

# Transforming healthcare through research

Imperial College London







The ROYAL MARSDEN NHS Foundation Trust ▼ Specialist Biomedical Scientist at Imperial College Healthcare NHS Trust

### Welcome from the Director

Imperial College Academic Health Science Centre (AHSC) is a strategic partnership between the researchintensive universities and NHS organisations in West London. Through collaboration and alignment of our research and education activities, we are focussed on turning our latest science and engineering advances into new ways of preventing, detecting and treating disease.

The AHSC has made great advances in improving people's health since creation in 2008 and our work and achievements have been recognised by NHS England and the National Institute for Health and Care Research (NIHR) with a further five years of AHSC designation for the period 2020-2025.

Our partners have a strong record of excellence in medical research, clinical care and education. Imperial College London and The Institute of Cancer Research, London, were rated first and second for their world-leading research by the 2021 Research Excellence Framework – the Government's evaluation of university research quality, impact and environment.

Our experimental medicine capability is supported with NIHR Biomedical Research Centre funding to Imperial College Healthcare NHS Trust and The Royal Marsden NHS Foundation Trust. NIHR Biomedical Research Centres are partnerships between world leading universities and NHS organisations, turning discoveries into medical improvements. In 2022, both partners successfully renewed their five-year programmes with NIHR.

Chelsea and Westminster Hospital NHS Foundation Trust hosts the North West London NIHR Applied Research Collaborative, in partnership with Imperial College London, which aims to respond to and meet the needs of the local populations, local health and social care systems and accelerate the implementation of research into policy and practice.

Together, the partners have access to a comprehensive research infrastructure, which can take scientific discoveries from the laboratory into the clinic and wider outcomes benefitting the people in North West London and globally.

### Navigating challenges

The year 2020 brought challenging and worrying times on a global scale with the COVID-19 pandemic affecting populations, healthcare systems and governments. The AHSC played a pivotal role in responding to the pandemic, bringing together our exceptional academic and clinical abilities to respond rapidly, rigorously and robustly. Our work has had impacts locally, nationally and globally.

For example, AHSC researchers from Imperial's School of Public Health informed national and international governments' responses to the pandemic and lifting of lockdown restrictions. We developed a new rapid COVID-19 test for use in hospitals and we led clinical trials evaluating COVID treatments, which transformed outcomes for the most critically ill patients. We also led a nationwide surveillance programme to track the prevalence of COVID-19 in the community - the REACT study.

These are just a few of the extraordinary examples that highlight the incredible efforts of our staff and what partnership working can achieve in the most testing of circumstances.

population. This results in better health

### Looking ahead

Although we had to focus on responding to the pandemic, we are making good progress to achieve our 2020-2025 vision and objectives. In this brochure, we highlight some of our achievements over the last couple of years.

There are still challenges ahead, with more work to be done to address some of the pressing issues in health research and care.

We are strengthening our linkages with the North West London Integrated Care System (ICS), whose 2.4 million residents, over eight boroughs, represent one of the most ethnically rich and socio-economically diverse populations in the country.

In partnership, we can support the ICS' priorities in health inequalities, unwarranted variations in care and disease prevention whilst also pushing forward the boundaries of clinical care and improving current best practice through research into disease diagnosis and treatment.

As Director, I look forward to further advancing our plans and work in translational medicine. We want to create a global legacy of long-lasting research and medical breakthroughs that improve the health and wellbeing of the communities we serve.

### **Professor Jonathan Weber Director of Imperial College Academic Health Science Centre**

### **The Partners**

Imperial College Academic Health **Science Centre is a partnership** between Imperial College London, The Institute of Cancer Research (ICR), Imperial College Healthcare NHS Trust, The Royal Marsden **NHS Foundation Trust and Chelsea** and Westminster Hospital NHS Foundation Trust.

### The Institute of Cancer Research

The Institute of Cancer Research, London (ICR), is one of the world's most influential cancer research organisations. Its mission is to make the discoveries that defeat cancer.

A member institution of the University of London, the ICR is one of the UK's leading higher education institutions, placed first for biological sciences and second overall in the definitive REF 2021 rankings of UK university research quality, impact and environment, and provides postgraduate higher education of international distinction.

The ICR has an outstanding record of achievement dating back more than 100 years. It is a world leader at identifying cancer-related genes and discovering new drugs for personalised cancer treatment. Through its unique partnership with The Royal Marsden NHS Foundation Trust and 'bench-tobedside' approach, it is in the top four centres for cancer research and treatment globally.

### Imperial College Healthcare **NHS Trust**

Imperial College Healthcare NHS Trust is one of the largest NHS Trusts in England, with over 14,500 staff providing acute and specialist health care to over one million people each year. The Trust has five hospitals -Charing Cross, Hammersmith, Queen Charlotte's & Chelsea, St Mary's, and The Western Eye – and a long track record in research and education, influencing care and treatment nationally and worldwide.

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### The Royal Marsden NHS **Foundation Trust**

The Royal Marsden opened its doors in 1851 as the world's first hospital dedicated to cancer. It has an international reputation for groundbreaking research and pioneering the very latest in cancer treatments and technologies.

