but also consider how and what we touch, smell and taste. Multisensory interfaces can enrich our experiences and are often undervalued in the digital health domain. ”

Professor Marianna Obrist

APP DETECTING JAUNDICE IN BABIES A SUCCESS IN FIRST MAJOR CLINICAL TRIAL

A smartphone app that identifies severe jaundice in newborn babies by scanning their eyes could be a life-saver in areas that lack access to expensive screening devices, suggests a study co-authored by researchers at UCL and the University of Ghana.

The app, called neoSCB, was developed by clinicians and engineers at UCL and was used to screen for jaundice in over 300 newborn babies in Ghana, following an initial pilot study on 37 newborns at University College London Hospital (UCLH) in 2020.

For the large-scale study, published in Paediatrics, the team tested over 300 babies with the app, which analyses images taken on a smartphone camera to quantify the yellowness of the white part of the eye (sclera) – a sign of neonatal jaundice. Analysing the yellowness of the eye just by looking is unreliable, and the neoSCB app can give early diagnosis of neonatal jaundice requiring treatment. The study compared the effectiveness of the neoSCB app with conventional screening methods. Of the 336 babies tested by the app, 79 were severely jaundiced newborns, and the app correctly identified 74 of them. This is in line with the accuracy of the most common conventional screening method, a non-invasive device known as a transcutaneous bilirubinometer, which correctly identified 76.

The transcutaneous bilirubinometer works by measuring the yellow pigment under the newborn's skin to give a measure of jaundice levels. All screening results are then followed up by blood tests to determine the type of treatment required.

“

The study shows that the neoSCB app is as good as commercial devices currently recommended to screen for severely jaundiced newborns, but the app only requires a smartphone which costs less than a tenth of the commercial device. We hope that, once rolled out widely, our technology can be used to save the lives of newborns in parts of the world that lack access to expensive screening devices.”

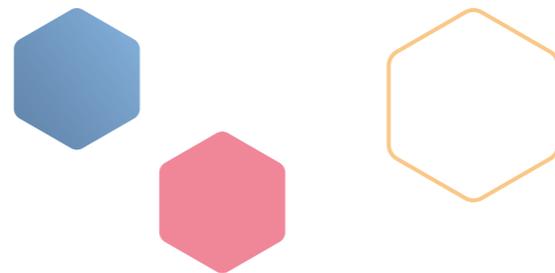
Dr Terence Leung (UCL Medical Physics & Biomedical Engineering), developer of the technology behind the app

The neoSCB method was acceptable to mothers in urban and rural communities where the study was conducted.

Mothers easily devised ways to keep the baby's eye open, most often by initiating breastfeeding.

– Study lead Dr Christabel Enweronu-Laryea (University of Ghana Medical School)

Jaundice, where the skin and whites of the eye turn yellow, is common in newborns and is usually harmless. The yellowness is caused by a substance called bilirubin, which in severe cases can enter the brain, leading to death or disabilities such as hearing loss, neurological conditions such as athetoid cerebral palsy and developmental delays.



Every year severe jaundice causes about 114,000 newborn deaths and 178,000 cases of disability worldwide, despite it being a treatable condition. Most cases of neonatal jaundice occur in the first week after birth, and routine screening for early diagnosis in higher income countries has reduced the risks of severe complications.

Newborns in low- and middle-income countries are typically at a greater risk of severe jaundice, or neonatal hyperbilirubinemia, because of the lack of resources required for screening. A commercial transcutaneous bilirubinometer typically costs around £4,000 per device, and blood tests require a large amount of capacity.

Additional factors such as a higher prevalence of home births and early postnatal discharge can contribute to fewer newborns going through screening.

Babies in sub-Saharan Africa are also at a greater risk because of a high prevalence of glucose-6-phosphate dehydrogenase (G6PD) deficiency, which is an inherited genetic disorder associated with an increased risk of haemolysis – where red blood cells break down at a faster rate than they are made – and hyperbilirubinemia.

In total, 724 newborns aged between 0 and 28 days were initially considered for the study. The 336 whose datasets were used for the paper had had no prior treatment for jaundice. Babies who were born at less than 35 weeks, were critically ill or had a very low birth weight were excluded from the final study. The app was tested with frontline healthcare workers and the babies' mothers, who provided feedback on the usability of the app.

The study was supported by the Saving Lives at Birth consortium and the EPSRC UCL Centre for Doctoral Training in Intelligent Integrated Imaging in Healthcare.



“

This app has the potential to prevent death and disability worldwide in many different settings.

It will reduce unnecessary hospital visits and potentially empower community health workers and parents to care for newborn babies safely.”

Senior author Dr Judith Meek (UCLH)

HOW COVID-19 SURGE IMPACTED MENTAL HEALTH OF NHS STAFF

Almost two-thirds (64%) of intensive care staff may have experienced a mental health disorder during the Covid-19 winter surge last year, according to a new study led by researchers from UCL and King's College London.

A similar proportion of staff said their ability to do their job was impaired because of the state of their mental health, researchers found.

The peer-reviewed study, published in the British Journal of Anaesthesia, concluded that the prevalence of mental health disorders among intensive care staff was likely to affect patient care and the long-term welfare of staff.

For the study, staff at 56 intensive care units in England answered questions designed to assess their mental health and whether their ability to carry out day-to-day tasks was affected. In total, 6,080 survey responses were completed before last year's winter surge (November-December 2020), during the surge (January-February 2021) and after (April-May 2021).

The researchers found that during the surge, 64% of respondents met the criteria for having a mental health disorder – encompassing depression, anxiety, harmful use of alcohol and post-traumatic stress disorder (PTSD) – while 69% of respondents reported that their ability to carry out daily tasks was impaired by their mental health.

Around 45% of the correspondents met the criteria for PTSD – a level at least as high as that seen in British military veterans who had been deployed in Afghanistan in a combat role.

“

This study shows the impact that the Covid-19 pandemic has had on the mental health and wellbeing of NHS staff working in intensive care units. The scale and severity of the symptoms reported here are impossible to ignore.

The comparatively poor mental health and wellbeing of the NHS workforce is a long-standing issue that for too long has been seen as secondary to the core business of the NHS. However, poor mental health affects absence rates and staff retention and, as our study suggests, likely impacts the quality and safety of patient care.

Improving wellbeing is about more than better access to mental health services for NHS staff. Those things are essential but prevention, as always, is better than cure. However, prevention here isn't easy or cheap: we need investment in better buildings, better rest areas, better working conditions and more staff.

This is often cast as a difficult choice: between investing in what patients need and what staff need. But in truth there is no choice: to care properly for our patients, we need to care properly for our workforce. ”

Professor Kevin Fong (UCL Science, Technology, Engineering & Public Policy, or STEaPP), senior author on the paper and also a consultant anaesthetist at UCLH



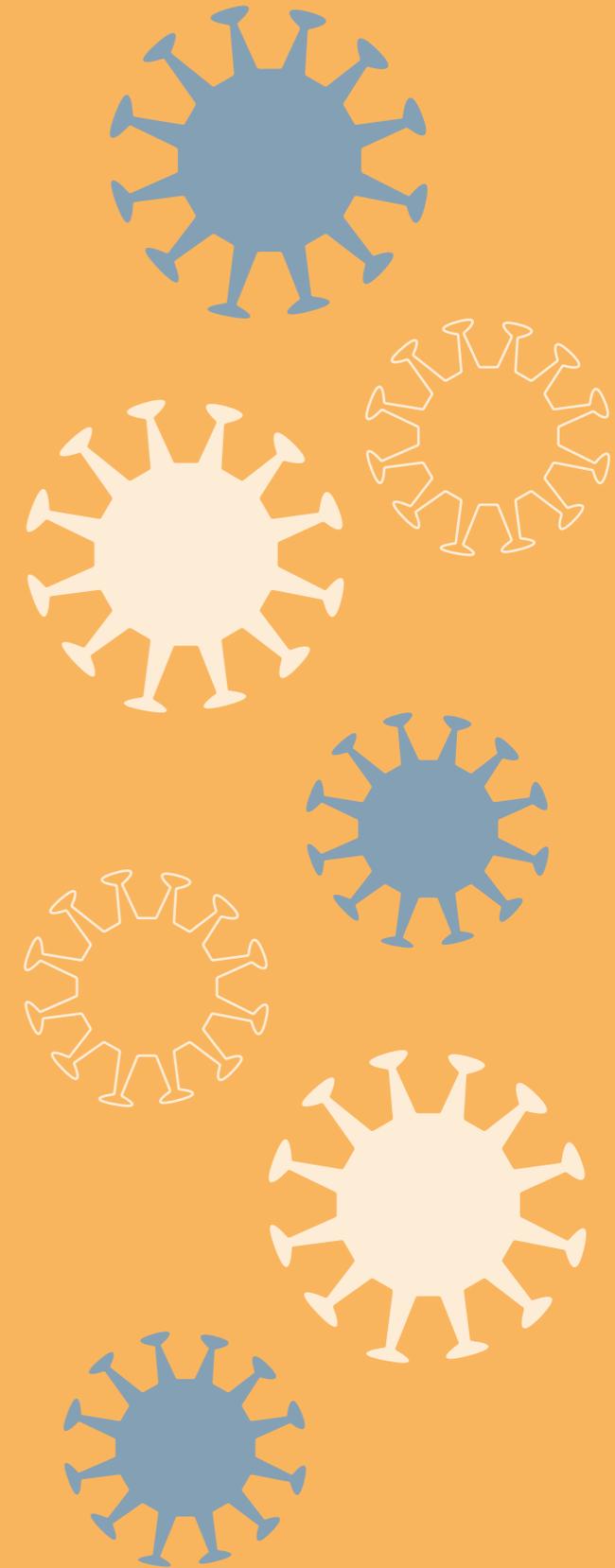
The surveys were designed to estimate prevalence of four mental health disorders: depression, general anxiety disorder, harmful use of alcohol and PTSD. The researchers found that levels of these disorders were lower before and after the surge. In the April-May surveys after the surge, 45% of respondents met the criteria for having a mental health disorder, while 29% met the criteria for PTSD/ Nevertheless, these levels are still very high compared with what one would expect when compared with the general public.

Levels of functional impairment remained high in April-May after the surge, with 52% of respondents reporting that their ability to carry out daily tasks was impaired by their mental health and this is a significant concern.

Younger, less experienced staff and nursing staff were more likely to meet the criteria for having a mental health disorder, the study found. More than half of the respondents were nurses (57.5%), while 27.9% were doctors, and 14.5% were other healthcare staff.

The researchers cautioned that the survey alone is not diagnostic and that because it relies upon the self-reporting of symptoms, it should be seen as providing estimates of prevalence only. Nevertheless, these findings have serious implications for the NHS and how it should recover its workforce following the extraordinary challenges experienced during the COVID-19 pandemic.

This study involved researchers from UCL STEaPP, UCL Institute of Health Informatics, King's College London and the UK Health Security Agency. It was supported by the National Institute for Health Research's Health Protection Research Unit (NIHR HPRU) in Emergency Preparedness and Response, a partnership between Public Health England, King's College London and the University of East Anglia.



STUDENTS DEVELOP SOFTWARE TO REVOLUTIONISE COMPUTER USE FOR MILLIONS

Ground-breaking software that allows users to control their PC through their webcam using face and body movements has been developed by a team of UCL Computer Science students in collaboration with Intel, Microsoft, IBM and the NHS.

The software could revolutionise the way that millions of people use computers by allowing those with mobility issues to easily interact with their PCs without the need to buy adapted computers and use pointer devices.

It has already been endorsed by charities including the International Alliance of ALS/ MND Associations, which supports people with Motor Neurone Disease (MND) around the world and is making a positive impact on people's daily lives.

Called 'UCL MotionInput Version 3', the software removes the need for a keyboard or mouse, allowing users to interact with their computer by moving their hands, fingers, head, eyes, nose, eyebrows, mouth or full body in front of the webcam. They can also simultaneously give spoken commands and dictate text, for example to fill in a website form, captured by their computer microphone.



Professor Dean Mohamedally (UCL Computer Science), the academic who led the project and tasked the team of 54 students with developing the software, said:

We initially worked on the software in response to the Covid-19 pandemic as a means of supporting NHS frontline staff. We wanted a way to help prevent the spread of viruses and other bugs by enabling medical staff to use communal computers without touching the keyboard or mouse, but the applications are much further reaching than that."

It is unique in that it can be used on the majority of Windows PCs and doesn't require any specific equipment other than the webcam and microphone, which most laptops already have, meaning there are very few barriers to access. People don't need pointers, or a mouse, to move a cursor. They can simply raise an eyebrow or open their mouth to click and use their eyes to direct the cursor.

I'm incredibly proud of what the students have achieved with colleagues in industry and the real-life, positive impact this is already having on people with mobility issues and those working in high-risk environments. The software is still maturing, but with a supportive community collaborating with us, we hope to see it flourish with more user needs met, making computing more accessible and enjoyable to millions.

UCL academics and students have been developing the software for over two years, also in collaboration with Great Ormond Street Children's Hospital (GOSH) and UCLH Institute for Child Health.

Two UCL Computer Science students, Sinead V Tattan and Carmen Meinson, currently in their final and second years respectively, led the team of 54 students who had volunteered to work on developing the software, under the guidance of Professor Mohamedally and Professor Graham Roberts. Carmen Meinson focused on highly optimising the software architecture whilst Sinead Tattan led on development.

As well as its clinical uses and for those with mobility issues, the software can also be used for teaching and presenting in schools, universities and businesses, and by people playing Windows computer games.

