ICU
MANAGEMENT & PRACTICE

Engineering the Future of Healthcare - from Brain Mapping to Smarter Limb Prostheses

Ultrasonic needle that penetrates bones without damaging tissue, University of Glasgow (Image Credit: EPSRC)

A £12.2 million investment in 15 creative engineering research projects, that can deliver major advances in healthcare, is announced today by the Engineering and Physical Sciences Research Council (EPSRC).

Professor David Delpy, CEO of EPSRC said: "The research we are funding is aimed at developing a range of innovative technologies which can, improve the diagnosis and treatment of serious illnesses including Alzheimer's and cancer, improve patient outcomes, and help severely disabled people. EPSRC funds projects which are both world leading research, and can make a real difference to people's lives."

Richard Prager, from the University of Cambridge, who chaired the panel assessing the research proposals, said: "Technology for rehabilitation, acute care and imaging has huge potential to transform lives and improve medicine. It is great that such an exciting set of ambitious projects has been funded.

"The referees and review panel were greatly impressed by the large number and outstanding quality of proposals received."

Three health areas needing investment were identified by the EPSRC:

Medical Imaging with particular focus on neuroimaging

£5.8 million for projects developing technologies and techniques which could:

- lead to better diagnosis and treatment for epilepsy, multiple sclerosis, depression, dementia as well as breast cancers and osteoporosis
- reduce risks during brain surgery by creating ultrasound devices in needles
- improve therapies for brain injured patients and help severely disabled people interact with the world around them

Acute Treatment Technology

£3.5 million awarded for projects to develop technology to improve patient outcomes such as:

- a multiphoton scanner and amultiphoton endoscope to collect images of tissue at depth and sub-cellular level, allowing immediate diagnosis during surgery
- ultrasonic bone-penetrating needles to deliver drugs and obtain biopsies in bone
- laser spectroscopy to quickly analyse tissue in cancer patients
- a pulsed laser system to restore tooth enamel

Assistive Technology and Rehabilitation

£2.9 million awarded for technologies to improve patients' quality of life. The projects funded aim to improve prosthetics, hearing aids, and develop a wearable material to support healing muscles or create an exoskeleton.

The 15 research projects involve 27 university research teams and involve numerous industry partners and NHS Foundation Trusts. The projects are:

Medical Imaging:

- Radio and sound waves to image cancer treatment: Developing a new medical imaging technique called electromagnetic acoustics (EMA) which sends ultrasound waves and radio waves into the body. Research will study how it can be applied to detect breast cancer and to monitor the treatment of cancer tumours. **Led by Professor Robin Cleveland, University of Oxford** , in collaboration with the Cancer Centre at the Churchill Hospital, Oxford. **Grant: £978,000.**

- Point-of-care high accuracy fracture risk prevention: Researchers aim to develop a new diagnostic tool to examine bone quality characteristics in order to accurately predict fracture risk arising from diseases such as osteoporosis. Potentially hand held devices could be made. **Led by Professor Keith Rogers, Cranfield University** with the University of Bristol, Nottingham Trent University, the University of Exeter, HALO X-ray Technologies LTD and Radius Diagnostics Ltd. **Grant: £766,000.**

- Quantitative functional MRI: developing non-invasive neuroimaging to map the human brain's consumption of oxygen : Magnetic Resonance Imaging (MRI) will be developed to map the amount of oxygen that the brain uses. The technique will offer a marker for diseaseand treatment effects in neurological conditions such as epilepsy, multiple sclerosis and dementia, as well as psychiatric conditions such as depression and schizophrenia. **Led by Professor Richard Wise, University of Cardiff** . Project partners: University of California, San Diego,the University of Toronto. GE Healthcare, GlaxoSmithKline and Thornhill Research Inc. **Grant: £570,000.**

- Ultrasound in a Needle: Minimally-invasive High Resolution Imaging for Neurosurgery : Brain surgery could be transformed by the creation of a needle containing miniaturised ultrasound devices. High resolution images of brain tissue would give neurosurgeons information about lesions and critical structures in the brain during operations, giving better patient outcomes. The research will produce and test the needle for surgery. **Led by Professor Sandy Cochran, University of Dundee** with the University of Birmingham and Heriot-Watt University. Project partners: Merlin Circuits & Applied Functional Materials Limited.Collaborators: Diagnostic Sonar Ltd & Scottish Health Innovations Ltd. **Grant: £726,000.**

- Medical imaging markers of cancer initiation, progression and therapeutic response in the breast based on tissue microstructure : New ultrasound and MR imaging techniques will examine breast tissue at the microscopic level. The aim is to help identify different types of breast cancer and classify them as high risk and low risk, as well as predicting their likely response to therapy. These methods will be used not only to examine the cancer itself but also microscopic changes in the stroma or connective tissue near to cancers. The results should lead to a clinical trial. The project is led by Professor David Hawkes, University College London and Professor Andrew Evans, University of Dundee. **Grant £812,000.**