Together with its academic partner, the ICR, it is the largest and most comprehensive cancer centre in Europe treating over 60,000 NHS and private patients every year. The partnership also hosts the only National Institute for Health and Care Research Biomedical Research Centre solely focused on cancer.

### **Chelsea and Westminster Hospital NHS Foundation Trust**

Chelsea and Westminster Hospital NHS Foundation Trust is one of the top performing hospital Trusts in the UK. In addition to Chelsea and Westminster Hospital and West Middlesex University Hospital, it provides HIV and sexual health services in the community; including the award-winning 56 Dean Street and 10 Hammersmith Broadway.

It hosts the National Institute for Health Research Northwest London Applied Research Collaboration in partnership with Imperial College London.

CW Innovation, a joint venture with the Trust and hospital charity, CW+, supports the Trust's portfolio of innovation projects; such as: • The Klick mobile app allows patients with stable HIV to manage their condition remotely and communicate with their healthcare

- team from home. • The DBm-Health app enables
- patients with diabetes to remotely contact with them.

monitor blood glucose levels while allowing clinicians to stay in regular



### **Imperial College London**

Imperial College London is a sciencebased university. Consistently rated amongst the world's best universities, Imperial is committed to ensuring excellence in research and education in its core academic disciplines of science, engineering, medicine and business.

The AHSC encompasses the Imperial College Faculties – in Medicine, Natural Sciences, Engineering and the Business School.

The Faculty of Medicine is one of Europe's largest medical research and teaching institutions, with 477 academic staff (FTEs) and 5,157 undergraduate and postgraduate students (2021/22). It is ranked third in Europe and fourth in the world in clinical and health subjects (Times Higher Education World University Rankings by subject 2023).





The purpose of Imperial College AHSC is to align the research, education and clinical care missions of the university and NHS partners and accelerate the translation of research into better patient outcomes and population health.

▼ A research nurse takes a patient's blood pressure at the Clinical Research Facility

The AHSC's vision is to reduce the burden of disease and improve human health by:

- Preventing disease wherever possible,
- Where ill health cannot be prevented, detecting it earlier, and
- For all diagnosed disease, developing better disease treatments.

The AHSC forward strategy unites common priorities in the partner institutions and aligns with local and national health goals.

### **Strategic objectives**

### To deliver on its vision, 2020–2025 AHSC objectives are to:

- Champion a multidisciplinary ('convergence') science approach to health improvement uniquely enabled by Imperial College London's world class expertise in physics, chemistry, engineering, maths, computing and business
- Develop new programmes in disease prevention, taking advantage of the world class expertise at Imperial's School of Public Health, one of the largest academic public health departments in the world and ranked first in the 2021 REF
- Become the leading centre for research using routinely collected health data from NHS patient records and other databases
- community and workforce in tomorrow's healthcare
- care by capitalising on local clinical initiatives • Support economic growth
- at our Life Sciences Campuses at White City and Sutton

PHILIPS

• Educate and involve our local • Deliver innovation in integrated

### We have six priority disease areas where the AHSC has academic critical mass and clinical expertise:

- Cancer
- Cardiovascular disease
- Infection & antimicrobial resistance
- Lung disease
- Metabolic disease
- Brain disease and mental health



## Infection/antimicrobial resistance

Infectious diseases are the world's greatest killers, accounting for more than 13 million deaths.

The complex challenges posed by infections and the diseases they cause, such as flu, tuberculosis and hepatitis, require creative approaches and collaboration.

Through Imperial College London's Institute of Infection, one of the largest academic groupings of infectious disease researchers in Europe, the AHSC is able to deliver new interdisciplinary approaches to bacterial, fungal, parasitic and viral disease that can then be trialled and evaluated at our NHS partners' hospitals.

Alongside this, Antimicrobial Resistance (AMR) is also a huge global health concern with growing

numbers of infections – such as tuberculosis, sepsis and those acquired in healthcare settings – becoming harder to treat. The AHSC is at the forefront of responding to the increasing threat of AMR through a range of activities.

The College's Centre for Antimicrobial Optimisation (CAMO) is an example of this. It supports and delivers innovative technologies to optimise the use of antibiotics, antifungals and antivirals to improve patient care and reduce the drivers of drug-resistant infections. The Centre brings together a range of expertise from across the College and NHS partners, to support and deliver research to improve infection management.

The following pages highlight several recent examples of our work in this area.

# Landmark human challenge study charting the course of COVID-19 symptoms and infection

### Imperial College London was the leading academic partner in the world's first human challenge study to infect healthy volunteers with COVID-19.

This approach has the advantage of being able to study the full course of COVID-19 infection in a controlled, experimental setting. The study found that the period between infection and first symptoms is much shorter than was previously thought, that virus loads are particularly high in the nose, and that the virus can remain for a considerable time in the body – supporting the need for proper mask wearing and for isolation periods.

