EPSRC HEALTHCARE TECHNOLOGIES STRATEGY SUMMARY

March 2015

EPSRC vision for healthcare technologies

The vision of the healthcare technologies theme is to accelerate the translation of EPSRC research to healthcare applications by:

- Building critical mass around UK research strengths in computational, engineering, mathematical and physical sciences that underpin healthcare;
- Maximising business, charity and clinical engagement in research, thereby increasing translation to products and practices.

Strong features of the theme are:

- Focussing on the highest priority healthcare challenges and the research capabilities that will address them;
- Partnerships with other funders to encourage translational research and open up pathways to impact;
- Providing support for environments that promote multidisciplinary research and training;
- Stimulating creative and transformational approaches to address unmet clinical needs and improve patient outcomes.

Healthcare technologies strategy

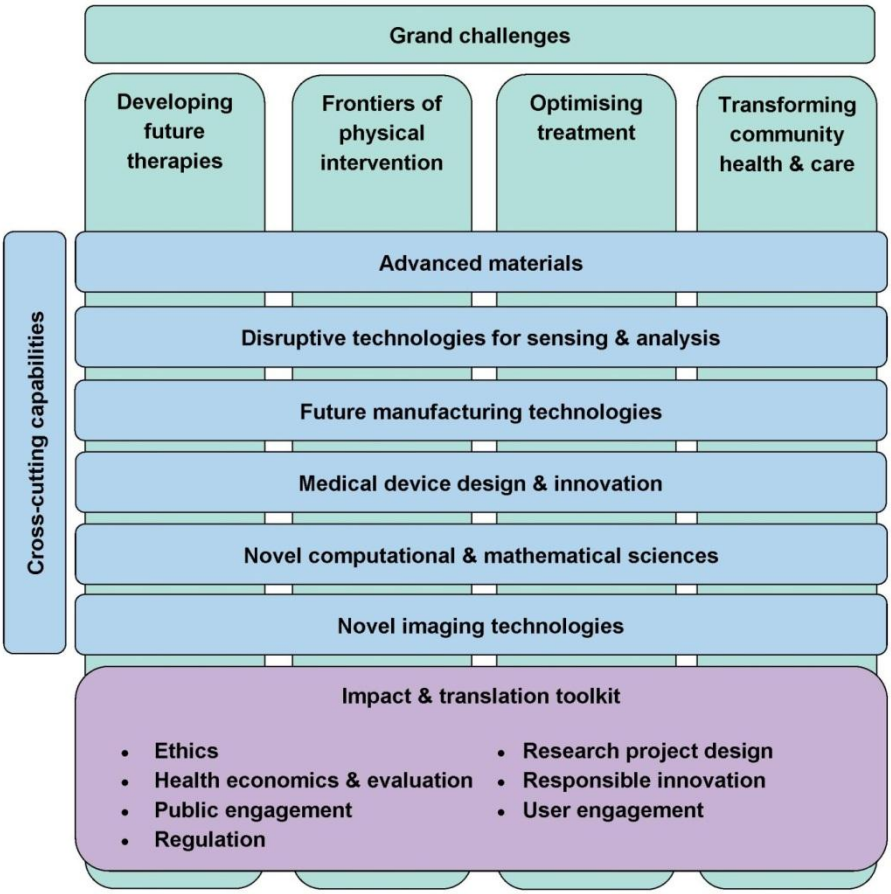
The healthcare technologies strategy aims to achieve the vision of the theme; to accelerate the translation of EPSRC research to healthcare applications. The strategy was developed in collaboration with our Strategic Advisory Team (http://www.epsrc.ac.uk/research/ourportfolio/themes/healthcaretechnologies/strategy/sat/) and through engagement with the research community, users and other funders. It builds on the recommendation of the Maxwell Review 'The importance of engineering and physical sciences research to health and life sciences' which highlighted the benefits of challenge led approaches in stimulating multidisciplinary research (http://www.epsrc.ac.uk/newsevents/pubs/the-importance-of-engineering-and-physical-sciences-research-to-health-and-life-sciences/).