The software is freely available to download for individual users, and the team hope to see it widely rolled out across NHS sites as well as schools and other industries looking to invest in the technology.

The team are also keen to connect with user groups with various accessibility and education requirements in supporting equitable computing access for all.

LIVING WITH COVID RECOVERY WINS AT THE INNOVATE AWARDS 2022

The Living With Covid Recovery (LWCR) project won the Innovate Award 2022 for 'Excellence in Patient and Public Involvement in Transformation and Innovation' at a ceremony held in London on 29 September 2022, attended by 400 NHS leaders, innovators and partners.

The Covid-19 pandemic highlighted exemplary efforts by staff in health and social care teams but also shone a light on the need for innovation and transformation in the way we work. The Innovate Awards celebrate excellence in innovation in health and care, showcasing those teams, organisations and health and care systems leading the way in positive change.

The LWCR app provides evidence-based therapeutic intervention, supporting multidisciplinary teams to manage patients remotely, whilst providing personalised guidance and symptom monitoring. It has gone through nine iterations, led by structured patient and clinician engagement and is now in use in over 30 NHS trusts, supporting more than 5,500 patients.

Patient and public insights underpin the success of the programme. By harnessing real-life experiences, we are helping people with Long COVID, a novel and complex condition, to feel well supported and cared for.

The Innovate Awards is a collaboration between the [AHSN Network](#), which operates as the innovation arm of the NHS in England and acts as the collective voice of the 15 academic health science networks (AHSNs), and the [NHS Confederation](#), the membership body representing healthcare in the UK.

BioMedEng22

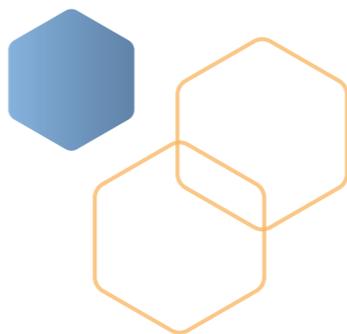
UK'S LARGEST ANNUAL CONFERENCE IN BIOMEDICAL ENGINEERING

On 8 and 9 September 2022, 400 guests joined us at the UCL for BioMedEng 22 – the UK's largest annual conference in biomedical engineering. Hosted under the umbrella of the UCL Institute of Healthcare Engineering, the conference was a celebration of interdisciplinary collaboration and the latest advances in the field.

The two-day event featured a packed agenda of around 100 oral presentations, 100 posters, eight workshops and four plenary sessions.

We were joined by esteemed plenary speakers from home and abroad:

- Prof Eric Aboagye, Professor of Cancer Pharmacology and Molecular Imaging at Imperial College, and Director of the CRUK-EPSC-MRC-NIHR Comprehensive Cancer Imaging Centre
- Prof Treena Arinze, Professor of Biomedical Engineering at the New Jersey Institute of Technology
- Prof Tim Chico, Associate Director, British Heart Foundation Data Science Centre
- Dr Michelle J. Johnson, Associate Professor of Physical Medicine and Rehabilitation at the University of Pennsylvania



Well done to Prof Vanessa Diaz, Prof Rui Loureiro and their team for putting together an engaging conference with excellent plenary speakers and a diverse range of topics and workshops. The team worked incredibly hard to deliver the BioMedEng22 conference at UCL with the support of the UCL Institute of Healthcare Engineering. I had a great time working with Alice, Ferdouse and the entire team in implementing the BioMedEng Association's objectives for the conference.

– Dr Gifty Tetteh, Head of Operations, BioMedEng Association.

For many of the PhD students in attendance, the event was especially poignant as it provided their first opportunity to present their work in person. Prizes were awarded to the best PhD student oral presentations:

- First place: Panagiotis Tsakonas, 'Parameter estimation of a model describing the Index finger'
- Second place: Poppy Smith, 'Production of tissue engineered endothelial cell-containing conduits for peripheral nerve regeneration'
- Third place: Saira Farage-O'Reilly, 'Effect of the loading direction on the predicted local mechanical properties of the mouse tibia'

There were also prizes for the best early-career researcher posters, sponsored kindly by Applied Sciences by MDPI:

- First place: Salwa Alamir, 'Deep Learning Prediction of Coronary Wall Shear Stress for Fast Analysis of Atherosclerotic Disease'
- Second place: Samuel McPhee, 'A multimodal imaging-based approach to incorporate 'hidden porosity' in the computational fracture risk assessment of equine third metacarpal bones'
- Third place: Ruby Sedgwick, 'Transfer Learning Design of Experiments for Molecular Assay Development'

Thank you to everyone who attended the conference and made it such a memorable occasion – in particular, the BioMedEng22 organising committee:

- Prof Vanessa Diaz
- Prof Rui Loureiro
- Dr Antonio Lombardo
- Federica Ninno
- Dr Sarah Keating
- Louis Girardin
- Dr Rupy Kaur Matharu
- Dr Hirak Patel
- Dr Pawel Markiewicz
- Dr Daniel Stuckey
- Ebba Montgomery Liljeroth

Next year's event will be hosted in September at Swansea University, Wales. Keep an eye on the BioMedEng Association's website (www.biomedeng.org) for further details.

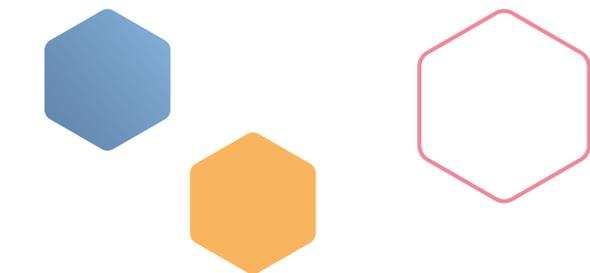
CONGRATULATIONS TO
ALL OUR WINNERS!

IHE HEALTHY AGEING CHALLENGE AWARDS

Continuing IHE's work on Healthy Ageing and building on our activities with the Tomorrow's Home project, the Age Innovation Hub and Healthy Ageing Policy workshop, this award supports projects that show great potential in addressing pressing challenges in healthy ageing through the development of innovative technology and digital solutions co-produced with end users and their communities.

IHE's Healthy Ageing Challenge Award aims to stimulate innovation through the principles of responsible innovations and genuine co-production. This reflects IHE's core belief that for healthcare engineering to achieve meaningful impact, it must address real needs and co-created through interdisciplinary collaborations.

Defining the need and therefore the solution must be done in partnership with a multi-disciplinary team of end-users, researchers, technology designers, service designers from both specialist and generalist communities whose perspectives and experience will inform the design of impactful solutions.



An award of £10,000 each has been given to projects which address one of the following Healthy Ageing Challenges with a healthcare engineering solution:

1. Creating/supporting healthy active places
2. Design for age friendly homes
3. Living with cognitive impairment
4. Managing common complaints of ageing
5. Maintaining health at work
6. Supporting social connections
7. Sustaining physical activity



THE SUCCESSFUL PROJECTS

- 'MindLETS: Mindful Living Experiences using Tactile Stimulation in Mid-Air', PI: Dr Madhankumar Vasudevan (UCL Computer Science)
- 'Empowering infrastructures: Cultivating digital workforce capabilities for healthy ageing through co-design', PI: Dr Cian O'Donovan (UCL Science and Technology Studies)
- 'I-Powered App for Managing Poly Pharmacy', PI: Dr Moe Elbadawi (UCL School of Pharmacy)
- 'An EIT infused insole for early gait disorder detection', PI: Dr Yu Wu (UCL Electronic and Electrical Engineering)



To help develop their project and co-create innovative solutions with their intended communities and the end-users of their technology, the teams will also receive the following training and development support:

- Co-production training from The Co-production Collective, UCL
- Responsible Innovation training from Dr. Stephen Hughes, UCL
- Community and End-user Engagement from The Social Innovation Partnership (TSIP)
- Dragon's Den Pitch training from Simon Cain's Westbourne Consulting

At the end of the award period, all the projects will be entered into a Dragon's Den competition, where one project will receive an additional £50,000 to continue their work into the next stage of the translation pathway.

Further details about the Dragon's Den process and selection criteria will be released nearer to the time.

IHE RESEARCH SYMPOSIUM

On 13 November 2022 we were delighted to welcome the UCL healthcare engineering community back to Wellcome Collection for our annual showcase.

Our fourth IHE research symposium was a celebration of UCL's healthcare engineering excellence. Highlights included:

- A focus on digital health
- A panel discussion on sustainability in healthcare
- Early-career researcher poster session
- Clinician and engineer duos talking about their collaborations
- A spotlight on our IHE Summer Studentship Scheme
- Information about the UCL Therapeutic Innovation Networks

The event was hosted by Oriol Roche i Morgo, a researcher in UCL Medical Physics and Biomedical Engineering, and a former IHE Impact Fellow.

First up, we heard from leading digital health researchers about their latest advancements.

Our Deputy Director (Digital) Professor Marianna Obrist discussed her work in digital sensory health, and the economic and societal potential of smell technology.

20% of people over 60 are affected by a partial or total loss of smell and this can have an enormously negative impact on quality of life. Marianna also explained how smell dysfunction can be an early biomarker for common degenerative conditions such as Alzheimer's and Parkinson's.

Welcome to the IHE Research Symposium

#IHESymposium22

@Health_Eng

Professor Henry Potts' talk was entitled 'digital health in a pandemic, and in a pingdemic'. He spoke about his work on the NHS Covid-19 app and measuring its public perception and use.

Professor Paul Foster, a consultant at Moorfields Eye Hospital, gave an insight into his work on 'Project HERCULES' - a piece of research which aimed to optimise the efficiency of diagnostic hubs, while still providing high-quality care. They did this by creating a reconfigurable hub at Brent Cross Shopping Centre.

Finally, Professor Sonya Crowe and Dr Zella King described their work using machine learning to provide real-time predictions of hospital admissions for emergency patients at UCLH. Up next, we gave the audience an insight into the IHE Summer Studentship Scheme, which just wrapped up its second year. The studentship is an 8-week paid placement working in the heart of a research hospital on a multidisciplinary project.

UCL biomedical engineering undergraduate students Alba Morillo Paterson, Rachel Tan, and Ines Marti Vigray shared their experiences of working in the Royal National Orthopaedic Hospital over the summer. All three mentioned how the programme had been an enriching learning experience and given them further insight into the field of biomedical engineering.

Helen Cooksley, Portfolio Manager for the Translational Research Office, wrapped up the morning session with a look at the funding schemes her team provide. The TINS Pilot Data Scheme provides funding for early-career researchers to generate pilot data for translational healthcare engineering projects. The scheme enables awardees to learn crucial skills, generate data, and lead them to follow-on funding.

Professor Rebecca Shipley opens the symposium



We picked up in the afternoon with a fascinating panel discussion on sustainability in healthcare, hosted by Luke O’Shea, Executive Lead for Sustainability at University College London Hospital.

Luke was joined by:

- Prof Mark Miodownik (UCL Mechanical Engineering)
- Dr Alexandra Lyne (UCLH/Eastman Dental Hospital)
- Dr Gesche Huebner (UCL Energy Institute)

Then, we heard from clinicians and engineers who had collaborated on interdisciplinary projects. Dr Henry Goodfellow and Jonthan Waywell discussed their work on the Living With COVID Recovery app.

They discussed the challenges of developing an app to support people with what was then a novel disease with no existing NHS infrastructure.

They described the app development process – from mapping user journeys to content writing and video creation, through to integrating it with clinical pathways.

By September 2022, the app was being used by 34 long COVID clinics and more than 6,000 patients.

Carmen Salvadores Fernandez and Dr Hugo Layard Horsfall, both from WEISS – a centre founded on engineer-clinician collaboration – spoke about developing a sensorised surgical glove which can analyse forces during surgery. This innovation will provide real-time force data to clinicians and reduce the risk of tissue damage during surgery.

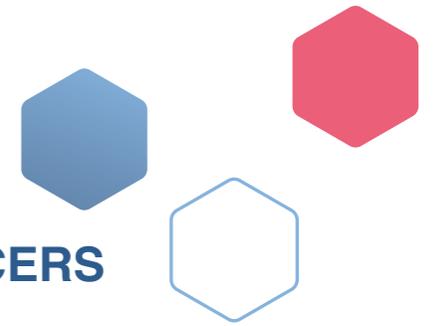
We wrapped up the day with a look at the IHE Impact Fellowship scheme. A panel of Impact Fellow alumni spoke about their experiences during the Fellowship, and their future engagement and impact plans.



Thank you to everyone who came along and made the day such a special event

OncoEng

ENGINEERING QUALITY OF LIFE FOR PEOPLE WITH ADVANCED CANCERS



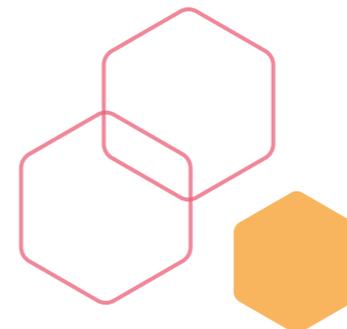
A £7 million research project has been launched to develop a new imaging and keyhole surgery approach to the treatment of secondary bone tumours of the spine.

Known as metastatic bone disease, the tumours spread from a primary cancer located elsewhere in the body. The condition is particularly associated with breast cancer.

The bone tumours cause vertebrae to weaken and eventually fracture, leaving people in severe pain, immobility and requiring surgery. In some cases, the fracture may damage the spinal cord and cause paralysis. For these patients, however, quality of life is a key issue and complex surgery may be inappropriate.