Thirty-six healthy male and female volunteers received a low dose of virus and were carefully monitored by clinical staff over a two-week period. Eighteen of the volunteers became infected and 16 went on to develop mild-to-moderate symptoms. The average time from first exposure to the virus to viral detection and early symptoms (incubation period) was 42 hours, significantly shorter than existing estimates.

The levels of infectious virus usually peaked at around five days, although high levels were still detected in laboratory tests up to 12 days after inoculation.

The researchers also found that although the virus was first detected in patients' throats, the highest levels were found in the nose. In addition, they established that lateral flow tests are a reliable indicator of a person's viral status.

This study was a partnership between Imperial College London, the Vaccine Taskforce and Department of Health and Social Care (DHSC), hVIVO (part of Open Orphan plc.), and the Royal Free London NHS Foundation Trust.



Future studies will see the team, led by Professor Christopher Chiu from the Department of Infectious Disease at Imperial College London, in new facilities at Chelsea and Westminster Hospital NHS Foundation Trust, determine why some people become infected and others do not. Work is also underway to develop a challenge virus using the SARS-CoV-2 Delta variant, which could be used in follow-on trials, funded by the Wellcome Trust.

 Professor Christopher Chiu administers the COVID-19 virus by drops in the nose



# Bacterial balance may be linked to the risk of miscarriage

A mother's risk of miscarriage may be affected by the bacteria in her vaginal microbiome, according to a study by AHSC researchers.

Around half of miscarriages are the result of chromosomal abnormalities in the embryo, but little is known about other causes. One potential factor could be changes to the bacterial environment (or microbiome) in a mother's birth canal or vagina.

The study, led by Imperial College London and Imperial College Healthcare NHS Trust, included 167 pregnant women who had previously experienced a miscarriage or threatened miscarriage. In total, 93 women experienced a miscarriage during the study, of whom 54 had no chromosomal abnormalities in the embryo. The researchers examined the vaginal bacteria present in all these women, as well as looking for molecular signs of inflammation.

In general, a healthy vaginal microbiome is rich in acid-producing *Lactobacilli*, which help to prevent the growth of other potentially harmful bacteria. The researchers found that compared to the women whose miscarriages were linked to chromosomal abnormalities, the women experiencing chromosomally 'normal' miscarriages had a reduced number of *Lactobacilli*. In the women who had bacteria such as *Prevotella* and *Streptococcus* instead of *Lactobacilli*, the researchers found high levels of inflammation.

The researchers say that their findings suggest a potentially treatable cause for miscarriage, but more research is needed to confirm the association first.

Based on this research, the researchers are also working on a new test which helps identify women who could benefit from treatment to reduce the risk of miscarriage.

The study was led by Professors Phillip Bennett and David MacIntyre and Dr Karen Grewal. The study was supported by the NIHR Imperial BRC.

# Digital sepsis alert system saves lives and improves care

Sepsis, also known as blood poisoning, is life threatening and accounts for an estimated 48,000 deaths in the UK each year. If diagnosed early it can be treated effectively with antibiotics, but the difficulty lies in spotting sepsis before it develops, as symptoms are similar to other illnesses such as flu.

In 2016 a digital sepsis alert system was introduced at Imperial College Healthcare NHS Trust. The system monitors a range of changes in patients such as temperature, heart rate and glucose levels and automatically alerts doctors and nurses if they fall outside safe parameters so that they can be investigated further. In addition to the alert, the team at Imperial College Healthcare NHS Trust designed and implemented a digitally activated multidisciplinary care plan, supporting the clinical team to determine the best treatment options.

Researchers at Imperial College London then carried out an evaluation of the system and demonstrated that it improved patient outcomes; with fewer deaths, shorter hospital stays and more prompt administration of antibiotics. This was the first evaluation of a digital sepsis alert system in a British hospital trust and the largest undertaken anywhere to date. It was funded by the NIHR Imperial BRC. The research team led by Dr Céire Costelloe, Professor of Health Informatics at the ICR, are now assessing the effectiveness of the digital alert system across six UK NHS trusts, including Chelsea and Westminster Hospital NHS Foundation Trust.

## Cancer

Half of the UK population is expected to be diagnosed with cancer during their lifetime. It is also a critical area of focus for the AHSC.

The partnership draws on the strengths of The Royal Marsden NHS Foundation Trust, a specialist cancer centre renowned for its research and clinical care, the academic excellence at The Institute of Cancer Research (ICR) and Imperial College London and comprehensive cancer services for the local North West London population provided by the other AHSC NHS partners.

Underpinned by the AHSC's objectives to transform healthcare using new interdisciplinary approaches, Cancer Research UK has funded a joint centre between ICR and Imperial, the Cancer Research UK Convergence Science Centre. Its vision is to develop innovative ways to address challenges in cancer research to benefit patients. Directed by Professor Axel Behrens, it synergises the ICR's and Imperial's complementary strengths in cancer and interdisciplinary research by bringing together a critical mass of physicists, engineers, computer scientists, chemists, biologists and clinicians. The aim is to stimulate innovative, interdisciplinary collaborations to co-create new cancer tools, technologies and methodologies for the detection and treatment of cancer. Another AHSC initiative has been in cancer prevention. Although understanding of the causes of cancer, and particularly modifiable risk factors, has progressed substantially, the underlying cause for around 30–40 per cent of all cancers is still unknown.