The strategy has three elements which form an interconnected matrix and provide a framework for the activities of the theme:

- **Grand challenges** – these are healthcare focussed challenges to which computational, engineering, mathematical and physical scientists can make a significant contribution;

- **Cross-cutting research capabilities** – these are areas of research which are essential for delivering the grand challenges;

- **Impact & translation toolkit** – these are specific topics and issues that we encourage researchers to consider in order to make it more likely that impact will arise, that it will arise more quickly and that it will bring benefit to the UK.



Future activities undertaken by the theme will have their scientific focus framed by the grand challenges and the capabilities required to deliver them. Such interventions will, where possible and appropriate, be delivered in partnership with other funders or EPSRC themes.

We will continue to work in partnership with the EPSRC Capability themes to provide opportunities for investigator led research programmes with the potential to deliver the aims and vision of the theme. This is a long term strategy for healthcare technologies at EPSRC which will guide us for a number of years. We will amend and update the strategy periodically to ensure it remains timely.

Grand challenges

These four grand challenges are a key part of the healthcare technologies theme strategy and provide a focus for funding opportunities offered by the theme.

Developing Future Therapies
Supporting the development of novel therapies with technologies to enhance efficacy, minimise costs and reduce risk to patients.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to develop the drug, biological, cell and regenerative therapies of 2050. Research supported by EPSRC will seek to enhance the efficacy and precision of therapies, improve the efficiency of discovery, lower the cost of manufacturing and reduce the risk to patients from side effects.

Some specific impacts that could be achieved under this challenge include:

- In-silico, in-vitro, and biomarker technologies for drug discovery, allowing rapid prediction and measurement of therapeutic effect, toxicology and in-vivo drug-target interaction, to reduce development costs and minimise the use of animal models.

- Advanced drug delivery technologies to administer novel therapeutic agents effectively, targeting specific sites, allowing co-delivery of multiple agents, or providing controlled release.

- Flexible, adaptive manufacturing processes for high-quality medicines tailored to demand, allowing cost-effective scale-up for mass production (e.g. for epidemics) and scale-down for personalisation (e.g. regenerative therapies from a patient's own cells).

- Innovative technologies for Regenerative Medicine allowing the creation of a functional organ in the lab to repair or replace damaged organs, without the need for organ donation.

- Advanced technologies for clinical trials, using multiscale modelling, adaptive design, and data analytics to reduce the time to market for new therapies and identify opportunities for drug-repurposing, maximising cost-benefit.

Frontiers of Physical Intervention
Restoring function, and optimising surgery and other physical interventions to achieve high precision with minimal invasiveness.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to develop prostheses and devices to restore normal function, and develop precise, minimally invasive physical interventions to repair damage or remove disease. Interventions may include established techniques such as surgery, radiotherapy or high field ultrasound, but we also encourage new approaches to physical treatment.
Some specific impacts that could be achieved under this challenge include:

- Autonomous or cooperative robotic surgery to reduce costs and recovery times, and improve outcomes by enabling minimally invasive intervention, improving accuracy and lowering infection rates.

- Advances in physics modelling and image guided planning for surgery and radiotherapy to improve precision/targeting, leading to fewer side-effects, faster recovery, and better outcomes.

- New affordable, targeting methods, including but not limited to nanoscale devices, for delivering non-ionising energy into patients to revolutionise treatments for cancer and other diseases, by improving efficacy and reducing side effects.

- Bioelectronic devices that enable long term sensing and control, which could re-establish function, reduce pain, or aid recovery.

- Disruptive technology for implants, prostheses and assistive devices, to restore function, adapt to changing needs and capabilities, improve success-rates and longevity (e.g. reducing the need for revision surgery), and encourage uptake.

Optimising Treatment
Optimising care through effective diagnosis, patient-specific prediction and evidence-based intervention.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to optimise treatment for the individual, improving health outcomes. Research supported by EPSRC will focus on technologies for timely and accurate diagnosis, stratification, predictive modelling, and real-time, evidence-based decision making. The aim is the right treatment at the right time.