A research collaboration between the University of Leeds, Imperial College London and UCL has received funding to develop an alternative approach based on developing new imaging and modelling techniques that will enable clinicians to predict which patients are at a high-risk of a vertebra fracturing.

They would then be fitted, using minimally invasive surgery, with a tailor-made implant to strengthen the spine and prevent the fracture.



The project – Oncological Engineering: A new concept in the treatment of bone metastases – has attracted £7 million in research funding, including a £5.6 million grant from the Engineering and Physical Sciences Research Council (EPSRC), part of UK Research and Innovation, the Government-funded body set up to support research and innovation.

Professor Richard Hall, an expert in medical engineering from the School of Mechanical Engineering at Leeds who is leading the research collaboration, said:

The problem facing doctors is they have no way of knowing which of the spinal vertebrae is going to collapse. But when that happens, patients may require major surgery which involves a lengthy period of rehabilitation.

Our approach is to intervene by developing new techniques and equipment that will prevent spinal fractures, crucially helping to maintain a patient’s quality of life at a time when they may be terminally ill.

According to Cancer Research UK, 150 people every day are diagnosed with breast cancer. Although more than 76% of people with the disease survive for more than ten years, some patients do develop stage four cancers, of which it is estimated about 50% to 60% get bone tumours.

Stage four cancer is sometimes called metastatic cancer because the disease has spread to other organs.

Within five years, the research team hope to have developed new techniques and materials that will revolutionise the treatment of bone metastases.

The approach is based on personalised medicine, assessing an individual's risk that the spine has weakened so much that a vertebra will fracture. In those cases where surgeons intervene to strengthen the spine, the implant will be tailor-made.

“*Through improvements in imaging and modelling and a personalised approach, this project has the potential to revolutionise the treatment of secondary bone tumours.*”

It demonstrates the importance of fundamental research and engineering solutions in developing new treatments that will have a profound impact on people's lives.”

Dr Kedar Pandya, Director for Cross-Council Programmes at the Engineering and Physical Sciences Research Council

PREDICTING THE RISK OF BONE FRACTURE

Researchers will develop new approaches to patient imaging and computer modelling, enabling them to track tumour development in the spine over time and how it might be weakening individual vertebra. The information would be compared with the loading on the spine, enabling clinicians to predict which of the vertebrae is at risk of fracturing.

This funding will enable us to significantly expand our work combining computational modelling with cutting-edge imaging to better understand how cancers grow and interact with surrounding tissues.

We are excited to use these multidisciplinary frameworks to understand vertebra fracture risk and ultimately help to improve quality of life for cancer patients.

– **Professor Rebecca Shipley, from the Department of Mechanical Engineering at UCL and one of the co-investigators**

IMPLANT FROM ADVANCED MATERIALS

Those vertebrae at a high-risk of collapse would be supported by an implant inserted into the spine using minimally invasive techniques.

The implant would be made from what is called a metamaterial, a material that has uncommon properties that can be fine-tuned to the needs of the patient, for example the material could harden when under stress.

Metamaterials are currently used in the aerospace industry but with advances in 3-D computer printing, the research team believe they could be adapted to provide tailor-made structural integrity to vertebrae at high risk of fracturing.

The advanced manufacturing group from the Dyson School of Design Engineering at Imperial will be developing a novel 3D printer capable of fabricating the intricate implant designs. Their machine will utilise smart optical systems to print photopolymers at extremely fine resolution.

“

This project allows us to expand our expertise in the analysis, optimisation and 3D printing of structural metamaterials. By working as part of the multidisciplinary team we aim to apply the new approaches and knowledge to improve the quality of life of late-stage cancer sufferers.

We will also be able to apply some of these new approaches back into the aerospace and mechanical engineering sectors where advanced meta-materials have a wide range of potential applications.”

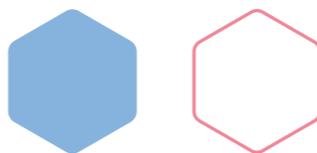
Dr Rob Hewson, co-investigator at Imperial

MINIMALLY INVASIVE SURGERY

By using minimally invasive techniques to implant the material, the recovery period for patients will be days, rather than weeks or months with the surgery that is required if one of the spinal bones fractures.

The NHS long-term plan for cancer treatment had called on researchers to develop new interventions that would improve the quality of life of patients living with advanced cancers.

It is hoped the new techniques will be applied to other areas of the healthcare sector.



3 CAREERS

ECR TRAVEL BURSARIES

The IHE Early-Career Researcher Travel Bursary aims to support our early-career researchers in sharing their healthcare engineering research nationally and abroad. By promoting world-class healthcare engineering research to a wide audience, we hope to pave the way for interdisciplinary networking and collaboration.

In 2022, we provided 10 bursaries to the following early-career researchers which allowed them to travel to these locations:

- Marim Basiouny - Porto
- Annalisa Bettini - Toronto
- Adam Doherty - San Diego
- Marie Georgiades - Honolulu
- Danielle Konig - Rotterdam
- Andrea Mazzaloni - Maine, USA
- Oriol Roche i Morgo - Grenoble
- Thomas Niederhoffer - Glasgow
- Diana Marta Cruz de Oliveira - Porto
- Jing Xue – Barcelona

The bursary is open to all UCL students (MSc and above) and postdoctoral researchers in healthcare engineering and digital health.

Successful applicants can receive:
£250 for UK conferences and
£500 for international conferences.

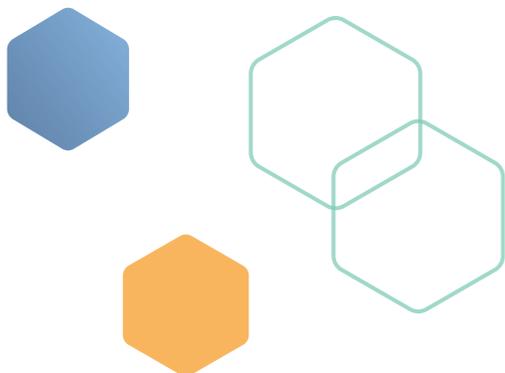
We will be re-opening the travel bursary for applications in early 2023.

HOW THE BURSARY HELPED EARLY-CAREER RESEARCHERS

I had the chance to present a piece of my PhD work at the international IEEE Engineering Medicine and Biology conference (EMBC) in Glasgow, Scotland. Going to EMBC was important for myself and my career as EMBC is one of the largest conferences in my field, neural engineering, and my first in-person conference, and I was able to go thanks to the IHE Early-Career Researcher travel bursary to support me. I had the opportunity to present my poster on neural implant electrochemistry and get some feedback on my research and presentation skills. I could also engage in very interesting conversations and network with other specialists and early-career researchers in my field, and I attended some great, inspiring keynote presentations.

Overall, what I retain from this week in Glasgow is: a lot of motivation and new ideas for my future work, a broader understanding of the present and future of my field, and great connections professionally, as well as personally. Therefore, I would like to thank the IHE for awarding me the travel bursary that made this possible, as well as UCL and my supervisors for supporting me.

– Thomas Niederhoffer



I would like to thank the Institute of Healthcare Engineering for supporting my attendance to the Tissue Engineering and Regenerative Medicine International Society – America (TER-MIS-AM) annual conference in Toronto. This annual conference attracts early career and leading scientists in the field of regenerative medicine to discuss their latest research.

I presented my PhD research in two sessions, a poster and a podium presentation. This was the first time I presented at a conference in North America, and it was a great opportunity to receive feedback on my work. The feedback has been particularly useful in the writing of my thesis and networking for future collaborations.

Attending this international conference was inspiring, I learnt about recent progression of research in my research field and the breadth of the programme also allowed me to explore novel regenerative medicine applications in different research areas. The conference workshops were particularly interesting as I managed to engage in fascinating discussions with other international researchers.

Once again, I am thankful for the support of the IHE ECR travel bursary. I look forward to using the scientific feedback and collaborations developed in this conference to progress my academic career.

– Annalisa Bettini



Thanks to funding from the UCL's IHE Early-Career Researcher Travel Bursary, I was able to attend Rehabweek 2022 in Rotterdam and present my undergraduate research project on the effects of transcutaneous spinal cord stimulation, delivered with and without high frequency modulation, on spinal and corticospinal excitability as part of the International Functional Electrical Stimulation Society program.

The opportunity to present my research as an undergraduate student was an incredible experience. The questions I received post-presentation from the audience forced me to really think about the work I'd done, and also exposed me to different related areas that I hadn't considered or explored, but which could be interesting to pursue in future work. A few people from the audience came up to me afterwards to congratulate me on my presentation, and ask more questions or discuss my work further, which was really cool.

Rehabweek is an international event focused on rehabilitation technology that is made up of several different conferences. This was my first time ever going to a conference, so getting to listen to other presentations, discussions and panels all related to rehabilitation technology, as well as speak to people working and researching in the field from around the world was an extraordinary opportunity. Being able to attend such an amazing conference really highlighted the different options available for pursuing research and professional work in the future within this exciting and rapidly developing field of rehabilitation technology.

– Danielle Konig



Thomas Niederhoffer



Annalisa Bettini



Danielle Konig

4 ENGAGEMENT



Visitors explore Tomorrow's Home

TOMORROW'S HOME EXHIBITION

Tomorrow's Home 2050 was an immersive installation where the home of the future – 30 years from now – became a reality. It took place at the Museum of the Home in Hoxton between November 2021 and January 2022.

Drawing upon leading research from the UCL Institute of Healthcare Engineering, Tomorrow's Home playfully imagined how our dwellings could be designed to help us live independently and well as we age and support our changing planet.

The project brought together leading interdisciplinary researchers from UCL, designers and the public to reimagine and realise a vision for future homes through an immersive multisensory space and interactive experiences.

The initiative, led by Prof Rebecca Shipley (Director, UCL Institute of Healthcare Engineering), Dr Mine Orlu (School of Pharmacy) and Marilyn Aviles (Tomorrow's Home 2050 Project Manager), was a recipient of the Royal Academy of Engineering's prestigious Ingenious Award for public engagement. We partnered with design and engagement specialists The Liminal Space to bring the exhibition to life at the Museum of the Home.



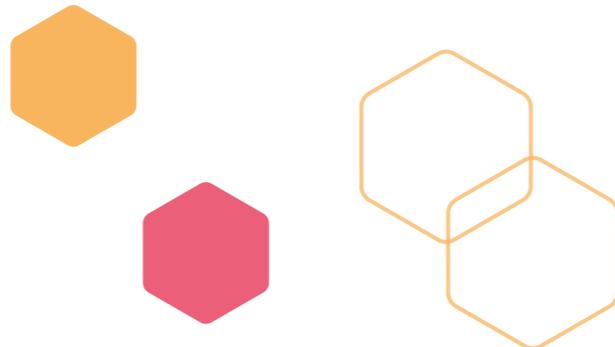
Visitors encountered a talking smart toilet which could analyse waste to make health predictions, mugs which could administer medication, and doormats that recognise the homeowner's footsteps.

The imagined technologies straddled the line between life-enhancing and invasive – inviting visitors to question what types of technology they'd be comfortable with in the home.

Alongside the installation, we hosted an exciting programme of workshops and drop-in activities, from online conversations with experts to a creative singing workshop.

HOW DID VISITORS FEEL ABOUT TOMORROW'S HOME

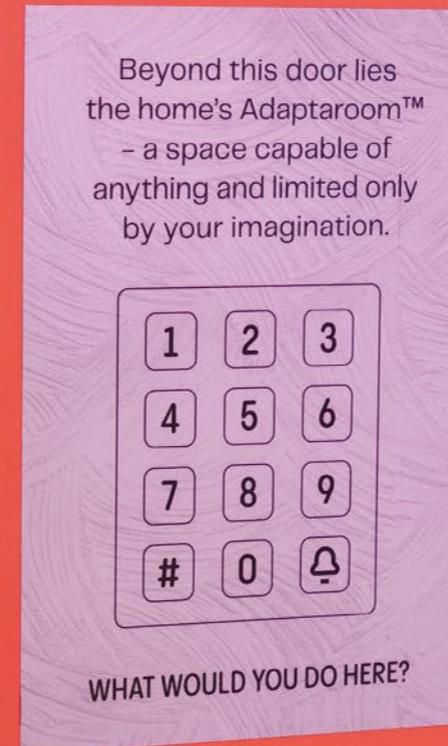
Visitors witnessed the ways technology was embedded in the lives of three fictional characters – how it supports them to live healthier, more independent lives but also ways it could cross the line from convenient to creepy.



QUESTIONS RAISED DURING THE EXHIBITION

Q: With smart sensors installed across the home, how would you ever disconnect?

Q: Would you offer living space to a climate change refugee?



Q: What if your toilet could detect health problems early but also tell your partner you were having an affair?

Q: Would you prefer to snack on perfectly optimised 'smart' food or host healthy microbes on your wallpaper?

By posing these provocative questions the hope was to engage new perspectives into current research and technology development.

Visitors filled out questionnaires designed by the IHE and the Liminal Space, in which they responded to the ideas envisioned in the Tomorrow's Home exhibition. They also gave feedback on how they would like healthcare engineers and scientists to engage with the general public.

We used this information to explore potential future research themes around the concepts of connectivity, sustainability, adaptability, data security, and responsibility.

Of the innovation ideas that were presented in Tomorrow's Home, those that focused on enhancing personal wellbeing and community cohesion were received most positively by visitors. Smart devices that used personal data for tracking or controversial purposes drew more mixed reactions from visitors, reflected in similar percentages of negative and positive responses.