In 2020, the ICR and Imperial College London launched the Cancer Epidemiology and Prevention Research Unit (CEPRU) to respond to this challenge. CEPRU aims to address unmet challenges in cancer prevention research that will benefit patients.

With new international academic appointments in 2022, CEPRU will be one of the largest national groupings working in cancer prevention; building on epidemiological, statistical and population health expertise at Imperial's School of Public Health and the ICR's expertise in cancer epidemiology (especially in breast cancer), cancer biology and genetics, and its expert oncologists.

The examples over the next few pages highlight some of our most exciting, recent work that has significant potential to advance patient care.



# Switching the order of breast cancer treatments may lead to better care

Changing the order of treatments given to breast cancer patients could reduce side effects and improve outcomes, according to an AHSC study.

Breast cancer cells

Many breast cancer patients who need a mastectomy – an operation to remove a breast or breasts to treat cancer – will also desire a reconstruction and require radiotherapy. Internationally, many hospitals will offer patients a mastectomy first followed by radiotherapy and then reconstructionn at a later date, meaning many women will have to wait for a reconstruction, which can often be delayed by many years. Some women will not receive delayed reconstruction at all.

Other hospitals decide to proceed with reconstruction at the time of mastectomy and then give radiotherapy to the chest wall (including to the reconstruction itself). However, this pathway can lead to complications such as damage to healthy tissues used for the reconstruction – including shrinkage, firmness and loss of symmetry. In a clinical feasibility trial, AHSC researchers found that switching the sequence of treatments given to breast cancer patients was safe, without any increase in complications and could lead to patients receiving faster and more effective care compared to current methods.

Thirty-three women with breast cancer requiring a mastectomy and postmastectomy radiotherapy were recruited to the primary radiotherapy and deep inferior epigastric perforator flap reconstruction for patients with breast cancer (PRADA) trial between January 2016 and December 2017. They were also eligible for a breast reconstruction using tissue from another part of their body.

The women were given chemotherapy followed by radiotherapy before having a mastectomy and breast reconstruction. The team found that this approach was feasible and safe. They also found that side effects were low and that 12 months after surgery patients reported high levels of satisfaction with their breast reconstruction.



The study was led by researchers at Imperial College London and clinicians at The Royal Marsden NHS Foundation Trust and Imperial College Healthcare NHS Trust.

The team led by Dr Daniel Leff, Reader in Breast Surgery in the Department of Surgery & Cancer and Honorary Consultant in Oncoplastic Breast Surgery at Imperial College Healthcare NHS Trust, and Paul Thiruchelvam, Honorary Clinical Senior Lecturer in Breast Surgery at Imperial College London and a Consultant Surgeon at Imperial College Healthcare NHS Trust, will look into a further and larger trial – PRADA 2 – to urgently confirm the benefits of their treatment approach on quality of life, long-term cancer outcomes and timelines for treatment plans.

The study was funded by the NIHR Imperial BRC and the Cancer Research UK Imperial Centre.

### New scan for prostate cancer could help relieve pressures on NHS

A new type of ultrasound scan provides a cheap, accessible test for the most common cancer affecting men, researchers at Imperial College London, Imperial College Healthcare NHS Trust and University College London found.

One in six men will be diagnosed with prostate cancer in their lifetimes and that figure is expected to rise. Magnetic resonance imaging (MRI) scanning is one of the tests used to diagnose the condition. Although effective, MRI scans are expensive, take up to 40 minutes to perform and are not easily available to everyone.

The new test uses a different kind of imaging called multiparametric ultrasound (mpUSS), which uses soundwaves. The doctor conducting the test also uses specialised types of ultrasound imaging, which analyse the stiffness of the tissue and the blood supply to it. Cancer cells are more dense and have greater blood supply than other cells, so they are identifiable on the ultrasound scan.

In the study, this ultrasound test successfully identified almost all cases of prostate cancer that needed treatment.

The team, led by Professor Hashim Ahmed, Chair of Urology at Imperial College London and Consultant Urological Surgeon at Imperial College Healthcare NHS Trust, believes that ultrasound should be used as a first choice in a community healthcare setting, and used in combination with MRI scans to maximise cancer detection. The study was carried out in collaboration with University College London.

▼ Prostate ultrasound scan



### New MRI tool can identify hard-to-diagnose ovarian cancers

Researchers at Imperial College London have developed a new imaging tool that can identify cases of ovarian cancer, which are difficult to diagnose using standard methods.

At the moment, doctors use a combination of ultrasound scanning and blood tests to analyse ovarian cysts. However, in a quarter of cases this method cannot identify with confidence whether a cyst is benign or malignant. As a result, these patients have to undergo surgery, which carries risks (including potential fertility loss) and is not advisable in the small number of cases that do turn out to be malignant.

