Strategy

EPSRC health technologies strategy

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Background

In November 2021, the healthcare technologies theme at the Engineering and Physical Sciences Research Council (EPSRC) started a community consultation process to gain advice on how to refresh the current strategy.

The strategy refresh project was intended to engage the community in identifying and exploring some of the major health challenges over the next 10 years, and the role of the engineering and physical sciences in addressing these.

An inclusive process of community engagement was undertaken over a 12-month period. This included a series of workshops, roundtable meetings and written contributions via an open survey. It involved representatives from academia, industry, early career researchers, healthcare professionals and patient and public representatives.

This new strategy is a refreshed vision, widely endorsed, for EPSRC to stimulate advances in transformative engineering and physical sciences research to have a significant impact in health and ultimately to enable people to live healthier lives.

Context

The Engineering and Physical Sciences Research Council (EPSRC) has published a **strategic delivery plan** that sets out our strategy, priorities and

what we will deliver between 2022 and 2025. This delivery plan is structured around **UKRI's six strategic objectives**.

EPSRC has eight cross-cutting priorities, which have been developed to deliver against the UKRI strategy, support research and innovation and address government priorities. These priorities aim to provide a balance across our portfolio between discovery research, mission-inspired research and an effective ecosystem to underpin them.

Our new health technologies strategy links to many of our EPSRC priorities, for example, net zero, but specifically aligns to our priority around transforming health and healthcare.

Research delivered through the health technologies theme aims to address the priorities we have identified in consultation with our community. This will also contribute to the UKRI strategic themes, ageing and wellbeing and tackling infections.

EPSRC will work in partnership with other funders to support collaborative working across communities and deliver the EPSRC contribution to the wider health agenda.

Engineering and physical sciences and our future health

Engineering and physical sciences research can have a huge impact on health, healthcare and wellbeing, and is critical to successfully tackling many challenges faced by the health service.

Breakthroughs arising from past research include:

- DNA sequencing technology: in 1953, James Watson and Francis Crick published the structure of the DNA helix. Their discovery was the result of a combination of experimental (x-ray crystallography) and theoretical approaches. We can now sequence the entire human genome, and the opportunities this offers include:
  - genotyping of specific viruses to direct appropriate treatment
  - identification of oncogenes and mutations linked to different forms of cancer
  - the design of medication and more accurate prediction of their effects

- biomaterials: another breakthrough in the engineering and physical sciences has been scientific advances in biomaterials used every day in dental applications, surgery and drug delivery. They are the combined product of medicine, biology, chemistry, tissue engineering and materials science

The **NHS Long Term Plan** states: "As medicine advances, health needs change and society develops, the NHS has to continually move forward so in 10 years' time we have a service fit for the future."

The widely acknowledged challenges of delivering future health services for an ageing society and supporting people to live healthy lives requires more effective prevention or delay to the onset of illness, improved treatments and more effective interventions for individuals and populations. A future health system also needs to be sustainable and provide support more equitably across society.

Engineering and physical sciences research can play a key role in ensuring health service delivery is suitable for the future. As the COVID-19 pandemic demonstrated, the engineering and physical sciences community contributes analytical, system-thinking and multidisciplinary approaches to solving the challenges faced by the healthcare system and the rapid implementation of new solutions at scale.

With limited skills and resources available, and a growing number of people living with complex health needs, engineering and physical sciences have huge potential to improve efficiency and quality of delivery of future healthcare. This includes enabling increased automation across the system without compromising patient care, freeing up resources for more bespoke interventions.

Engineering and physical sciences research is also key to the development of new technology including biopharmaceuticals, medical technology, genomics, diagnostics, and digital health technologies. It follows that it is also key to development of a wide range of products including therapeutics, medical technologies, diagnostic devices, and digital tools, as well as products for consumer health.

The engineering and physical sciences are therefore critical for the UK life sciences industry (one of the dominant economic and major growth sectors in the UK).

Engineering and physical sciences research can make a significant contribution to the priorities identified in the NHS Long Term Plan, such as ageing well, digital transformation and delivering personalised care. It can also help provide new treatments for acute and chronic conditions and enable the more effective management of multiple, complex long-term conditions.