The way that visitors responded to the collection of personal data by smart devices also appeared to be connected to how their functionality was described, with terms such as 'monitor' and 'analyses' triggering more negative responses than descriptions such as 'respond to' and 'enhance'.

Visitors of Tomorrow's Home



OUT OF TOMORROW'S HOME VISITORS:

42%



Reported feeling worried about devices in their home collecting information about them and their health

58%



Strongly or very strongly agreed that Tomorrow's Home was relevant to them

63%



Strongly or very strongly agreed they had learned something new

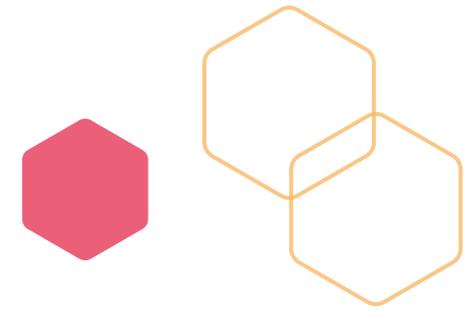
FUTURE DIRECTIONS

Although the installation has come to an end, that doesn't mean Tomorrow's Home is over. The project sparked several discussions and collaborations around its key topics.

We're exploring different options to ensure the longevity of Tomorrow's Home and we look forward to updating you on the progress of new developments when we can.



IHE IMPACT FELLOWSHIPS



Now in its third year, the IHE Impact Fellowship Scheme helps UCL healthcare engineers make impact and engage with people beyond the university.

The year-long Impact Fellowship scheme welcomed its current cohort in October 2022. The scheme will train and guide its impact cohort to build their engagement skills and grow their network beyond university walls, building up a real-life, impact-driven, engagement activity at the end of the year.



Impact Fellows kick-off meeting



Fellows receive personalised training and skills-building in a range of engagement and impact topics, including:

- How to engage with policymakers
- How to explain your research in simple terms so everyone can understand what you do
- How to work with audiences from widely diverse backgrounds
- How to work with community groups and patients
- How to measure your impact
- How to co-produce research with community members

They also receive plenty of additional advice and guidance, including mentorship from experts, peer-to-peer learning activities and opportunities for external network-building and exchanges.

Crucially, all Fellows are supported to take part in at least one structured activity each term which allow them to practice the skills they've learned.



WE'RE DELIGHTED TO WELCOME 18 NEW FELLOWS ON BOARD THIS YEAR

- Adam Szmul – WEISS
- Alissa Parmenter – UCL Medical Physics & Biomedical Engineering
- Arsalan Marghoub – UCL Mechanical Engineering
- Atheer Awad – UCL School of Pharmacy
- Beatrice Taylor – UCL Computer Science
- Carlos Navarrete Leon – UCL Medical Physics & Biomedical Engineering
- Carmen Salvadores Fernandez – WEISS
- Charlotte Maughan Jones – UCL Medical Physics & Biomedical Engineering
- Danica Pacis – UCL Medical Physics & Biomedical Engineering
- Diana Oliveira – UCL Mechanical Engineering
- Elze Porte – UCL Mechanical Engineering
- Evangelos Mazomenos- WEISS
- Giada Brianza – UCL Computer Science
- Hugo Layard Horsfall – WEISS
- Katherine Wang - UCL Mechanical Engineering
- Liam Collins-Jones – UCL Medical Physics & Biomedical Engineering
- Peter Woodward-Court – UCL Institute of Health Informatics
- Rebecca Baker – UCL Institute of Cardiovascular Science



IHE SCIENCE SHOWCASE

Five minutes to talk about your research to a group of people who aren't familiar with it – can it be done? That's what our Impact Fellows have been doing this year with the Science Showcase.

Hosted by podcaster and comedian, Steve Cross, the 'Science Showcase' is a relaxed public event aimed at showcasing the great research our Fellows have been conducting.

The IHE Impact Fellowship was launched in October 2020 and since then has helped two cohorts of researchers develop their engagement skills and build a network beyond university walls.

The Impact Fellows have received bespoke training sessions and advice from science impact and communication experts such as the UCL Co-Production Collective, the Policy Impact Unit, and UCL Engagement.



Over the course of the programme, our Fellows explore ideas like how to measure their impact, how to engage new voices, values of co-production, how to engage with policymakers, how to communicate their research to different audiences, how to work with community groups and patients.

The 'Science Showcase' is a culmination of all the engagement training our Fellows have received. The Showcase challenges our Fellows to communicate their research and its impact to an audience who isn't familiar with healthcare jargon and language.

Apart from becoming more confident in presenting and speaking, it also helps our Fellows question what is 'understandable' and what is interesting to the general public.

TWO DAYS OF SHOWCASE

You can watch both sessions on YouTube – just search ‘Science Showcase with UCL Healthcare Engineering’!



SPOTLIGHT ON DR NAZIA MEHRBAN

Nazia was an IHE Impact Fellow in 2020. Now she leads her own research group at the University of Bath.

Could you tell us about your ‘day job’, your area of research, and its impact?

I am currently a Lecturer (Assistant Professor) of Biotechnology at the University of Bath. When I started the Impact Fellowship, I was a Senior Research Fellow at the Ear Institute at UCL. It was quite a transition going from working ‘for someone’ to setting up my own research group! I am still in the early stages and learning a lot about my job. It’s slightly daunting that students now look to me for guidance!

My area of research is regenerative medicine and I specialise in designing and creating biomaterials that are implanted into the body for various reasons; for example, to repair diseased/ damaged tissue or to build robotic tissues that help a patient function.

As my research is based in medicine and benefits patients, the impact is possibly easier to envision. At the moment I am working with a team of researchers and clinicians from multiple institutes to help develop robot muscles to allow patients to move as they should.

However, I think it’s important to say that my research isn’t always linear. I will be talking about my involvement with patients and the impact they have on my research in an article I am writing for The Conversation.

You were an IHE Impact Fellow from 2020-21. How do you feel it has helped you develop?

The Impact Fellowship was something I went into with no expectations, partly because we were the first set of Fellows to go through the programme. However, the lessons I have learned from the network I have established (both with colleagues and external speakers) have been amazing. I now look back and think I had a very narrow-minded view of what impact meant before I started the Fellowship.

How did this change your understanding of creating impact?

I feel I now have a broader understanding of impact beyond the medical aspect. The Fellowship gave me skills in all areas from policy to media and public engagement. I was convinced policy engagement was beyond my level of expertise but I now find myself contributing to policy documents for the UK Parliament! As well as broadening my understanding of the theme I feel it has boosted my confidence to engage with all the various stakeholders.

After the Impact Fellows, what impact/ engagement work have you been involved in?

The Fellowship organisers were generous in providing a small bursary for the Impact Fellows to explore their newly-acquired skills and engage with external institutions to showcase the impact of their research. I created a research exchange programme with a university in Colombia to share research across cultural and language barriers. This was all done via Zoom and involved a huge team and students from both sides. The students even got to design the logo that was used for the symposium and printed on

all the prizes. It was a hugely successful event with over 150 attendees and both the UK and Colombian researchers have been giving us positive feedback!

The programme is currently in its final stages in which Colombian university students are mentoring high school students and encouraging them to explore healthcare subjects and research. My hope is that this programme will serve as a template to enable future events between the UK and other countries as well as creating a lasting relationship between the Colombian university and high school so that future generations can benefit from the idea.

What would you like to do next?

I am hoping to develop an Impact Fellowship here at Bath and give Bath researchers the same training and opportunities I was lucky to receive. It's still early-stage but the university is certainly interested.

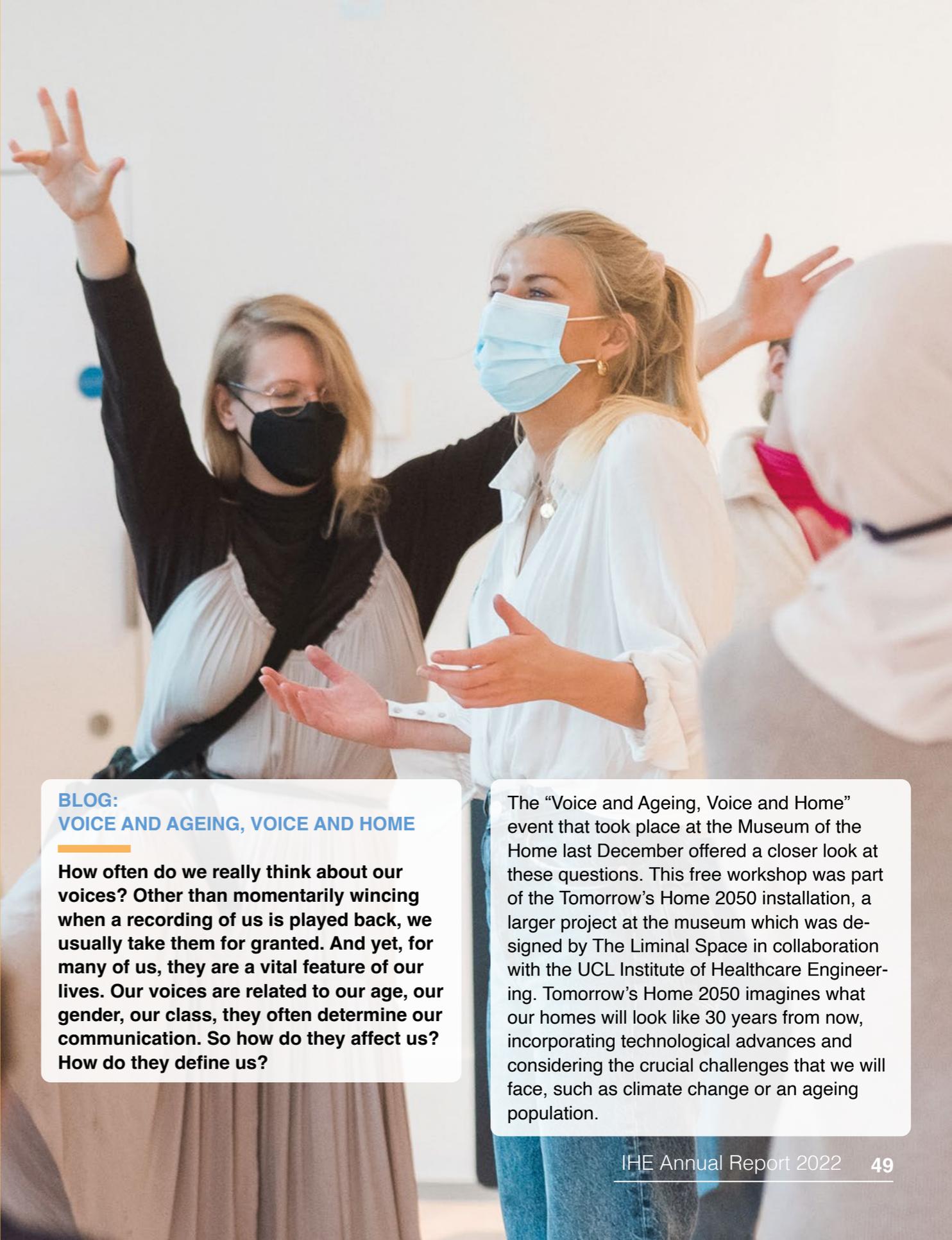
I am also writing an article for The Conversation and hoping to continue engaging (and not being frightened to engage) with healthcare policy.

Anything else you'd like to say?

I have had a fantastic time with Georgie Cade and Alice Hardy (the IHE Marketing & Communications team) as they helped us navigate through all that encompasses impact! I have to say this programme far exceeded my expectations and so many months on I find myself referring back to the lessons I learned and engaging across all sectors. I would like to say a huge thank you to the team but also if you are given the opportunity then do sign up, you may be surprised by what you learn!



Dr Nazia Mehrban



BLOG:
VOICE AND AGEING, VOICE AND HOME

How often do we really think about our voices? Other than momentarily wincing when a recording of us is played back, we usually take them for granted. And yet, for many of us, they are a vital feature of our lives. Our voices are related to our age, our gender, our class, they often determine our communication. So how do they affect us? How do they define us?

The “Voice and Ageing, Voice and Home” event that took place at the Museum of the Home last December offered a closer look at these questions. This free workshop was part of the Tomorrow’s Home 2050 installation, a larger project at the museum which was designed by The Liminal Space in collaboration with the UCL Institute of Healthcare Engineering. Tomorrow’s Home 2050 imagines what our homes will look like 30 years from now, incorporating technological advances and considering the crucial challenges that we will face, such as climate change or an ageing population.

The workshop was led by Hannah Conway and Hazel Gould, a composer and a writer respectively with experience in running artistic, interdisciplinary events with the general public, such as their project SoundVoice.

Through a mixture of singing, creative writing and discussion, they took a group of people on a journey to explore deeper questions about their vocal identity, and its relationship to the home. The workshop environment allowed for interesting synergies between people of all backgrounds, with surprising and fascinating results. The joy of collaboration is discovering, through others, things we did not know about ourselves.

Three of our IHE Impact Fellows participated in the workshop and have written about their experience.

ORIOLE'S EXPERIENCE

One of the most fascinating aspects of the workshop was talking to Charmian Bedford, a trained opera singer who performed for us. On a very basic level, listening to an opera piece from up close (we were only a few feet from her) is staggering.