The new tool is called Ovarian-Adnexal Reporting Data System Magnetic Resonance Imaging (O-RADS MRI). In the study led by Professor Andrea Rockall, Chair of Radiology at Imperial College London and Consultant Radiologist at Imperial College Healthcare NHS Trust and at The Royal Marsden Hospital, researchers developed a 'risk stratification score' for reading magnetic resonance imaging (MRI) scans. A score of one to three was identified as 'no mass' or benign, and a score between four and five was deemed 'high risk'. Each patient was given a pelvic MRI examination, which looked for particular features that an ultrasound examination could not detect (such as changes to tissue structure) and

radiographers 'scored' each cyst using the O-RADS MRI tool.

The team found that the system outperformed current methods and was 90 per cent accurate at identifying malignant and benign cysts.

The team believes that the new tool can be used as a triage test to decide whether patients need further follow up or treatment. They also believe that the tool could help stratify patients who are high-risk enabling treatment at a much earlier stage.

The research was funded by the Societé d'Imagerie de la Femme and supported by the NIHR Imperial BRC and the Cancer Research UK Imperial Centre.

**3D MODEL** 

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## Cardiovascular disease

Heart and circulatory diseases affect millions of people in the UK. Some of these conditions are a result of inherited risk factors, others are determined by lifestyle and behaviours, and many are influenced by an interplay of both genetics and the environment.

The AHSC draws on the strengths of the scientific community at Imperial, through the National Heart and Lung Institute, the School of Public Health, and the faculties of Natural Sciences and Engineering, to understand the causes and biological processes involved in cardiovascular diseases and then to develop new diagnostic tools and treatments.

The AHSC hosts a British Heart Foundation (BHF) Centre of Excellence and, through the NIHR Health Informatics Collaborative, has pioneered the use of routine cardiovascular data held by the NHS to gain new disease insights.

On the next pages are a few examples of recent projects with encouraging results to improve patient care in the UK and worldwide.







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▲ Developing next-generation cardiovascular imaging techniques for improved diagnosis



### Al in the doctor's surgery: diagnosing heart failure

### Artificial intelligence (AI) can now help identify heart failure at the GP surgery, thanks to researchers at the National Heart and Lung Institute and Imperial College London's Centre for Cardiac Engineering.

Although heart failure is on the rise, and carries a higher risk of death than most cancers, it is usually only reliably diagnosed through a series of expensive and invasive procedures in hospital. However, a study led by Professor Nicholas Peters, Head of Cardiac Electrophysiology at Imperial College London, has found that using AI in combination with a commercially available 'smart stethoscope' can provide a reliable test.

The *smart stethoscope* records the heart's electrical signals as well as the sounds it makes. The researchers combined this with an AI algorithm that makes it possible to determine, within 15 seconds, whether the heart's pumping action is weakened. They found that this was almost as effective at diagnosing heart failure as the hospital tests.

Professor Peters describes the new tool as a 'gamechanger', because GPs will be able to use it as part of their regular work when patients come in with symptoms such as breathlessness.

# Blood test could save lives of thousands of heart attack patients

Adding one simple blood test after a suspected heart attack can help identify those patients who need urgent care, researchers at the National Heart and Lung Institute, Imperial College London, in collaboration with the NIHR Health Informatics Collaborative, have found.

Currently, doctors test for the protein troponin, which is released into the bloodstream when the heart is damaged. The new research showed that a rise in levels of high sensitivity C-reactive protein (CRP) – a sign of inflammation – also indicates that a patient is at higher risk of death in the three years following the heart attack.

The blood test – already used in hospitals to diagnose other conditions – could be used to streamline how patients are treated following a suspected heart attack. Those identified as being at high risk of death could be given more aggressive treatment and monitored more closely, while those identified as low risk could be given reassurance and sent home.

The study was led by Dr Ramzi Khamis, Consultant Cardiologist at Imperial College Healthcare NHS Trust and Reader in Cardiology at Imperial College London. He and his colleagues are particularly interested in the antiinflammatory drug colchicine, which has already proved effective in combating the build-up of fatty deposits in the arteries.

The work, funded by the BHF and the NIHR Imperial BRC, was the largest study of its kind.



### Machine learning to help doctors treat patients with heart disease

In a development that could transform the way that doctors treat heart patients, computers are being used to interpret heart scans to improve treatment plans and make a better prediction of how long a patient will live.

Machine learning is already helping research into cancer and brain diseases, but analysing moving images of the heart has been more challenging.

The study, from the Institute of Clinical Sciences at Imperial College London, is the first to use the approach in heart disease. The technology has been tested on patients with pulmonary hypertension, a condition that can lead to heart failure. Patients with this condition are identified as 'high' or 'lower' risk in order to determine the most appropriate treatment. Until now, the only way to identify a patient's risk level has been through taking measurements of heart function by hand – and the results are not always accurate.

Using historical data from 250 patients at Imperial College Healthcare NHS Trust's Hammersmith Hospital, the AHSC researchers developed software to analyse moving MRI images of each patient's heart to replicate the way over 30000 points in the heart contract during each beat. With this information, they created a 'virtual  Computer software creates a 3D virtual heart from MRI scans then learns to predict how long a patient might live

3D heart' of each individual and used machine learning techniques to automatically learn which features were the earliest predictors of heart failure and death.