Furthermore, EPSRC-supported research can have an important role in prevention of disease, from preparing for pandemics and slowing the spread of infectious diseases to diagnosing diseases such as cancer at a much earlier stage.

Engineering and physical sciences research can create solutions and treatments, from the personalised up to the large-scale population-level interventions to benefit people’s health.

Working with our community, we have refreshed our strategy for health technologies. This refresh provides an ambitious plan for how the engineering and physical sciences will enable a healthy society, building on UK long-

standing strengths and unique capabilities in health technologies. It shows how this research will develop new creative approaches to realise the potential of new and emerging technologies, for example in neurotechnologies, artificial intelligence, precision medicine and quantum technologies.

Our strategy recognises that we need to achieve a balance between responding to current health priorities and helping to open up possibilities to transform our future health. It stresses the importance of working in partnership and enabling our researchers to tackle complex, and in many cases, global challenges with a focus on translating our research from the laboratory to the real world.

Vision

The health technologies' theme vision is to stimulate advances in transformative engineering and physical sciences research to have a significant impact in health and ultimately enable people to live healthier lives.

Mission

1. We will deliver impact through high quality engineering and physical sciences research co-created with end users, stakeholders and the public in the following challenge and priority areas:

- improving population health and prevention
- transforming prediction and early diagnosis
- discovering and accelerating the development of new interventions

2. We will encourage and support disruptive and transformative ideas in engineering and physical sciences research with the potential to deliver a step change for health.

3. We will support and attract people from a diverse population to build capacity for future skills requirements in health technologies.

4. We will support the accelerated translation of engineering and physical sciences research into health applications.

Our strategy identifies a number of challenges, important enablers and key outcomes in addition to our aim of supporting world-leading research and skills.

Challenges

Challenge one: Improving **population health** and prevention

Supporting people to live healthier lives and preventing ill health are of key importance for the UK and globally but an area of relative under investment. A recent review of investment in public health interventions found that spending in this area has a long-term return on investment and saves healthcare costs (Masters et al., Return on investment of public health interventions: a systematic review, BMJ, 2017).

In the UK, prevention is highlighted as a key priority for the NHS in its long-term plan. Improving prevention across the life course will enable people to live better lives and will save on treatment costs.

This challenge focuses on the need for novel techniques that optimise health, prevent, and ultimately help eliminate disease. Research within this challenge should be co-created with stakeholders, including policy makers, to ensure real world impact.

Prevention includes promoting wellbeing in a population, addressing the determinants of health (in the physical environment), as well as tackling the causes of disease and enabling people to have a better quality of life.

Identified priorities where we believe engineering and physical sciences will make important advances in improving the health of the population include the following.

Population models

This priority focuses on the development of new tools and technologies to interpret and analyse population data to provide advice and guidance to communities and health professionals. These tools could be predictive models developed through advancements in machine learning approaches used to understand individual and population scale variation in disease phenotypes, considering physiological and biological mechanisms. These models could also be used, for example, to forecast and warn of infectious disease spread.

Predictive approaches to a healthy society

This priority focuses on development of novel tools and technologies, for example, digital twins, to understand what normal health looks like and create models of wellness. It includes the development of technology that measures, monitors and understands disease through data, and identifies when deviations occur within an individual.

For example, the harnessing of digital technologies and data analytics can lead to the discovery of indicators of susceptibility and risk of disease, and this can help identify at-risk individuals and enable people to stay healthy and avoid medical complications. Tools can also be developed to stratify and identify groups likely to follow a particular path, be particularly vulnerable to a certain risk factor or environment or respond particularly well to a lifestyle change or treatment.