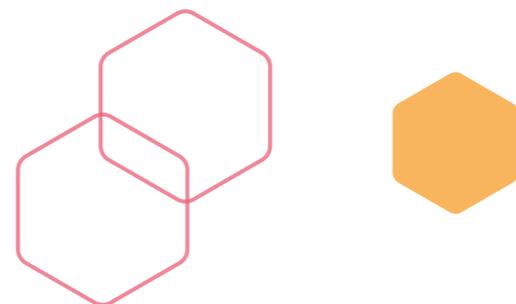
The power and control in her voice was unlike anything else, a show of skill as impressive as that of a weightlifter or a pro runner. At a time when mumblecore and breathy pop delights are the norm (and I have nothing against them!, God knows I love Taylor Swift), Bedford's performance was a reminder that the voice is as much of an instrument as the piano, one that you can tune and modify and improve.

After the song, we were asked to describe Bedford's voice. It was a trusting environment, yet describing her voice was challenging. I wanted to find a positive descriptor, one with minimal negative connotations, but I also wanted to take the exercise seriously. Bedford was gracious and took all our comments well, but the activity made me reflect on how personal voice can be.

This, in turn, made me wonder about the impact of voice changes. This is a natural part of ageing, on top of a side-effect of many other things (disease, travel, training...). I remember when my voice changed as a teenager. I had been part of a choir for a few years by then, and the sudden deepening of my register had a direct impact on singing. I prided myself on being able to hit the high notes, and suddenly that which had brought me much joy was gone.

A similar thing happened with my accent. Living in the UK for a long time has 'Britishised' my speech. I'm not aware of this myself, but I can track the change by how other people's perception of me changes.

First they used to think I was Spanish, then they were confused, now they think I'm... Irish? This is rather amusing to me, but it forces me to confront how things that I barely think about, such as my voice, and how it can have a huge impact on the way I come across.



Hannah Conway,
co-lead of the workshop



SARAH'S EXPERIENCE

Have you ever sung a song to summarise a discussion? We did – singing a song to summarise a creative exploration into the voice. Very different to a typical day as a PhD student!

Questions such as: "how does ageing change your voice?" and "what does voice in the home mean to you?" kickstarted conversations. The safe, but fun, space created for the workshop encouraged involvement and promoted inclusivity; to the extent that it was difficult to get everyone to stop talking!

The openness and honesty shown in answering the questions surprised me. The shared personal stories made us consider the physical and psychological effects of the environment on voice and identity. Participants spoke of times during their lives in which they did not feel listened to, causing them to lose their confidence and lose their voice, with the result that they barely spoke. After the workshop, I reflected on these life experiences.

The importance of proper listening and in valuing all contributions were crucial, two aspects that I will take with me and promote in the future.

At the end of the workshop, threads from all the conversations were pulled together in a poem and a song. Summarising the different voice-themed discussions by exploring our own voices was a fun and fitting way to end the workshop. I found singing the thoughts and personal reflections from others, and hearing other people sing my ideas, a unique experience that connected us all.

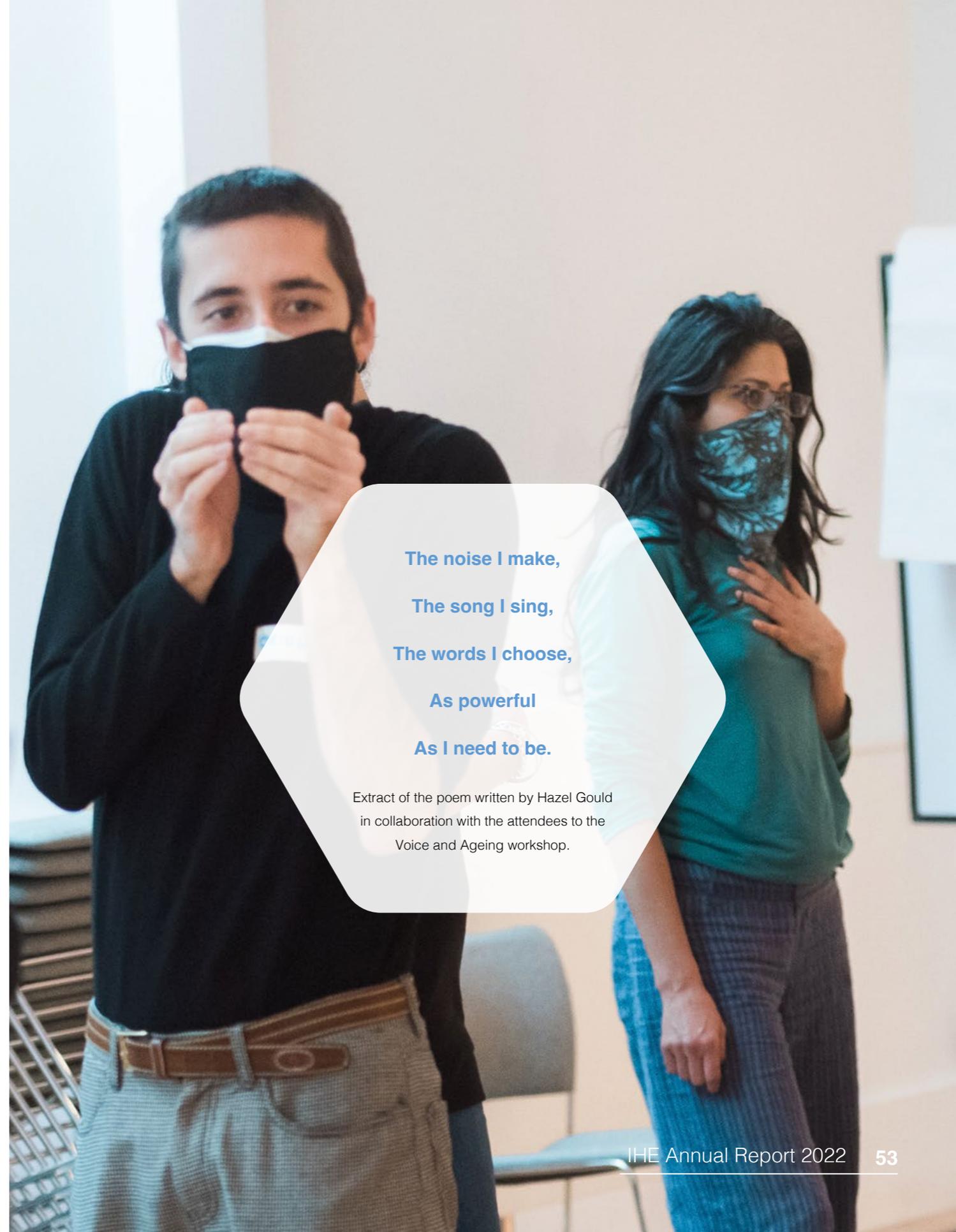
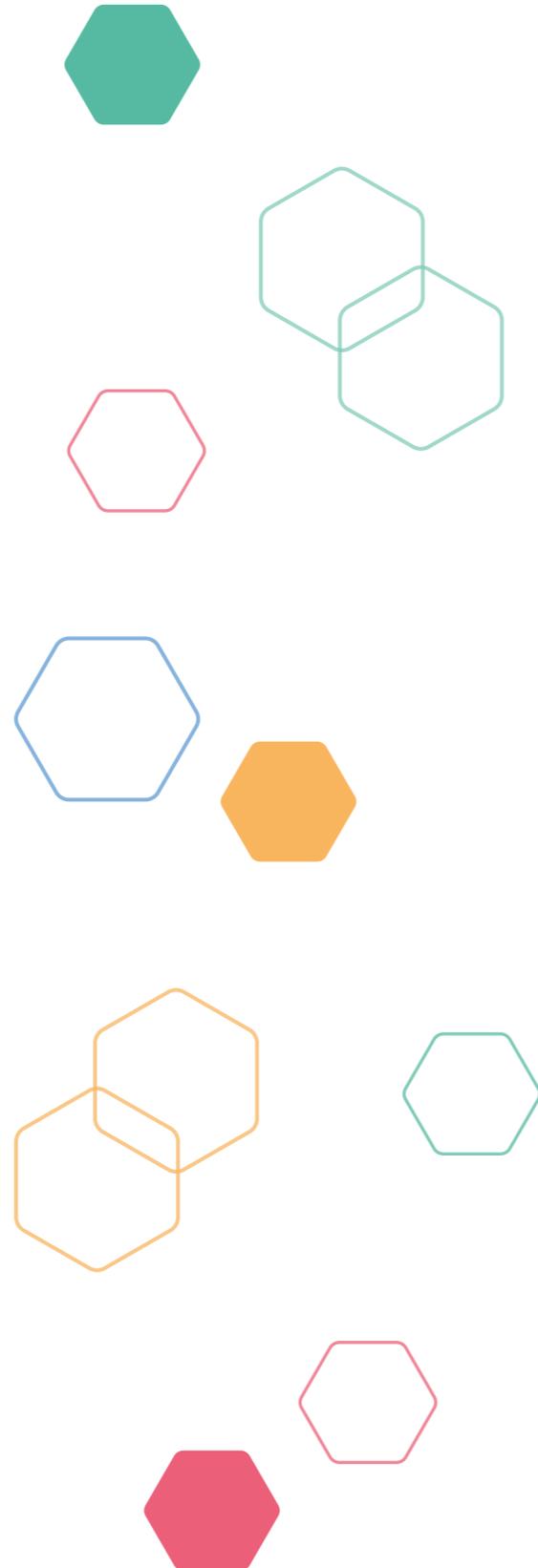
It was fascinating to observe the techniques used by Hannah and Hazel in engaging the workshop participants and cultivating collaboration. Collaboration and co-production had previously seemed like a daunting endeavour. Now these present exciting possibilities - if a two-hour collaboration between strangers can inspire the creation of a poem and a song, anything seems possible!

NOUR'S EXPERIENCE

We live in a very loud world. Voices are all around us. But have we ever stopped and taken a moment to think about what these voices really mean and what they represent? For me, this was not something I reflected on until I participated in the "Voice and Ageing" workshop. Within two hours of that session, people who were complete strangers at the beginning, ended up writing and singing a song together in great harmony. All by the power of voice.

During the session, we had conversations about voice and what it represents for each person. Talking to people from different walks of life made it very clear that, despite our differences, we are all similar in the way we perceive our identity through our voices and much more. Voices reflect history, heritage, memories, vulnerability and empowerment. Voices mean home. Voices mean belonging. Our voices are actually what sparked these conversations in the first place and created a safe space for all of us to open up and share.

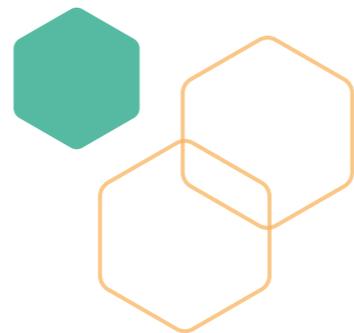
When we were asked to describe our voices and Charmian's voice, the words we used actually described how the voice made us feel rather than describing the voice itself. It was very interesting to hear what people thought about their voices and how others perceived them. Something that again showed the impact of our voices. This beautiful tool that can build bridges, create a home, and empower us and those around. It was truly a humbling and inspiring experience.



**The noise I make,
The song I sing,
The words I choose,
As powerful
As I need to be.**

Extract of the poem written by Hazel Gould
in collaboration with the attendees to the
Voice and Ageing workshop.

POLICY ENGAGEMENT



POLICY NOTES ON HEALTHY AGEING

New policy notes from UCL IHE, Policy Impact Unit and CelebrAGE set out the challenges and opportunities of an ageing population.

Healthy ageing is a national and international strategic priority, and it is one of the Institute of Healthcare Engineering's priority research areas.

The IHE has hosted a range of activities in light of this strategic priority, including a Healthy Ageing Symposium in 2019, and launching the Age Innovation Hub in 2020. The activities aim to find and address the gaps in healthy ageing research by building a diverse collaborative community that can co-develop innovative ideas.

In January 2021, we hosted a policy workshop on healthy ageing in conjunction with the STEaPP Policy Impact Unit (PIU) and CelebrAGE.

Dr Ana Rita Pinho, a policy adviser from the Policy Impact Unit (PIU) working with the Institute of Healthcare Engineering, led the organisation of the workshop. A wide range of stakeholders from the university and policy communities were invited to participate, with the goal being the development of research questions with value for both sectors.

Following the event, discussions from the workshop were distilled down to the core messages. These have now been turned into five policy briefings – each focusing on a different area of concern for the ageing population. You can read the full policy notes on the IHE website.



PROFESSOR MARIANNA OBRIST ATTENDS PARLIAMENTARY ROUNDTABLE ON HEALTH TECHNOLOGY

On 16 March, IHE Deputy Director (Digital) Professor Marianna Obrist contributed to PICTFOR's Health Tech Roundtable at the House of Commons.

PICTFOR (the Parliamentary Internet, Communications and Technology Forum) is the largest and most active All-Party Parliamentary Group, bringing together Parliamentarians from all parties and Houses alongside key stakeholders in the relevant sectors.

This roundtable event centred on the question, "how can health tech support the Government's public health agenda and maintain well-being?".

The key points being considered were:

- In response to the COVID-19 pandemic, how do we ensure the UK embraces cutting edge digital technology and remote services which best serves the NHS and patients?
- How can HealthTech support the Government's sexual health strategy and contribute towards the Government's target to eliminate HIV transmission in England by 2030?
- What are the barriers to the uptake of HealthTech by the NHS and Local Government?
- What more can the Government do to drive the use of HealthTech and the digitalisation of services, where appropriate?