The team, led by Professor Declan O'Regan, also an Investigator at the MRC London Institute of Medical Science and Director for Imaging Research at Imperial College Healthcare NHS Trust, now plan to test the software on patient data from a different hospital to verify the findings. The ultimate goal is to develop software to make predictions not only about survival, but also about which type of treatment will work best in each patient.



### Rehab device can help recover arm function after serious stroke

### A new rehabilitation device can help people with severely damaged arm function due to stroke to do more physical training, through playing specialised computer games.

Over five million people in the UK live with arm weakness, as the result of stroke (which accounts for one million); arthritis, other musculoskeletal disorders; or brain damage. The only intervention shown to improve arm function is repetitive, task-specific exercise but this usually requires the support of occupational therapists or physiotherapists. The GripAble™ device, created by researchers at Imperial College London and clinicians at Imperial College Healthcare NHS Trust, consists of a lightweight electronic handgrip that interacts wirelessly with a standard tablet computer to enable the user to play arm-training games in their own home.

In a clinical trial of 30 patients, researchers found that the device enabled on average 104 upper limbs (UL) repetitions per day whereas conventional therapy achieved 15 UL repetitions per day.

## Brain disease and mental health

The AHSC brings together scientists and clinicians with a common interest in reducing the impact of brain disorders. Our main focus is on dementia, Parkinson's disease, multiple sclerosis, traumatic brain injury and stroke. The AHSC is also tackling mental health issues in children and young people, which can often continue into adulthood and is an emerging public health priority.

Through the NIHR Imperial BRC, multidisciplinary teams of engineers, biologists and clinicians are discovering disease mechanisms and risk factors that could be translated into new diagnostic tools and therapies for these conditions.

The partnership is part of UK Dementia Research Institute. It also hosts the UK Dementia Research Institute Care Research & Technology Centre which is focussed on transforming dementia care through the use of new technology. Researchers will harness advances in artificial intelligence, engineering, robotics and sleep technologies to create new innovations that will deliver the highest quality of dementia care in the home. The AHSC is also focusing on improving mental health. There is now strong evidence to show that tackling mental health issues at an early stage and in the same way as physical health reduces subsequent problems, improves people's life chances and saves money for the wider economy.

The AHSC's focus in this area is through the NIHR Applied Research Collaboration (ARC) Northwest London. Led by Dr Dasha Nichols, Clinical Reader in Child and Adolescent Psychiatry at Imperial College London, the ARC is developing tools, using routinely collected data, to identify high-risk individuals and populations at which a range of proven treatment options can be targeted. Researchers will work with schools and assess the impact of interventions such as digital tools on equitable health outcomes in children and young people.

The following examples give an overview of the AHSC's work in these areas.



The study was led by Michelle Broderick, occupational therapist and PhD student at Imperial College London. The study was funded by the NIHR Imperial BRC.

The team is now completing a further study to assess the impact of *GripAble* on clinical outcomes. This is a multicentre study, which runs across three NHS trusts.

▼ The GripAbleTM device



# Severe morning sickness has serious mental health implications

Severe morning sickness increases the risk of depression both during and after pregnancy, according to research by a team at Imperial College London, Imperial College Healthcare NHS Trust and Chelsea and Westminster Hospital NHS Foundation Trust.

Severe morning sickness, known as hyperemesis gravidarum, is a debilitating condition that affects around one to two per cent of pregnant women in the UK.

Far more serious than 'normal' morning sickness, it is one of the most common reasons for hospitalisation during pregnancy and can continue right up until birth. Women can be bedbound for weeks, suffer dehydration and weight loss and are often unable to work or care for other children they have. In a study led by Dr Nicola Mitchell-Jones, specialist registrar in obstetrics and gynaecology at Chelsea and Westminster Hospital NHS Foundation Trust, nearly half (49 per cent) of the women with symptoms of hyperemesis gravidarum in the first trimester of pregnancy experienced depression during pregnancy, and nearly a third (29 per cent) after their babies were born. In women without the condition, just six per cent experienced antenatal depression and seven per cent postnatal depression.

Dr Mitchell-Jones hopes that her findings can help to improve understanding of hyperemesis gravidarum and change clinical guidelines on how women with the condition are treated, to include a psychological screening and referral to specialist mental health services where required.

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### Using a single scan to diagnose Alzheimer's disease

New research from our AHSC suggests that Alzheimer's disease could be identified by a single magnetic resonance imaging (MRI) brain scan, making it possible for patients to get help and treatment much more quickly.

Currently, doctors use a raft of tests and brain scans to diagnose Alzheimer's disease.

The new approach requires just one MRI scan taken on the type of scanners commonly found in most hospitals.