Engineering healthier environments

This priority focuses on ‘engineering healthier environments where people live and work’. It will build on UK strengths, transforming support for built environment and infrastructure research. This will include research and enhanced use of health data analytics on:

- smart cities
- assistive technologies
- robotics
- artificial intelligence

We will transform the built environment into a tool that will:

- enable a step change in our ability to predict and anticipate factors to prevent ill health
- prevent infection spread
- shape the future living and working environment
- enable the re-design and adaptation of existing spaces to promote increased wellbeing

Challenge two: Transforming early prediction and diagnosis

Early diagnosis, prompt detection of acute and chronic disease recurrence and treatment monitoring are among the key foundations of any healthcare system.

Addressing all aspects of health from physical and mental to environmental, this challenge focuses on the need for novel techniques that optimise patient-specific illness prediction and early and accurate diagnosis.

The aim includes:

- reducing the incidence of disease
- intervening before full symptoms develop
- reducing the impacts of multiple long-term illness
- strengthening the ability to take exactly the right steps to combat disease at precisely the right time

Scientific, mathematical, and other techniques, from biomarker identification, research into medical imaging and risk stratification to predictive modelling and real-time, evidence-based decision-making, will all play a role.

Identified priorities where we believe engineering and physical sciences will make important advances include the following.

Tools to advance earlier diagnosis and detection of disease

This priority focuses on the development of novel tools and technologies, such as non-invasive sensors, devices and medical imaging instrumentation, image visualisation and interpretation. This is to enable earlier and more reliable diagnosis of physical and mental health conditions. This priority could include:

- development of low-cost, portable technologies more accessible to communities, such as medical imaging technologies delivered in primary care
- development of novel non-invasive sensors and devices to detect disease earlier and more accurately
- complex models and decision-support systems that use data to support rapid diagnostic decisions, including diagnostics that can be used in the home

Novel techniques for patient specific diagnosis

This priority focuses on new methods of recognising abnormal data patterns and harnessing digital technologies (artificial intelligence, modelling, simulations and digital twins) and data analytics to predict susceptibility to illness. Working at a person-specific level, these will:

- analyse physiological and behavioural data collected over time
- identify causes for concern
- provide early warnings for the patients themselves, their carers and healthcare professionals

Detecting infections and antimicrobial resistance

This priority focuses on the earlier detection and prediction of infectious disease. This could include development of novel diagnostics that can deliver rapid and accurate tests at the point of care and will improve patient safety and health outcomes.

Supporting people to manage their own health

This priority focuses on the development of novel digital tools for technology-enabled learning that could support people to make health decisions. These novel technologies will be person-centred and enable the public to better manage their health in their own homes.

For example, they could include individually adaptive, minimally intrusive monitoring technologies enabling individuals to track their own health and have informed interactions regarding healthcare needs. They will also make it easier for patients to interact with healthcare professionals and provide updates on their medical conditions.

Challenge three: Discovering and accelerating the development of new interventions

In a world challenged and changed by the COVID-19 pandemic, the unrelenting drive to tackle existing and emerging diseases must continue apace. We can do

this by harnessing engineering and physical sciences to develop new and advanced therapies, medicines and other interventions. This challenge focuses on the need to produce safer, more targeted treatments and interventions fit for the future.

This challenge includes therapies and treatments as well as physical interventions. These are fundamental to restore function, repair damage and eliminate disease. They could be surgery and radiotherapy and physical interventions, such as provision of prostheses.

Developing novel treatments and therapies that could be personalised and designed for the setting in which they are being delivered, for example home, community or acute care, is of key importance.

Identified priorities where we believe engineering and physical sciences will make important advances include the following.

Resilient manufacturing

This priority focuses on improving UK capability in developing and manufacturing new medicines, and interventions and delivering these more rapidly and sustainably through:

- research to accelerate the time taken from discovery to deployment of new interventions
- scale-up technologies that allow future medicines to be manufactured in an affordable way that meets safety and environmental requirements
- research to understand and address the manufacturing challenges for novel therapies, from small molecules to cell and regenerative medicine therapies
- processes that will be capable of cost-effective scale-up to enable mass production of medicines, for example, to tackle epidemics.

It could also include processes that will be capable of scale down to produce personalised medicines, such as regenerative therapies using patients' own cells.