The event was chaired by Baroness Neville-Rolfe. The Shadow Minister for Public Health, Andrew Gwynne MP attended as well as representatives from McKessonUK, OpenUK, Lloyds Pharmacy, Voror Health Technologies and Terrence Higgins Trust.

Much of the discussion emphasised the importance of taking a patient-centred approach to the development of health technologies. New technologies should respond to patients' genuine needs, rather than advancing technology for its own sake.

Professor Obrist said:

It is clear from the discussion that patient experience needs to be at the heart of health technology innovation and development, and there is still a great need for overcoming challenges such as barriers when it comes to accessing digital health solutions, and the health inequalities that can arise as a result.

Enabling people to be in charge and have agency over their health is essential for deploying innovative digital solutions not only in hospitals but for people's self-care at home.

REFLECTIONS ON THE AGE INNOVATION HUB

WHAT WE LEARNED FROM CROWD-SOURCING IDEAS

Launched in late 2020 and running to mid-2021, the Age Innovation Hub was a digital platform that crowdsourced ideas and needs for technologies to support healthy ageing.

The Age Innovation Hub platform was the first of its kind at UCL. Using the Medallia Crowdycity software, we built an accessible online forum where members of the public could directly share their ideas and feedback with UCL researchers. We also invited UCL researchers to get involved by submitting their own experiences and engaging in the discussion.

The vision was that the insights gleaned from this platform would inform our research into healthy ageing – making sure that we are focusing on delivering usable solutions to real problems.

We asked the public:

- What needs and challenges do they have around healthy ageing?
- What ideas do they have for technologies to help?

While the platform was open to everyone, we were particularly keen to hear from older people themselves, their carers and family members, and healthcare professionals.

WHY DID WE FOCUS ON THE TOPIC OF HEALTHY AGEING?

Thanks to advances in healthcare and living standards, people are living longer than ever in the UK and many parts of the world. An ageing population brings new benefits and challenges

The UK government and the NHS have made it a priority to tackle the challenges associated with an ageing society – which include struggling with deteriorating health, loneliness and difficulty accessing services.

As healthcare engineers, we can contribute by ensuring we develop technologies that help people live healthy lives from the moment they're born through to later life. In order to develop the most effective technologies that we can, it's crucial we take a collaborative, multidisciplinary approach – harnessing the expertise of older people themselves.



WHY DID WE ENGAGE WITH THE PUBLIC IN THIS WAY?

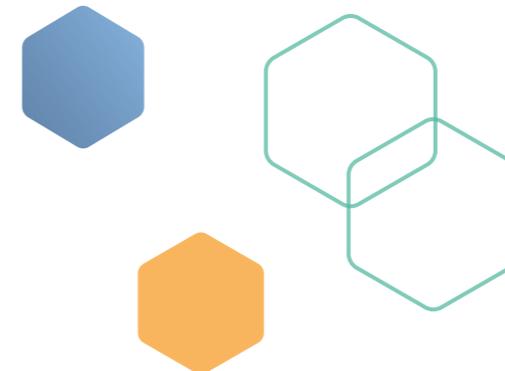
We know from our own experience that many of the same people tend to engage with universities – while a large swath of the population never does.

We're all growing older each day, so we're all experts in ageing!

We wanted to tap into the expertise of people from all walks of life, who may have never engaged with research and make it as effortless as possible for them to take part.

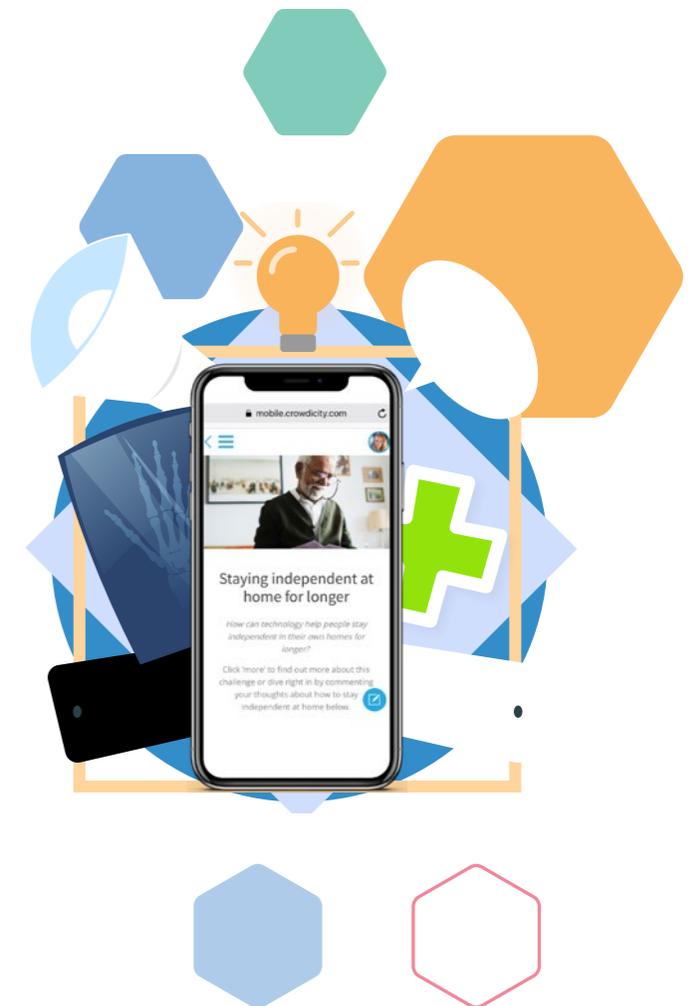
The nature of the Age Innovation Hub was designed to overcome several of the barriers that prevent people from engaging with researchers, such as:

- Lack of time: users could contribute whenever and wherever suited them. A contribution could be as quick as a comment or an upvote.
- Fear of not belonging in a 'university setting': engagement with the platform took place in the comfort of their own homes and we made a strong effort to keep the tone and experience of the platform welcoming and accessible.



Of course, a digital platform is not the best way to engage all voices, particularly older people experiencing digital exclusion. The original plan was to combine the online platform with in-person community sessions with charity and hospital partners, however, the COVID-19 pandemic meant this was not feasible.

Another unforeseen consequence of COVID-19 meant that we saw far less engagement from healthcare professionals than we would have hoped for in 2019, as staff were stretched to their limits and under enormous pressure.



HOW DID IT GO?

We had 121 unique users in total – 105 from the UK, and 16 from across the globe. Most users were based in London, and we saw the highest engagement from 55-65-year-olds. 16% of our users were healthcare professionals.

We arranged the platform in different 'challenge areas,' based around key challenges faced by older people:

- Building social communities
- Creating healthy environments
- Staying independent for longer
- Support for health concerns common with age
- Staying active
- The bigger picture

Staying independent for longer was the most active challenge area, with 14 ideas, 34 active contributors and 66 comments.



WHAT WERE THE MOST RECURRENT IDEAS AND SUGGESTIONS?

A thematic analysis of the platform data shows the top three recurring themes were:

- Assistive technology
- Communication technology
- Healthy ageing strategies

THE THREE MOST PREVALENT AREAS OF SUGGESTED SUPPORT

- Physical activity
- Digital inclusion
- Cognitive impairment/dementia



WHAT DID WE LEARN?

Many of the ideas and comments related to the lack of user-friendliness and accessibility of technology for older people, especially those with physical or cognitive impairments. These types of insights suggest potential focus areas for the IHE and have already been incorporated into our strategic priorities and future funding we provide.

We learnt a lot about the process of digital engagement and achieved our goal of fostering a lively, respectful online community. We are particularly pleased to have had the most engagement from 55-65-year-olds, who are likely to become increasingly aware of the value of healthy ageing strategies and innovations.

We did not have as much involvement from healthcare professionals as we had hoped for, but this was a difficult challenge to overcome given the period. For future engagement with healthcare professionals, we need to be very conscious of the circumstances they are operating in and make it as effortless as possible for them to take part – this needs to be done in equal



collaboration with them, and with careful consideration to their needs and concerns (which differ from the general user).

An area that we could improve on for all users, but particularly those in healthcare, is to clearly elucidate the benefits to them of taking part. While the insights are very useful to the IHE in the longer term, the immediate impact is less obvious to the general user – what's in it for them? We need to consider ways of incentivising user involvement, perhaps in the form of a prize.

The Age Innovation Hub pilot was enormously beneficial in broadening our contacts in the healthy ageing space – from community and charity partners through to policymakers. The benefits from this have been long-lasting. Community and charity partners went on to be an integral part of our Tomorrow's Home exhibition planning, as we were keen to incorporate their knowledge and valuable input.

5 EDUCATION

TEST

EVALUATE

LEARN



IHE SUMMER STUDENTSHIP SCHEME

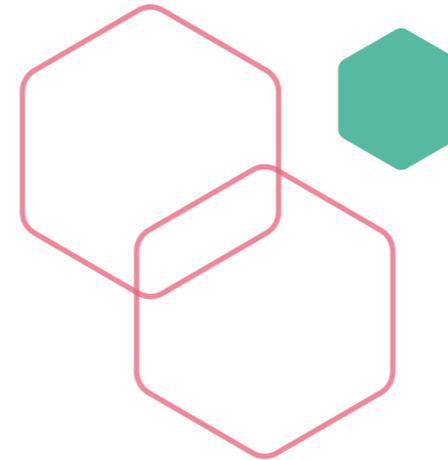
In 2022, UCL Engineering and the UCL Institute of Healthcare Engineering provided 16 summer studentships to undergraduates at the Royal National Orthopaedic Hospital and UCLH.

The Summer Studentship Scheme gives undergraduate students an exciting opportunity to shadow clinicians and take part in related projects at the Royal National Orthopaedic Hospital (RNOH) and the UCLH/UCLH Biomedical Research Centre. The projects are jointly supervised by a clinician and UCL academic.

The scheme is open to undergraduate students in UCL Engineering. The paid studentships run for 8 weeks from June to September.

THIS YEAR'S SUMMER STUDENTS:

- Amit Bhudia
- Michael Chiu
- Mihaela Croitor
- Yujia Gao
- Jonathan Holt
- Maciej Kaczorek
- Joe Tsu Lee
- Xing Lim
- Lian Liu
- Zhiyu Ma
- Oreeditse Mogobye
- Alba Morillo Paterson
- Rachel Tan
- Ines Marti Vigaray
- Vishlesha Vinjamuri
- Cemel Can Yurtcu
- Keyuan Zhang



HOW DID THE STUDENTS FIND THE EXPERIENCE?

The Queen Square smart shunt project - studying the effects of movement and body position on intracranial pressure

Over the past 8 weeks, I have had the privilege to be working on the Queen Square smart shunt project. The team included, Evangelos Mazomenos, an engineering researcher at UCL, Matt Bancroft, a clinical researcher at Queen Square, and Ahmed Toma, a consultant neurosurgeon at Queen Square.

My time working on the project started with an introduction to the research topic and background. I was presented with a lot of data and new terms which I hadn't previously encountered but enjoyed the process of becoming acquainted with the project, as I began to understand the significance and importance of researching this topic.

Throughout the studentship, I was able to develop and improve my practical programming skills. I enjoyed trying out new methods and techniques and adapting industry level code for my own project.

The administration of the Summer Studentship scheme is made possible by our Education Delivery Group and our hospital partners.

A special thank you to Billy Dennis and Iva Hauptmannova for all their help.

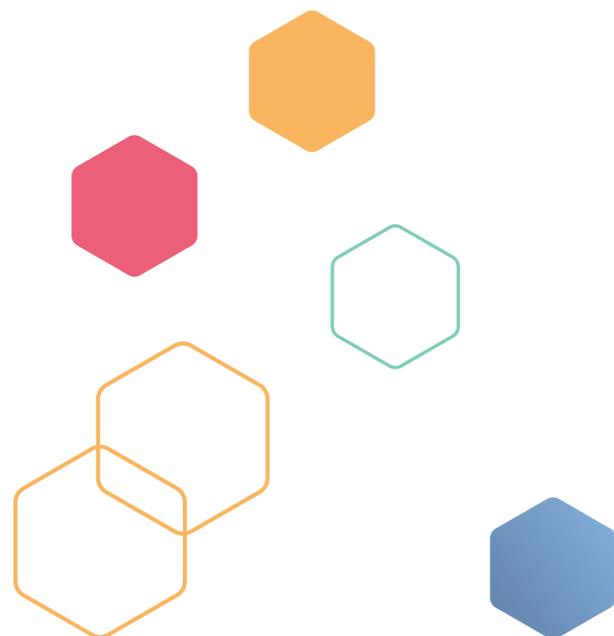
I found the working environment to be very independent and flexible, which I quite enjoyed and found that meetings were very much a discussion to which I could contribute.

The entire team was friendly and extremely helpful in answering questions and providing support, which made the experience much less stressful than I imagined.

This studentship gave me a short insight into a career in academic healthcare engineering which I thoroughly enjoyed. I gained a better appreciation for the field and was able to see the direct overlap between medicine and engineering and understood the importance of doctors and engineers working as a team.

Completion of this studentship has solidified my interest and passion for this field, and I hope to continue to carry out more projects in the field of healthcare engineering as a medical student and further into my career as a doctor.

– Amit Bhudia



Design of force-measuring apparatus for investigating screw compression

This studentship has been a meaningful experience where I got the opportunity to work with clinical experts who have first-hand experience working with newly developed medical devices and implants. I was interested to hear about their feedback on the various medical devices, whether they were easy to handle during surgery even down to the packaging of these implants.

As an engineer, it was a good chance to refocus on the motivations of each design – to provide aid and quicken healing, instead of producing extremely strong implants that may cause more injuries such as breaking bones.