By adapting an algorithm tool previously developed for classifying cancer tumours, researchers divided the brain into 115 regions and allocated 660 different features, such as size, shape and texture, to assess each region. They then trained the algorithm to identify where changes to these features could accurately predict the existence of Alzheimer's disease. In 98 per cent of cases, the MRI-based machine learning system alone could accurately predict whether the patient had Alzheimer's disease or not.

The new system also spotted changes in areas of the brain not previously associated with Alzheimer's disease. Importantly, it was also able to distinguish between early and late-stage Alzheimer's with high accuracy and to spot very early changes in the brain.

The study was led by Professor Eric Aboagye from Imperial's Department of Surgery Cancer and Dr Paresh Malhotra, who is a consultant neurologist at Imperial College Healthcare NHS Trust and a researcher in Imperial's Department of Brain Sciences. ▲ Alzheimer's disease on MRI scans



## Lung disease

Approximately 10,000 people are newly diagnosed with lung conditions each week and these are responsible for one million deaths and over six million in-patient hospital days per year.

The AHSC is the largest academic centre nationally for lung research, bringing together the National Heart and Lung Institute, the School of Public Health and Imperial College Healthcare NHS Trust.

Our programmes cover the spectrum of respiratory disorders including commonly acquired conditions such as acute respiratory infections, asthma, chronic pulmonary obstructive disease, interstitial lung disease, tuberculosis and lung cancer, as well as rarer genetic conditions such as cystic fibrosis.

Our thriving research portfolio is focused on developing new approaches to the detection and treatment of lung disease as well as targeted management strategies for chronic lung diseases, which can span the life course.

In addition to this, Imperial is the world's leading centre for the study of air pollution on health. Led by Professor Frank Kelly, who holds the inaugural Humphrey Battcock Chair in Community Health and Policy, within the School of Public Health, the centre is a focal point for air pollution research, bringing together one of the largest clusters of expertise in the field anywhere in the world.

The following examples demonstrate the impact of work to improve air quality in the UK and to treat long COVID-19 and asthma.

### **Gauging the effectiveness** of air pollution interventions

### Imperial College London and the Mayor of London have launched a new partnership to fight the capital's air pollution.

The Breathe London project, funded by the Mayor of London and supported by Bloomberg Philanthropies, monitors the quality of the air children are exposed to.

The team, led by Dr Benjamin Barratt, Deputy Director of the Environmental Research Group at Imperial College London, collaborated with the manufacturing company, Dyson, to mass produce wearable sensors attached to children's backpacks to monitor their school journeys.

The findings of the project, which enabled the school children and their parents to see how the amount of pollution they breathed spiked when they travelled on certain routes, or travelled to and from school by car rather than walked, led to children and families being able to make decisions to reduce their personal exposure to pollution.

One school reported a 54 per cent the study. Overall, thirty one per cent of children and parents changed the to a healthier alternative, such as walking to school a street away from the main road.

Ultra low

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ZONE

At all times

decrease in the number of people who drove their children to school following way they commuted to and from school

The next phase of the Breathe London project involves more than 200 low-cost sensors installed at hospitals, schools and other priority locations, giving communities access to affordable and reliable air quality data for the first time.

The project is focusing on reaching communities that research has previously shown to been less engaged with environmental programmes, including low-income and Black, Asian and Minority Ethnic groups.

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# Study shows COVID risk greater for those with poorly controlled or severe asthma

Research surveying data on more than three quarters of the population of England has confirmed that severe or poorly controlled asthma can heighten an individual's risk of severe COVID-19. People with mild or well-controlled asthma, however, are not at higher risk.

The findings underline the importance both of taking precautions against Covid – including vaccination – and of taking asthma medication appropriately. Professor Jennifer Quint, from the National Heart and Lung Institute at Imperial College London, led the study. She and her colleagues looked at anonymised information from the 2011 census of England combined with general practice data, hospital statistics and registered deaths between January 2020 and September 2021. In total, their work covered data on almost 80 per cent of adults and more than 75 per cent of 12 to 17-yearolds in England.



## Singing techniques can improve quality of life and breathlessness after COVID-19

Breathlessness is one of the most common symptoms in people with long COVID. Many factors can contribute, including damage to the lungs and supporting tissues, impact on the nervous system and other ongoing symptoms such as fatigue and cough.

As of January 2022, it is estimated that 1.5 million people in the UK may be experiencing long COVID symptoms.

The English National Opera (ENO) and respiratory clinicians at Imperial College Healthcare NHS Trust have developed an online breathing and wellbeing programme that can help to improve quality of life and breathlessness for people recovering from COVID-19.

ENO Breathe uses singing techniques to improve wellbeing for patients with persistent breathlessness due to COVID-19.

A clinical trial of 150 participants with long-lasting breathlessness after COVID-19 symptoms was conducted by researchers at Imperial College London, alongside the programme team at Imperial College Healthcare NHS Trust.

The study found that ENO Breathe participants experienced a 10.48 point

(out of 100) reduction in breathlessness while running, compared to people who continued with usual care alone. They also experienced a 2.42 point improvement in the mental component of quality of life, as measured by a validated online questionnaire.