- Multimodal neuroimaging: novel engineering solutions for clinical applications and assistive technologies : New imaging techniques will be developed to assess and improve therapies for brain injured patients and help very disabled patients to interact with the world. The team will create awearable, comfortable,brain imaging system capable of measuring regional electrical activity and oxygen utilisation for use in a range of patient environments. Researchers will investigate whether these systems can be used to help patients communicate and control the world around them and novel physiological models will enhance the extraction of clinically relevant information from the captured signals and images. **Led by Professor Clare Elwell, University College London.** Project partners: Custom Interconnect Ltd, g tec Guger Technologies, and the Royal Hospital for Neuro-disability. **Grant £993,000.**

- Zero-Field MRI to Enhance Diagnosis of Neurodegeneration : A diagnostic imaging method using a new type of MRI with the aim of early diagnosis of degenerative brain diseases such as Alzheimer's or Parkinson's. The method seeks to measure biomarkers that could reflect disease state and might ultimately be used to monitor the effectiveness of drug therapies. The technique will use a rapidly-switched magnetic field to provide images of the brain structure and function, reflecting subtle changes at molecular and cellular level, which arenot seen with existing MRI. **Led by Professor David Lurie, University of Aberdeen. Grant: £979,000.**

Acute Treatment Technology:

- Development of multiphoton microscopes for real-world clinical applications: Multiphoton microscopes extend the depth at which optical images can be collected within tissue allowing immediate diagnosis in areas such as brain, prostate, skin and spine. The research will use the technology to produce two new instruments:

    - a motion-stabilised hand-held multiphoton scanner producing images of external tissue and tissues exposed in surgery
    - aminiature, flexible multiphoton endoscopeused inside a fine needle and inserted via channels such as breast ducts or into organs, to provide sub-cellular images anywhere inside the body

Led by Dr Christopher Dunsby, Imperial College London with the University of Bath. **Grant £854,000.**

- Ultrasonic needles based on Mn-doped Ternary Piezocrystals will develop bone-penetrating ultrasonic needles for surgical procedures used for:

    - delivery of drugs to areas within or obscured by bone
    - gaining access within medullary canals and inside cranial sinuses/cavities
    - obtaining biopsies from the inside of the bone for diagnosis

The needles could be used in fields of oncology, neurosurgery, orthopaedics, bone biopsy, regional anaesthesia and rheumatology. **Led by Professor Margaret Lucas, University of Glasgow** with the University of Dundee and the University of Edinburgh. Project partners: Ethicon Endo-Surgery, Weidlinger Associates Inc. **Grant £982,000.**

- Phosphate Bio-mineral-Ultrafast Laser interaction - a pathway for future hard tissue re-engineering (Novel Tool for Surgical technologies) – LUMIN: The project will develop an ink-jet and laser system to apply a protective mineral layer to replace eroded enamel on teeth. The University of Leeds will be responsible for developing the ink-jet system, materials engineering, toxicity tests and erosion trials. The University of St. Andrews will develop the laser system. Three UK companies--British Glass, M-Squared Lasers, and Giltec—are industrial partners. **Led by Professor Animesh Jha, University of Leeds** with the University of St Andrews. **Grant: £997,000.**

- A novel Deep Raman spectroscopy platform for non-invasive in situ molecular analysis of disease specific tissue compositional changes: Researching the use of laser spectroscopy to rapidly analyse tissue molecules inside cancer patients. This will improve screening techniques leading to earlier diagnosis and better outcomes for patients. It could be used during surgery to improve decision making. **Led by Professor Nicholas Stone, University of Exeter** in collaboration with Gloucestershire Hospitals NHS Foundation Trust and Professor Pavel Matousek, STFC Rutherford Appleton Laboratory. **Grant: £723,000.**

Assistive Technology and Rehabilitation:

- A biomimetic, self-tuning, fully adaptable smart lower limb prosthetics with energy recovery : Developing more intelligent prostheses to work and interact with an amputee's body; adapting automatically to user needs based on changing terrain and amputee's activity as well as harvesting energy to make the system more efficient for longer battery life. Research will focus on measuring gait dynamics, sensors to measure loads during use and optimising performance to ensure user comfort. **Led by Dr Abbas A. Dehghani-Sanij, University of Leeds.** Project partners: Chas A Blatchford & Sons Ltd. **Grant: £619,000.**
- Energy efficient lower limb prostheses : The research will develop new, more energy efficient prosthetic legs to improve amputees' mobility, focusing on hydraulic technology. **Led by Professor David Howard, University of Salford.** Project partners: University of Manchester, Chas A Blatchford & Sons Ltd and University Hospital of South Manchester. **Grant: £672,000 to extend previous funding.**
- Designing better hearing aids using physiologically inspired speech enhancement aims to produce hearing aids which can distinguish better between speech and background noise. Researchers will use knowledge generated from neuronal brainstem recordings to design novel signal processing strategies. **Led by Dr Stefan Bleeck, University of Southampton** , in collaboration with the University of Cambridge. Project partners: Google Inc, and Siemens AG. **Grant £613,000.**
- Wearable assistive materials is a project which aims to study properties of new materials and composites which could be used to support joints which bend, to rehabilitate weak muscles needing exercise whilst healing after fractures, or in an exoskeleton to help people walk. **Led by Professor Nick Tyler, University College London** , in partnership with URT Group Ltd. **Grant: £994,000.**

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