On top of that, it has also made me truly appreciate the effectiveness of teamwork. Throughout my studentship, I got to work with people from the RNOH lab, the Institute of Making and the BME lab in UCL.

I have been working especially closely with Alba Patterson, and we facilitated and challenged each other during brainstorming and problem-solving. Overall, I have been greatly challenged in areas such as practical, critical analysis and social skills.

During this studentship, I got to appreciate the frustrations and joy of research. These include going through different trials and errors to identify the most suitable process and how there is no one right answer. I also got to practically apply what I have learnt in modules such as Solid Biomechanics and Design and Professional skills and see how each module integrates and complements each other. In addition, it was also humbling for me to realise the amount of work that has been placed to test and evaluate seemingly minute implants like a screw. Especially when carrying out the test on actual screws, even though we had run many trials to ensure that the apparatus we designed was working as desired, we faced many hiccups such as noisy signals and build-up of systematic errors on the day of the test which resulted in undesirable results.

I would definitely recommend to students interested in working closely with clinicians, areas of biomechanical testing and especially to those who would like to experience what research feels like. Though there may be moments of feeling lost and having to orchestrate the flow of work independently. It was a great learning experience that enabled me to actively reach out for help and better value the expertise that people around are very willing to share.

– Rachel Tan



MPBE ATHENA SWAN COMMITTEE SPONSORS A FEMALE STUDENTSHIP AT RNOH

One of the IHE Summer Studentships was generously funded by the UCL Medical Physics and Biomedical Engineering (MPBE) Athena SWAN committee. We spoke to the student, Alba Morillo Paterson, winner of the award, and Dr Charlotte Hagen from the committee about the award and what it means to them.

DR CHARLOTTE HAGEN

Can you tell me about the Athena SWAN committee in UCL Medical Physics and Biomedical Engineering?

Our Athena Swan committee was founded in 2012, determined to improve the gender balance within the department.

It has steadily grown since (and secured several Bronze Awards along the way), it has now got more than 20 members, including early career, senior academic and professional services staff. Our current focus is to deliver our 2025 Action Plan, which has four priority areas:

1. Strengthen the capacities and communication channels of our committee.
2. Address the recruitment and retention of our female postgraduate research students.
3. Address key career transition points for academic and research staff.
4. Change organisational culture and facilitate outreach.



The committee's flagship activities are a funding scheme through which we have supported this IHE Summer Studentship as well as a seminar series called "Female Futures", which is all about women's careers and common themes such as perceived and real barriers to success.

How did you hear about the IHE Summer Studentships?

From the committee member who suggested funding one! She did a very good job convincing us that it would be an excellent use of our budget.

What does it mean to you to be able to provide a female student with this opportunity?

It feels good to provide opportunities, very empowering actually. Who knows what else this studentship will lead to? I'd be very happy if it inspired our awardee to pursue a career in Medical Physics and Biomedical Engineering, the field is in dire need of more women! Hopefully, she will be able to meet interesting people and expand her network, too.



ALBA MORILLO PATERSON

How did you find out about the IHE RNOH studentship? Why did it appeal to you?

I found out about the IHE studentship from my teacher Pilar García. She sent out an email with information about various studentships at the RNOH. There were so many being offered, all of them so interesting and appealing.

Perhaps the most exciting aspect was the possibility of working and learning with doctors and clinicians at the RNOH.

As most of the studentships offered were related to biomechanics, I was sure that it would allow me to apply the knowledge I have attained over the last three years of my degree. I was very enthusiastic about having the chance to work on such an attractive project; building a device to measure force on orthopaedic screws.

Can you tell us a bit about the project you are working on at RNOH?

Orthopaedic screws are used to join broken ankle/foot bones that are distanced too far apart to heal properly on their own. There are multiple types of screws in the market used in orthopaedics such as headed screws, headless screws with opposing flanks, etc..., all of which are made of titanium alloy. However, the compression force they generate is not completely known, therefore we (Rachel Tan and I) have built a device which uses load cells to measure this compression.

This will be useful as it will let us know with how much force does the screw compress the two pieces of bone. We may find that certain types of screws are particularly stronger than other, or, that they are all quite similar. Additionally, the device also allows to perform a pull out test where the force required to take the screw out is found. The outcome of this test could be that the screw fails and is pulled out from the bone, or, that the screw is so strong that bone fails.

The first few weeks of the studentship the work was based mainly on learning about orthopaedics screws and designing an appropriate device. After actually building it and going through the design cycle (design, build, test, analyse) a few times, we made a working apparatus. As it is two of us in the project we have worked quite well and fast.

Moreover, we are currently testing these screws which was not part of the studentship plan and hopefully we will be able to write a paper on the results!



How are you finding the experience? How do you think it is benefiting you?

I am finding the experience very enriching indeed, it is deepening greatly my understanding of biomechanics. As the studentship is not fully face-to-face, the days that we work virtually allow me to organise the online courses, completing them at my own pace throughout the 8-week period. The e-courses are teaching me vital aspects about research that must always be considered: the legalities, ethics, and data protection, etc. On the other hand, the face-to-face time is improving my practical skills using tools and machines. I am finding the studentship very fulfilling and perhaps one of the most important discoveries that I have made is that I am very clear that after I graduate, I would like to continue to do research in the biomechanics field.

What does the support of the MedPhys Athena SWAN committee mean to you?

I greatly appreciate the support of the prestigious Athena Swan Committee. Without a doubt the experience and skills I have gained during my studentship at the RNOH cannot be taught in a lecture theatre. I am passionate about striving towards gender equality in biomedical engineering and so many other fields in which girls and women are underrepresented. To have received the MedPhys Athena SWAN studentship has helped me discover the path that I endeavour to pursue professionally, and it will be an honour for me to put their stamp on the work that I produce from this fabulous experience.

– Alba Morillo Paterson



IHE DOCTORAL STUDENTSHIPS



In March 2022, the IHE was awarded a UCL ESRC DTP-funded PhD studentship via the Faculty of Engineering Sciences.

The aim of this studentship is to support interdisciplinary collaborations in digital health which align with the IHE's priority research themes.

We allocated the award to a team led by Professor Miguel Rodrigues (UCL Electronic and Electrical Engineering), who appointed PhD student Zhuo Zhi. The team are developing a mobile health device that can diagnose anaemia in a non-invasive manner.

Anaemia is a condition where a person has low levels of healthy blood cells, or haemoglobin. It can cause fatigue, weakness, and shortness of breath. Young children, pregnant women and older people are particularly affected.

The traditional method of diagnosing anaemia involves taking a blood sample which is then analysed in a laboratory. The drawbacks to this method include its invasiveness, high cost and the amount of medical waste produced.

The team hope that similar technology could be developed to diagnose other conditions affecting the older population, such as kidney disease, colon disease, and vitamin deficiencies.

“ *[This studentship] has exposed me to knowledge and scholars from different disciplines and has broadened my research interests in engineering, health care, and medicine. I believe that the results of this project can effectively contribute to the development of multidisciplinary healthcare.* ”

Zhuo Zhi

The portable device and app being developed by Miguel's team will address these issues. Using artificial intelligence and smart sensing technology, the system will be able to non-invasively diagnose anaemia and display the results on a user interface. The mobile technology will use electronic health record data, non-invasive biometric sensor data, and body fluid data to make its diagnosis.

It's wonderful to receive support from IHE to work on an interdisciplinary project involving experts in engineering, life sciences, and healthcare.

– Professor Miguel Rodrigues

6 GLOBAL

GLOBAL DISABILITY INNOVATION HUB

Global Disability Innovation Hub becomes the world's first WHO Collaboration Centre on Assistive Technology (AT)

Global Disability Innovation Hub (GDI Hub) is a research and practice centre driving disability innovation for a fairer world. Operational in 41 countries, with more than 70 partners, it has a reach of more than 28 million people since launching in 2016.

GDI Hub is at the forefront of the disability innovation moment globally and recently become the world first World Health Organisation (WHO) Collaboration Centre for Assistive Technology (AT); forming part of an international collaborative network set up by WHO in support of its programme at the country, intercountry, regional, interregional and global levels.

UCL East, the location of GDI Hub's new research lab

Founded in the legacy of the 2012 Paralympic Games, GDI Hub Academic Research Centre (based out of UCL Engineering) delivers an extensive portfolio of international research, global programmes and technology accelerators – focussing global expertise on Assistive Technology including EdTech, AI-powered solutions and Humanitarian settings – to drive impact on the ground.

In 2022 the GDI Hub co-sponsored and contributed 150 papers to WHO-UNICEF Global Report on Assistive Technology (AT), building on the work from its AT2030 programme - the UK's largest ever aid investment into assistive technology. By testing 'what works' to get AT to those that need it most, the AT2030 programme has propelled capacity, innovative AT acceleration and data-developing tools and system change to deliver real impact for disabled people, families and communities.

The GDI Hub-WHO Collaboration Centre cements the UK's position of influence globally and signifies the level of progress in the AT sector. In May 2022 Trade Minister, Rt Hon Penny Mordaunt joined UCL Provost Dr Michael Spence AC and disability leads from WHO, UNICEF, ATscale and FCDO to announce the new centre at the UK Houses of Parliament.



Penny Mordaunt reflected on the progress of assistive and accessible technology in the last four years and on the opportunities ahead:

It's important to disabled people in their families, but it is also important to trade, investment, our economy, international cooperation, diplomatic relations, science research, innovation, and the market, even the effects of climate change.

I'm very clear that in the role that I have at the moment, we need to do more on this agenda." I stand ready in trade, to assist [GDI Hub] with the next chapter. But you've done an amazing thing, thank you.

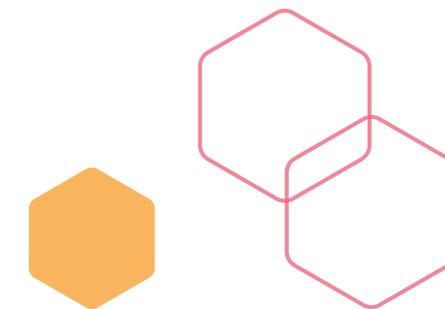
According to the Global Report on AT 2.5 billion people - one in three people - need one or more assistive products, such as wheelchairs, hearing aids, or communication aids and cognition. This figure increases to two-thirds of the global population of age 60 years and older. In low- and middle-income countries access levels can be as low as 3% of the need. By 2050 it is estimated that 3.4 billion will be without access to these life-changing products.

Despite overwhelming evidence that AT can have a significant effect on the user, the community and provide significant benefit to the economy, the sector remains in its infancy.

GDI Hub's new research labs opened at UCL East in September 2022.

It will be home to their Disability, Design and Innovation MSc programme, the first of its kind in the world.

DATA-ENABLED SOCIETY EVENT



On Thursday 3 November, the IHE Global Delivery Group held a workshop and strategic panel that explored the rapid rise of healthcare data and what this means for us.

During the early part of the event, our panelists spoke on varying themes and how they affected the healthcare data we hold in the NHS.

- James Wilson spoke on the trust and governance of healthcare data
- Neo Mapitse on identifying and understanding the needs of data
- Margeret Charleroy on the challenges and opportunities present in healthcare data
- Stefan Elbe spoke on data culture

After talks from our panel we had breakout rooms with attendees having the chance to discuss various topics. There were several topics of discussion.

OWNERSHIP AND CONTROL

Chaired by Dr Melanie Smallman, Associate Professor in the Faculty of Maths & Physical Sciences, this group explored who should really own our healthcare data, how we can protect privacy, how to globally address equality and equity of access to the opportunities of data enabled society for health and

how we may be able to reclaim data from Big Tech for public good.

REGULATIONS, STANDARDS AND PROTECTION

Chaired by Dr. Stephen Roberts, Lecturer in the Faculty of Pop Health Sciences, this group discussed how we can be consistent in regulating data on a national and international level, what the challenges and opportunities are and how we can protect the most vulnerable.

ETHICS, CULTURE, ACCESS AND EXPECTATIONS

Chaired by Neo Mapitse, Head of Department at World Organisation for Animal Health (OIE). Lastly, in this round table discussion we covered how we can shape international relationships that enable ethical and culturally sound access to data. We also discussed how we can address the legal challenges of data access and how we can identify the need for healthcare data.

Building on the momentum of this event, we will be publishing a white paper co-authored by the panellists and session chairs.

This event was a collaborative effort by our Global Delivery Group, the UCL IRDR Centre for Digital Public Health in Emergencies and the Institute for Global Health – with special thanks to Prof Patty Kostkova for all the work she put into making this possible.

7

TRANSLATION & INDUSTRY

UCL CENTRE FOR DIGITAL INNOVATION

UCL is joining forces with Amazon Web Services (AWS) to launch the UCL Centre for Digital Innovation (CDI), powered by AWS. The centre will help healthcare and education organisations to accelerate digital innovation and address global issues in the sectors.

The UCL CDI, powered by AWS, has sent out its first call for engagement via the Impact Accelerator, a programme offered by UCL and AWS which aims to boost startups by providing advice, education and funding initiatives. The call is open to all healthcare and education organisations, as well as research teams, startups and UCL's technology spinouts.

Projects should look to solve a global issue in health or education using cloud computing and have a real user and customer in mind. For example, a project focused on precision medicine which uses cloud computing to analyse and derive insights from data to generate patient prognostics, or a project which uses technology to reinvent the evaluation and marking process in education.

The UCL CDI will give successful applicants access to training, education and technical support, including access to a resident AWS Solutions Architect, domain experts in health tech and ed tech, and immersion days on specialist topics.