The study was led by Dr Keir Phillip, Clinical Research Fellow at the National Heart and Lung Institute at Imperial College London, alongside Dr Harriet Owles, a respiratory doctor at Imperial College Healthcare NHS Trust. It is one of the first clinical trials to report an effective intervention for people with long COVID.

## Education

Developing staff from across the AHSC is one of our goals. We aim to help scientists, healthcare professionals and other staff from a wide variety of disciplines, professions and backgrounds come together to excel as teams within our partner organisations, regionally and nationally. We have developed a number of professional development programmes and training opportunities to enhance the offering at individual partner organisations.

This includes opportunities to support a wider range of healthcare staff such as nurses, pharmacists, allied health professionals and midwives into research through the Clinical Academic Training Office and the NHS Digital Academy, hosted at Imperial College London, which is developing a new generation of digital leaders who can drive the information and technology transformation of the NHS.

Our educational objectives include reaching out to the local community that the AHSC services. The AHSC's Seminar Series promotes the partnership's research work and impact to staff, patients and the public in North West London and beyond.

The following examples show how we are developing and delivering a wide range of professional development programmes and opportunities to support our mission.



### **Healthcare Leadership Development programme**

In 2017, the AHSC's NHS partners came together with the Imperial **College Business School's Executive** Education programme to develop a bespoke AHSC Leadership and Development programme. The aim was to equip senior clinicians and NHS managers with the leadership skills needed to operate effectively at board level and champion systems transformation and share best practice across institutional boundaries.

Building on the successful in-house programme, the Business School's Executive Education team. in partnership with Corndel – an award winning training provider – have evolved the AHSC programme into an online apprenticeship programme specifically focussed on healthcare leadership. This new format allows participants from NHS organisations beyond the AHSC to take advantage of the programme.

Thirty-two staff from West London Children's Healthcare enrolled onto the programme in its first year. The programme is helping support North West London paediatrics leads achieve the sector's new vision for children's services.

### **The AHSC Clinical Research Training Framework**

### The Clinical Research Training Framework has been developed to help NHS staff support clinical research.

The framework, developed by the Clinical Academic Training Office, guides clinical staff in the AHSC organisations to develop an understanding of research, and necessary research skills, to allow them to become more directly involved in the mission of the AHSC: to accelerate the translation of research discoveries into improvements in human health.

The framework is facilitating staff to support NIHR and industry trials, and to develop their own clinical academic careers. It does this by outlining competencies, skills and training, and suggesting opportunities and resources offered within the AHSC and beyond.

### Imperial launches online courses for NHS staff

As part of a growing offer specifically targeted at NHS staff, Imperial College London has developed and launched a range of massive open online courses (MOOCs).

MOOCs – such as Participatory approaches in public health specialisation, Introduction to quality improvement in healthcare and Using data for healthcare improvement are designed to build and strengthen public health and quality improvement skills among healthcare professionals and address potential gaps in knowledge among NHS staff.

The courses are being run in partnership with Coursera - a global online learning platform - and form part of Imperial College London's Global Master of Public Health programme. NHS staff enrolled on the courses are able to gain a certificate once they complete the courses.

These courses have been designed by Professor Helen Ward, Clinical Professor of Public Health at Imperial College London, Dr Thomas Woodcock, Senior Research Fellow in the School of Public Health at Imperial College London, and Dr Bob Klaber, Consultant General paediatrician and Director of Strategy, Research and Innovation at Imperial College Healthcare NHS Trust.

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### End message from Professor Mark Walport, Chair of Imperial College AHSC Strategic Partnership Board.

As Chair of the AHSC's Strategic Partnership Board, I have been fortunate to see the incredible impact of the AHSC's research, clinical care and education outputs. However, the challenge for the AHSC partnership achieving its vision to improve health outcomes has never been greater.

The COVID-19 pandemic shone a light on societal inequalities and how they impact health such as socio-economic status and ethnicity. It also showed the huge clinical demands placed on an increasingly stretched healthcare workforce.

Research and education will be the foundation for the new technologies and service innovation required to address these challenges, transform healthcare management and delivery, and make the best treatments available better and more cost-effective.

In North West London, the AHSC is working closely with Imperial College Health Partners and the North West London Integrated Care System to spread the impact of its research and expertise to improve outcomes for the 2.4 million residents living in the sector. Working in this joined up way will allow us to do more, and be even more creative in our approach to health improvement.

As we look forward, I am confident of the AHSC's ability to meet these challenges because of the extraordinary staff who are part of it. It is because of their hard work and efforts that we are able to achieve success. I also want to acknowledge and thank our patients and public participants who have been part of our research and have input into the design of clinical trials. Their participation has allowed us to make such incredible progress in understanding and treating a range of diseases.

It is a great privilege to be part of the AHSC and through my role and working with others we will deliver on our ambitious strategy, improving healthcare for all.







### Imperial College Academic Health Science Centre

A partnership between Imperial College London, Imperial College Healthcare NHS Trust, Chelsea and Westminster Hospital NHS Foundation Trust, The Royal Marsden NHS Foundation Trust, and The Institute of Cancer Research, London.

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