Chemical engineering revolutionises the way diabetics monitor their blood glucose

Research into electrochemical biosensors creates health products targeted directly towards patients.

What is the problem?

Diabetes is an emerging global epidemic. The World Health Organization (WHO) estimates that 347 million people worldwide will suffer from diabetes between 2005 and 2030, and deaths from diabetes will double, 80% of which will be in poorer countries. Diabetes is a leading cause of blindness, amputation and kidney failure, and is a massive burden on global healthcare systems. Controlling diabetes well depends on precise monitoring of patients' blood glucose levels, but traditional blood glucose monitors – which rely on so-called static electrochemistry – are accurate only to plus or minus 20%. Many factors – from paracetamol to vitamin C – can distort blood samples. The challenge is how to improve the accuracy of blood glucose monitors, something Cambridge research has achieved thanks to innovative electrochemistry.

Why do chemical engineers make a difference?

Research on electrochemical biosensors in Professor Lisa Hall's lab in the Department of Chemical Engineering, University of Cambridge, has examined existing systems of blood monitoring, mostly applied fixed voltage stimulus to the electrochemical sensor and measured a steady-state current. Although this is a simple way to measure glucose concentrations, it is not accurate enough. This research applies a variable, wave-like signal instead. Together with some clever advanced processing this has allowed the biosensor to compensate for electrochemical reactions due to interfering substances such as paracetamol or vitamin C, as well as the glucose reaction itself.

This novel approach focuses on time-varying sinusoidal voltage waveforms to stimulate the electrochemical glucose sensor and generate a reciprocal sinusoidal response current. This enables the extraction of time constants related to the electrochemical reactions that are either specific to the glucose reaction or to an interfering substance (such as vitamin C). The time-varying nature of this approach inherently generates a measureable signal that contains more rich information (as compared to a steady-state response), and thus enables separation of the desired glucose signal from the interfering signal.

How has this made an impact?

AgaMatrix was founded in 2001. Its innovative technology – WaveSense™ – has now been built into a range of diabetes products including the diabetes iPhone App, iBGStar. Approved by the US FDA in 2011, iBGStar was the first smartphone-linked diagnostic device to gain FDA approval. It also won the Red Dot and Good Design awards – an honour shared with Apple, Mercedes and Bose products. As well as its iBGStar, AgaMatrix has developed more than 10 FDA-cleared products protected by more than 120 pending and granted patents worldwide.

By 2012, AgaMatrix had sold 3 million glucose meters and test strips, and today its products are sold in over 20,000 pharmacies worldwide. In 2013, the NHS in Staffordshire decided to give WaveSense™ Jazz meters to patients, saving the NHS £350,000. If the NHS adopted WaveSense™ nationwide, cost savings could top £4 million a year.

"This is a real step forward for patients, GP surgeries, hospitals and pharmacies."

Dr Manir Hussain, North Staffordshire and Stoke-on-Trent Clinical Commissioning Groups

"Smartphone apps – like the iBGStar – will help people take better control of their health."

Professor Lisa Hall, University of Cambridge

Impact

1 million test strips per month

Agamatrix UK now supplies over one million glucose test strips per month to the NHS. Agamatrix has developed more than 10 FDA-cleared products, including the first FDA approved smartphone linked diagnostic device.