The team will help successful applicants to build a product prototype or help to design it for scalability if one already exists. AWS will also provide AWS Credits of up to \$500,000 (around £370,000) per year to help fund the development of the prototypes and new solutions.

The sectors were chosen because UCL's research excellence in healthcare and education means the UCL CDI stands to have real impact in these areas.

UCL CDI Director Graça Carvalho (UCL Faculty of Engineering Sciences) said:

This ambitious collaboration brings together the strength of UCL and AWS to build trust within digital innovation, allowing hospitals, universities, patients, students, research teams and UCL spinouts to use cloud-based technology to compete on a global stage.

UCL will benefit from AWS' 'working backwards' innovation methodology and the world's most comprehensive and broadly adopted cloud offering, and we, in turn, hope to support AWS through our strong evidence base that demonstrates the importance of digital innovation within the health and education sectors to increase efficiencies and offer truly personalised intelligent products and services.

The centre will be hosted at IDEALondon in Shoreditch, a UCL technology hub and innovation centre that supports startups with space, advice and access to funding and talent.

John Davies, Director, Regional Government, UK, Worldwide Public Sector at AWS said:

We are delighted to collaborate with UCL to launch the UCL CDI, powered by AWS. We have a long history of working with start-ups and university spinouts in healthcare and education who choose to use AWS because we help them build virtually anything they can imagine at every stage of their journey, and they trust us to innovate quickly on their behalf. By bringing together UCL's world renowned academic rigour with AWS' cloud technologies and culture of innovation, we hope to provide healthcare and education organisations with a springboard to help them to address some of the toughest challenges facing society right now.

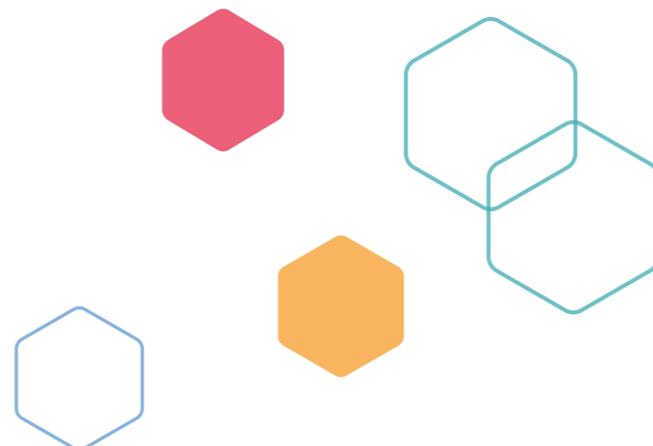
UCL's reputation in research excellence was a key driver behind the collaboration. The university will draw on expertise from several faculties including Medical Sciences, IOE, Engineering and Life Sciences, and experts from UCLH.

As part of the collaboration, UCL will also open a call for PhD studentships for the academic year beginning in September 2022. These can be focused on four main research topics –innovation, healthcare, education and innovative infrastructures. The studentships will be supported by a donation from AWS, and UCL will nominate an academic committee that will award the studentships.

“ Innovative digital solutions to the world's problems are best created in collaboration between academic and commercial organisations. The UCL CDI, powered by AWS, combines the best of both domains.

We believe that this combined endeavour will lead us to solutions that are evidence based, commercially sustainable and focus on the needs of the world's citizens. ”

UCL Pro-Vice-Provost (AI), Professor Geraint Rees



8 OUR TEAM

IHE MEMBERS



Prof Marianna Obrist



Prof Rebecca Shipley



Prof Geoff Parker

UCL Engineering

Main Entrance



Giada Brianza



Alice Hardy



Ferdouse Akhter

IHE DIRECTORATE

Professor Rebecca Shipley	IHE Director, Professor of Healthcare Engineering in UCL Mechanical Engineering
Professor Geoff Parker	Professor IHE Deputy-Director (Translation), Professor of Healthcare Engineering, Imaging and Enterprise in UCL Medical Physics and Biomedical Engineering
Professor Marianna Obrist	IHE Deputy-Director (Digital), Professor of Multisensory Interfaces in UCL Computer Science
<i>Vacant</i>	IHE Deputy Director (Clinical)

IHE CORE TEAM

Giada Brianza	R&D Coordinator
Ferdouse Akhter	Marketing & Community Manager
Alice Hardy	Communications & Impact Manager
<i>Vacant</i>	R&D Manager

OUR MANAGEMENT BOARD

Dr Billy Dennis	Co-chair, Education Delivery Group	UCL Medical Physics and Biomedical Engineering
Dr Pilar Garcia Souto	Co-chair, Education Delivery Group	UCL Medical Physics and Biomedical Engineering
Professor Vivek Dua	Co-chair, Careers Delivery Group	UCL Chemical Engineering
Dr Martyna Michalska	Co-chair, Careers Delivery Group	UCL Mechanical Engineering
Dr Rupy Matharu	Co-chair, Engagement Delivery Group	UCL Civil, Environmental and Geomatic Engineering
Dr Vassilis Georgiadis	Co-chair, Translation & Industry Delivery Group	UCL Innovation & Enterprise
Mr Liam McCafferty	Co-chair Research Infrastructure Delivery Group	UCL Innovation & Enterprise
Professor Patty Kostkova	Co-chair, Global Delivery Group	UCL IRDR Centre for Digital Public Health in Emergencies
Professor Ifat Yasin	Co-chair, Global Delivery Group	UCL Computer Science

OUR MANAGEMENT STRUCTURE

The UCL Institute of Healthcare Engineering consists of:

- The directorate team
- The core professional services team
- Six themed delivery groups, made up of members from across UCL:
 - Careers
 - Education
 - Engagement
 - Global
 - Research Infrastructure
 - Translation and Industry
- A management board made up of delivery group chairs, the directorate and the core team

OUR WORKING CULTURE

We have a working culture of respect, openness and inclusivity. Our community draws its strength from its diversity of backgrounds, disciplines, career-stages and experiences.

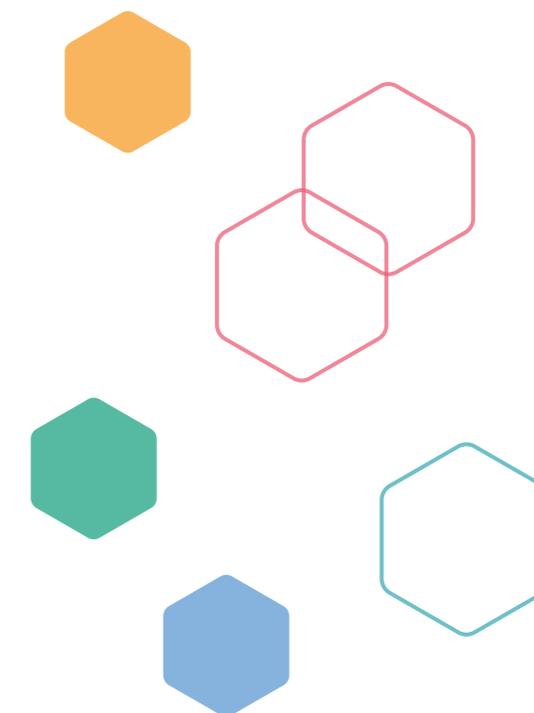
Interdisciplinarity is at the heart of what we do, and our work involves the collaboration of different groups at a local and international level. We strive to create a culture where community members listen to and respect each other's point of view; these principles have been integral to the successful partnerships we have formed.

WORKING WITH US

If you are a UCL academic or professional services staff member, our team is always happy to chat and see how we can support you. Although based in the Faculty of Engineering, our Institute remit cuts across all UCL faculties and departments where technology is being used to meet health needs.

If you are a business, not-for-profit or external research organisation, collaborations with external partners help us push the boundaries of our thinking and we would love to hear from you.

We also know that great research needs a variety of perspectives, and innovation can come from anywhere. Many of our events and initiatives are open to the public, so please keep an eye on our website and newsletter for opportunities to meet us.



PROFESSOR TIM BAKER AWARDED HONORARY FELLOWSHIP BY THE INSTITUTION OF ENGINEERING DESIGNERS

We are pleased to announce that Professor Tim Baker (UCL Mechanical Engineering) has been awarded an Honorary Fellowship by the Institution of Engineering Designers.

The Institution of Engineering Designers (IED) is the UK's only professional body representing those working in engineering and technological product design.

The Honorary Fellowship is the highest honour the institution can bestow and has been made in recognition of Tim's work on the UCL Ventura device – a non-invasive breathing aid that has already helped thousands across the world in the fight against COVID-19. The UCL Ventura is a continuous positive airway pressure (CPAP) device which supports COVID patients to breathe more easily, helping them to recover without the need for more invasive mechanical ventilation.

The UCL Ventura device has helped patients in 29 countries, including Pakistan, Peru and Uganda. The free manufacturing designs have been downloaded more than 2000 times across 105 countries – allowing local teams to produce the devices themselves to support their countries' health infrastructure. More than 24,000 devices have been made around the world.

On receiving this honour, Tim said;

I've been fortunate in my career to always do what I have found interesting. I often wonder how I have got to where I am, because it was never part of a master plan. I believe the secret is to find what inspires you, and then give it your all.

This ethos has led to incredible opportunities and working with amazing people. The UCL Ventura project, which I co-led with Rebecca Shipley, is a great example of what can be achieved when you gather like-minded people together. I have learned so much in return and it has challenged me more than anything I have done.

SPOTLIGHT ON NOORA ALMARRI

Noora Almarri: designing a battery-less power management circuit for medical devices.

Noora is a PhD student at the Electronic and Engineering Department. She's working on designing a battery-less power management circuit for medical devices. We asked Noora to speak to us about this ground-breaking work, what it means to start a PhD and be UCL's Research Officer, supporting other Research students.

Tell us a bit more about the battery-less implantable devices? Why is this so significant for a medical implant?

You might not have heard of the term 'implantable medical devices' but you would have heard of pacemakers, defibrillators, and deep brain stimulators. Implantable medical devices can monitor, communicate, diagnose, and treat various medical conditions but they're powered by batteries which have a finite capacity and their bulky volume hinder long term use and comfortable deployment.

Another problem is how big these batteries are. They can no longer keep up with the miniaturisation trends in integrated electronics, therefore, battery-less implants that are powered through external or internal sources are steps toward the future of personalized medicine.

What clinical areas could it be applied to?

One way to think of our bodies is like a big circuit with the nerves being wires to different organs in the body and the brain being the microprocessor. When the signals are transmitted properly to the organs, the body is healthy. When there is an interruption or changes in the signals this can cause further health issues. And so, monitoring the body is important. Battery-less implants can be used for all clinical areas including cardiovascular, neurology, Gastrointestinal, and much more. They also allow further testing of different rehabilitation approaches and help decrease invasiveness of devices.

What potential impact will this have on patients?

A possible application of this can be seen in Motor Neurone Disease.

Motor neurone disease (MND) destroys the motor neurons that can control the skeletal muscle activities leading to shortening of life expectancy. There is currently no cure for motor neurone disease and so stem cell derived motor neurons are put close to the targeted muscles to ensure muscle reinnervation before paralysis becomes irreversible. Recent studies have shown paralyzed muscles were innervated with stem cell motor neurons genetically modified with light sensitive ion channels can be optically stimulated to regain movement.

Therefore, the combination of integrated electronics, optogenetics and stem cell technologies can help in treating motor neurone disease. The electronics are in an Application Specific Integrated Circuit (ASIC) consisting of both a power management unit and optical and electrical stimulation, and monitoring sensors.



The system that our group is working on is miniaturized for in vivo animal studies to ensure successful clinical translation of the therapeutically strategy of using light to reverse paralysis. My focus is designing battery less power management circuit to allow miniaturization to make the device less invasive and have a longer life time.

What's the next step in terms of your research and the device?

Our group is working on various implants and wearable medical devices and power management is a crucial block in every system to increase life time. In fact, power management is important in all electronic devices to control the amount of electricity extracted, used, and provide different levels of power as needed. Through my PhD, I got the chance to worked with various researchers in the field on collaborative work and exciting projects. I also got to present my research in the global scientist youth summit by the National Research Foundation Singapore.

You're also the Research Students Officer - how is to juggle both a PhD and part-time student officer role?

I believe that there is always time to do more if you organize your time and spend it on things that you enjoy. Through this role I learnt extensive policy writing and leadership skills that are beneficial for widening my career options - I proposed different policies and programmes including a multi-layer induction programme and the PhD Penpal programme.

I will also be taking part of the League of European Research Universities (LERU) programme in the Netherlands in the first week of July. The LERU is a society of prominent European research universities that want to influence the European policy agenda in the field of research, education and innovation. The Research Students' officer position helped me integrate my knowledge and experience into policy making and giving back to UCL.



“ *Everyone starts from a different point. There are various ups and downs through the PhD journey but if you have the motivation, persistence, and determination then anything is possible.* ”

My biggest tip for people about to start a PhD is making a to do list! Writing down what you need to do and breaking tasks into smaller tasks can help you achieve your goals much quicker. ”

Noora Almarri



9 AFTERWORD

A view under de microscope of the implantable medical device Noora Almarri is designing

THANK YOU

We have done our best to acknowledge those involved throughout this report, but we know that our thanks extend far beyond those named. All our efforts are an interdisciplinary endeavour and would not be possible without the combined input of our researchers, professional staff, external partners, funders and the public.

CONTACT US

We're always interested to hear from potential collaborators, members of the public and others who are interested in our research.

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