Therapies for chronic conditions

This priority focuses on development of effective treatments for people affected by long-term conditions and co-morbidities (related to ageing). Research could include:

- targeted delivery of therapeutics and treatments to specific places in the body, to achieve controlled release of their active ingredients or deliver more than one active ingredient at a time
- development of long-lasting therapies
- advances in physics modelling and image-guided treatment planning to increase the precision and targeting of surgical procedures – these advances

will ensure fewer side effects, faster recovery times and better overall outcomes
- in-silico, in-vitro and biomarker technologies for use in drug discovery

Engineering and materials research with therapeutic properties

This priority focuses on innovative technologies that will:

- enable development of new materials to promote tissue growth
- create human organs in the lab, avoiding the need to rely on donors when damaged organs need replacement or repair
- optimise the capabilities of donated organs and tissues and maximise the benefits they deliver
- responsive materials that can respond to a wide range of biomarker triggers

Innovative technologies for physical intervention

This priority focuses on innovative technologies for physical intervention, such as assistive technologies and surgical robotics, for example:

- minimally invasive autonomous technologies for robotic surgery that will reduce recovery times, lower infection rates and lower costs
- novel, cost-effective technologies for implants, prostheses and assistive devices – designed to maintain or improve function, novel technologies will adapt to users' changing needs and capabilities, and so encourage more people to use (and keep using) aids that help them overcome impairment
- personalisation of physical intervention technologies – focusing on digital health or pain management in the home, for example, technologies customisable to individual needs will not only strengthen palliative and other types of patient care but also protect and improve the health of the population at large
- bioelectronic devices providing long-term sensing and control capabilities will help to re-establish function, reduce pain, and assist recovery

Enablers

Our strategy has also identified a number of enablers and outcomes that research within health technologies should address.

Responsible approaches to data

Health data should be accessed and used in a trustworthy, ethical and secure way. We want to ensure that all projects funded by the health technologies theme consider responsible approaches to data-gathering, storage and access, and we want to work with other partners to enable researchers to access health data appropriately.

Patient and public involvement and engagement

Patient and public involvement and engagement (PPIE) aims to deliver better quality research, whether patient-focused or accelerating the transfer of evidence into pre-clinical research through effective two-way communication.

This can include engagement with patients and other people with lived experience, such as carers or users of technology, including clinical and healthcare professionals. PPIE can offer valuable insights into the reality of facing or living with a disease or condition and can help better characterise the challenges and needs a technology might address.

While public engagement is important across all areas of research, it has particular importance for healthcare. People's interactions with healthcare technologies can be amongst the most personal, intimate and invasive of all the interactions with technology that they will experience during their lives.

EPSRC encourages researchers to engage with PPIE activities at the outset of their research and, where appropriate, draw from public, patient and user perspectives to inform and shape the next stage of healthcare research.

Sustainable healthcare and health systems

Healthcare's climate footprint is around 4.4% of global net emissions. Healthcare contributes to emissions through energy consumption, transport and through product manufacture, use and disposal.

Sustainability in this context can mean healthcare being delivered more affordably, more resiliently and in a more environmentally friendly way. We aim to scope areas of research opportunity in this space for healthcare technologies researchers and will encourage all applicants to consider sustainable healthcare practices when applying to EPSRC.

Improving translation readiness

The development landscape for healthcare technologies can be complicated. The journey from bench to end user application can be long and the pitfalls for new technologies are many. Successfully traversing this landscape requires preparation and an understanding of those challenges unique to the healthcare sector.

The health technologies theme would like to identify actions where we can help researchers successfully traverse this landscape. For example, working with regulatory organisations to use physical sciences and engineering methods to speed up the regulation process.

Reducing health inequalities

While life expectancy continues to improve for the most affluent 10% of the UK population, it has either stalled or fallen for the most deprived 10%. The NHS

and our community workshops highlighted this as a key issue nationally and we would like to embed and explore thinking about this issue in our projects.

Supporting knowledge and skills in health technologies

At the centre of excellent health technologies research and innovation are the talented people and teams. Therefore, EPSRC needs to invest and support the people, skills and careers of the next generation of health technologies leaders.