Engineering and Physical Sciences Research Council

Transforming Health and Care Beyond the Hospital: Case Study

Ensuring better healthcare begins at home

Improved wellbeing, increased independence, less pressure on hospital services: unobtrusive sensor-based systems that gather data on everyday behaviours are set to transform the way long-term health conditions are addressed.

Image credit: University of Bristol

Meeting the Grand Challenge:

Led by the University of Bristol, the SPHERE ('Sensor Platform for Healthcare in a Residential Environment') project is demonstrating the practicality of measuring, in people's own homes, behaviours that may indicate or adversely affect their state of health. In a world where COVID-19 has highlighted the need to move healthcare away from a purely hospital-based model, SPHERE is bringing closer the prospect of more effective home-based prevention and management of many physical and mental illnesses.

Vision and Value:

Dementia, diabetes, asthma, arthritis, depression: the UK and many other countries have seen an explosion in long-term health conditions. Understanding the causes of these illnesses and developing new therapies to manage – or even cure them – needs us to be able to measure minute-by-minute and day-by-day changes to symptoms in patients' own homes.

Many of SPHERE's aims, such as capturing posture, gait or activities of daily life, are straightforward in a constrained, controlled laboratory environment with scripted participants. But approaches or algorithms that perform well in carefully set-up environments with research-grade lab equipment are seldom robust enough to cope with real people in real homes, let alone with battery-powered devices connected via low-power wireless networks operated in busy domestic settings.

Detecting activities at home presents a data-fusion problem. For example, to detect and characterise cooking requires personal (for example, wearable) data, infrastructural data (such as water and electricity usage) and environment data (such as humidity). Training multi-modal data-fusion models is, however, a relatively unexplored area of research.

These were core challenges that the SPHERE team set out to address.

Key Components:

Supported by a total of £15.2 million from two EPSRC Standard Research grants[1] and running until 2023, this nine-year project involves six UK universities and partners including IBM, Toshiba and Bristol City Council. SPHERE has not only harnessed the expertise of engineers, designers, clinicians and health scientists but has also benefitted hugely from co-design with more than 220 members of the public who attended SPHERE workshops.

[1] 'SPHERE' - a Sensor Platform for HEalthcare in a Residential Environment. Grant numbers: EP/R005273/1, EP/K031910/1.

Ensuring better health care begins at home

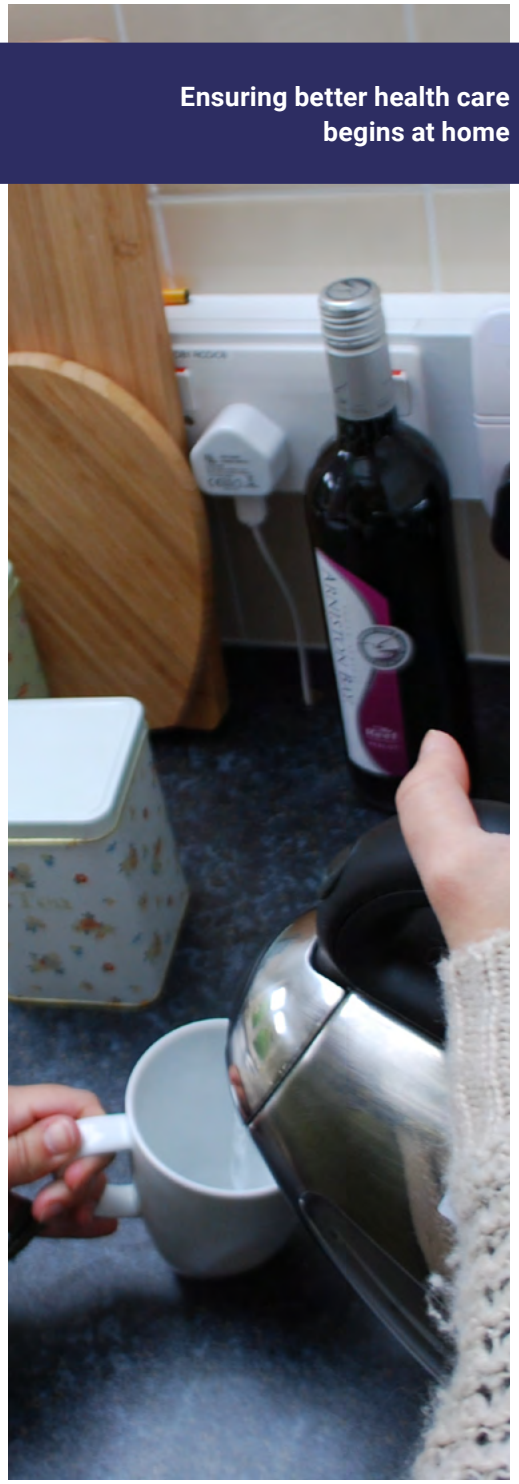

Image credit: University of Bristol

Outputs and Outcomes:

- The team has successfully designed, manufactured and deployed at scale a first-of-its-kind multi-sensor system for collection of health-related data in the home.
- The system has demonstrated its ability to track and characterise health-related behaviours in real-world domestic settings across a large geographical area.
- Research outputs have included qualitative papers in the areas of ethics and co-production, published quantitative work on machine learning, computer vision and low-power wireless communications, and papers in clinical journals on SPHERE's work with patients.
- Over 100 homes across 200 square miles have been equipped with SPHERE systems for a year or more, including many people with long-term health conditions.
- SPHERE has needed to install devices, including sensors and cameras, in people's homes for months and years, so in a very real sense has requested the support of members of the public to donate their homes and their daily lives to the service of research.

Impacts and Benefits:

- **Better prevention of illness and injury.** Millions of people could benefit from the analysis of SPHERE data which leads to an improved ability to predict falls or strokes, for example, and to more effective advice on healthy lifestyles.
- **Improved quality of life.** Insights generated by SPHERE systems will assist home-based management of illness, reducing the need for older people and those with disabilities or chronic conditions to go to hospital and enabling them to live at home for longer.
- **Measuring interventions in the real world.** The SPHERE team is gathering unique data on the response of patients to medication over long periods, with the aim of getting more new pharmaceuticals to market and being able to dynamically adjust dosages.

Next Steps:

Over the coming years, the ambition is to see SPHERE technologies and protocols being used more widely, whether in homes, care homes or hospitals. With a firm commitment to co-production and attention to privacy, researchers need new ways to see behind the curtains of daily life.

Behind the Project:

Professor Ian Craddock is Director of SPHERE. Key colleagues on the project have included Professors Rachael Gooberman-Hill (Anthropology, Bristol), Steve Beeby (Electronic Engineering, Southampton) and Majid Mirmehdi (Computer Vision, Bristol) and Dr Alan Whone (Consultant Neurologist at North Bristol NHS Trust). "Homes are more important than ever – for many of us in 2021 they have become our workplaces, where we shop, where our children are educated and even where we see our GP," Ian says. "At no time in history has it been more important for studies of mental and physical health to be able to characterise symptoms, exposures, outcomes and behaviours in the home."

70%

of the UK's health and social care budget is spent on long-term health conditions.

Relevant EPSRC Research Areas:

- Image and Vision Computing
- ICT Networks and Distributed Systems
- Artificial Intelligence Technologies
- Information Systems