Some specific impacts that could be achieved under this challenge include:

- Novel, low-cost diagnostic devices, with high sensitivity, specificity and reliability, for timely and accurate diagnosis, improving the choice and reducing the cost of intervention, and increasing the likelihood of successful health outcomes.

- Data analytic methods to identify disease phenotypes and associated responses to treatment from population data, allowing evidence-based selection of treatment options, with lower costs and morbidity, and improved health outcomes.

- Novel non-invasive sensing platforms for the capture of real-time health and lifestyle data, enabling automated intervention – e.g. controlled release of a drug – providing better disease control and allowing patients to lead more normal, independent lives.

- Patient-specific predictive models that integrate medical knowledge and knowledge of an individual - from medical records, imaging, physiological and behaviour monitoring, response to interventions, self-reporting etc. – for timely, accurate diagnosis and outcome prediction.

- Systematic treatment of uncertainty in complex models and decision support systems, allowing more sophisticated decision-making, based on an understanding of confidence and sensitivity.

Transforming Community Health and Care
Using real-time information to support self-management of health and wellbeing, and to facilitate timely interventions.

Through this challenge we aim to support the novel engineering, ICT, mathematical and physical sciences research required to transform community-based health and care. Research supported by EPSRC will seek to integrate, interpret and communicate information from multiple sources, including real-time sensing, to help individuals stay healthy, and support a collaborative model of care involving patients, healthcare professionals and informal carers. This should empower individuals to self-manage effectively, and facilitate timely intervention when necessary.

Some specific impacts that could be achieved under this challenge include:

- Methods for recognising person-specific abnormal patterns in physiological and behavioural time-course data, providing early warning of deterioration to patients, carers, and healthcare professionals.

- Decision support dashboards and tools for healthcare professionals, supporting safe and effective management in the community of patients with long-term conditions or following early discharge.

- An intelligent 'companion' that is fully aware of an individual's healthcare history and experience, empowering them to self-manage their health and care by providing directly relevant feedback, information and advice.

- Individually adaptive data-collection, interaction with healthcare professionals, and self-reporting requests, to support effective care whilst minimising intrusion.

- Technologies for promoting wellbeing by providing timely, personalised feedback, and exploiting social networking to influence health behaviours.

Cross-cutting research capabilities

These six areas of research are essential for delivering the grand challenges highlighted in the healthcare technologies strategy.

Advanced materials

Research focussed on the development, characterisation and processing of advanced materials with novel chemical, physical or mechanical properties, for health-related applications.

This may include but is not limited to:

- Development of biomaterials with innovative properties;
- Design of bio-responsive materials;
- Materials with enhanced biocompatibility;
- Mechanical properties of tissues and biomaterials;
- Applications of nano- and 2D-materials.

Disruptive technologies for sensing and analysis

Research focussed on innovative sensing systems or analytical technologies that could have a transformative impact on prediction, diagnosis and monitoring in healthcare.

This may include but is not limited to:

- High resolution sensors for real-time, point of care diagnosis;
- Integration of sensors in a system;
- Data capture and processing in real time;
- Robust, long-term sensing;
- Methods for rapid, detailed analysis of chemical or biological systems;
- Ultra low power sensing systems.

Future manufacturing technologies

Research focused on technologies that will enable health-related manufacturing processes, products and systems to function with high precision, efficiency, reliability and repeatability.

This may include but is not limited to:

- Design of novel, affordable manufacturing processes;
- Scale up technologies;
- Sustainable manufacturing;
- Cost effective patient-specific manufacturing;
- Integrated nano-micro-macro manufacturing;
- Additive manufacturing;
- Sensors, measurement and data analytics for process understanding and control.

Medical device design and innovation

Research focussed on the design, development, evaluation and production of cost-effective, reliable and effective medical devices.

This may include but is not limited to:

- Robotics for surgical applications;
- Wearable devices, prosthetics and orthotics;
- Human-centred design for enhanced usability and validation;
- Digital technologies for device design, prototyping and evaluation;
- Sustainable design of medical devices;
- Minimally invasive devices for monitoring, intervention and compliance.

Novel computational and mathematical sciences

Research focussed on the development of innovative computational and mathematical methods for prediction, analysis and modelling in healthcare.

This may include but is not limited to:

- New methodologies for making sense of complex healthcare data;
- Integration, analysis and interpretation of data for decision making;
- Data visualisation tools;
- In silico modelling and simulation;
- Mathematical and statistical modelling for healthcare applications;
- Optimising process, system and resource management.

Novel imaging technologies

Research focussed on the development of next generation imaging technologies for diagnostic, monitoring and therapeutic applications; with improved accuracy, affordability and incorporating new modalities.

This may include but is not limited to:

- Higher performance, novel or lower cost image acquisition technologies;
- Automated image interpretation to aid clinical decision making;
- Multi-scale and multi-modal imaging systems;
- Techniques for image reconstruction;
- High throughput, real-time imaging at the point of care;
- Qualification and technical validation of imaging biomarkers.

Impact & translation toolkit

EPSRC's Strategic Plan 2015 (http://www.epsrc.ac.uk/about/plans/strategicplan/) highlights Accelerating Impact as a key strategy for the organisation. Through this strategy we seek to maximise both academic excellence and the economic and social impact arising from our research and training portfolio.

EPSRC recognises that social and economic impact is delivered by diverse stakeholders such as business, policymakers, charities, healthcare professionals and others, and that it is not the primary role of the research community. Our goal is to help make it more likely that impact will arise, that it will arise more quickly and that it will bring benefit to the UK.

We therefore encourage all researchers seeking funding through the healthcare technologies theme to embed thinking about translation, and other potential impacts, into the planning and development of their research. In particular, there are a number of considerations that researchers working in the healthcare field could usefully take into account and these are detailed in the table below. The weight given to each of the topics will depend on the nature of the research. Some of the topics could form part of the pathways to impact for proposals, and associated resources may be requested (http://www.epsrc.ac.uk/funding/howtoapply/preparing/impactguidance/).

Topic	Details
Ethics	Research projects with healthcare applications often require ethical or other approvals (e.g. NHS R+D) before being undertaken. This is especially true if they involve human participation or the use of animal models (http://www.epsrc.ac.uk/about/standards/animalresearchpolicy/). We recommend researchers develop a thorough understanding of the requirements and likely timescales of any approval processes and build this into their applications.
Health economics and evaluation	We encourage researchers to consider the size and significance of the health issue to be addressed and the cost effectiveness and affordability of their proposed solution. We also recommend that researchers develop evaluation techniques to quantify and predict the impact of any new innovations. Note: EPSRC does not fund stand-alone health economic studies but support may be requested as part of the pathways to impact for technology developed in an EPSRC project.
Public engagement	Under EPSRC's Royal Charter, one of our objectives is to "generate public awareness; communicate research outcomes; encourage public engagement and dialogue; and disseminate knowledge". Researchers may request funding to support public engagement activities as part of their pathways to impact (http://www.epsrc.ac.uk/innovation/publicengagement/).
Regulation	We encourage EPSRC researchers to develop an understanding of current regulatory pathways and to engage with regulators to help shape future regulation. Researchers may request funding to engage with experts or undertake training to improve their awareness of possible issues. Some guidance for researchers is available via the MRC Regulatory Support Centre (http://www.mrc.ac.uk/research/facilities/regulatory-support-centre/).

Research project design	Researchers are encouraged to consider the future needs of others who may wish to 'take up' and translate their research and build this into the design of their research projects. Steps taken by our community in the early stages of research can help support, for example, regulatory approvals downstream or the de-risking of new concepts.
Responsible innovation	EPSRC promotes a responsible innovation approach and researchers are encouraged to familiarise themselves with our published framework (http://www.epsrc.ac.uk/research/framework/).
User engagement	We recommend that researchers collaborate with appropriate users of their research to increase the probability of successful, rapid translation to products and practices. Users may include business, clinicians, charities, patients, carers, policy makers or other researchers.