



Monitoring diabetes remotely

- Patients need not be tied to either doctors' surgeries or their own homes if they need health trend monitoring
- By looking at the data collected over time, clinicians can better decide what treatments and therapies are needed.
- The project has integrated technological work with an understanding of care pathways.

By [Gillian Law](#)

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DIABETES is an enormous and growing problem for healthcare organisations around the world.

The 'Western' lifestyle - little exercise, poor food choices and lots of TV watching - has become increasingly prevalent around the world, and levels of diabetes are growing along with it. World-wide, the number of adults with diabetes is expected to rise from 135 million in 1995 to 300 million in 2025.

This forecast has huge cost repercussions for the hospitals, doctors' surgeries, healthcare insurers and governments who finance the care of those people.

Having diabetes also makes life very hard for patients. Even where the condition can be self-managed by exercise, diet and monitoring, regular visits to doctors and clinics for check-ups are difficult to fit in around work and otherwise busy lives.

Cardiff University's Welsh e Science Centre (WeSC) and Diabetes Research Unit (DRU) have worked with industry partners: IBM, Zarlink Semiconductor and Smart Holograms, in the Healthcare@Home project, to create new approaches to remote management while improving monitoring of treatment outcomes for patients with diabetes.

Sensor devices on the patient's skin or clothing can use Bluetooth or other wireless communications technology to connect to mobile phones to securely forward the sensor data to a health service database. Information based on trends in that data can be fed back to the patient for ongoing monitoring.

"One idea is to demonstrate that patients need not be tied to either doctors' surgeries or their own homes if they need health trend monitoring," says Alex Hardisty, manager of WeSC.

WeSC and DRU have worked with IBM on a scaleable Service Oriented Architecture (SOA) approach to monitoring. Grid computing techniques are used to federate distributed data repositories and to support data mining and analysis. Smart Holograms has developed wireless sensors that measure blood glucose and other analyte concentrations, while Zarlink Semiconductor has created a biometric fingerprint reader module for confirmation of identity. Data from both of these products is transmitted via Bluetooth to a mobile 'Smartphone' acting as a hub, and

from there forwarded to a home healthcare server, developed by IBM. A suite of phone and PC software to enable end-to-end capability has also been created by IBM.

The project has focused on coordinating a number of areas to create a streamlined, simpler system. "It's about integrating a number of distinct things. First there are the technologies that one uses to collect information about the patients – i.e. the sensors, the Bluetooth and so on. Then there's the collection of that information to a secure structured repository, where it's stored on an ongoing basis in relation to that patient. If the patient does go to a clinic the sensor readings history can be discussed with the clinician, eliminating the usual transcriptional errors in patient-held records", Hardisty says.

"For diabetes, readings include the concentration of blood glucose, blood pressure and lipids like cholesterol. These are all important to keep under control" he says.

By looking at the data collected over time, clinicians can better decide what treatments and therapies are needed.

Ensuring the security of data collected has been a significant part of the project. There are also strict ethical guidelines on data use and re-use and all steps must be authorised. Healthcare@Home has a two-layer authorisation scheme in place: anyone wishing to access data has to be identified, and so does any person entering new data.

The fingerprint scanner developed by Zarlink acts as an exemplar patient identification method following a validated registration procedure. This has to cope with multiple patient users e.g. living in the same home using the same set of sensor devices and hub, while avoiding all possibility of confusion of data. Contact- or contact-less smartcards that have identity confirmation functions may be used in other scenarios to increase patient and staff safety.

Wireless technologies security standards can also be raised by including a HTTPS connection or VPN (virtual private network) tunnel.

Through the DRU and its clinical Lead Professor David R Owens CBE, the team has a close relationship with the National Health Service in Wales. This relationship has ensured that healthcare policy such as the Diabetes National Service Framework (NSF) for Wales is a key driver. Software is therefore being used as a vehicle or translator of evidence-based best practice encouraged by the NSF. The management of diabetes needs to be appropriate to the individual and the stage of his/her condition. The complexity of diabetes management is a major challenge for any integrated information system. Creating a system that gives reliable warning signals that are trusted is actually quite a difficult undertaking.

The project has also integrated technological work with an understanding of care pathways.

"Care pathways are processes that specify how a patient with a particular condition should be dealt with as he or she moves through the healthcare system. In the case of diabetes, there are a number of stages of treatment that need to be applied with monitoring cycles, feedback loops and so on," Hardisty says. Enabling such a system to be scaleable and capable of being used from the level of a single GP's surgery up to a nationwide system - and have it adaptable for other clinical areas has been and remains a huge challenge, Hardisty adds.

"We now believe the concepts developed in the programme are transferable to other long-term chronic conditions. The disease model approach that is at the centre of Healthcare@Home is applicable to other conditions, such as heart disease."

Significant disease modelling work is ongoing to develop methods and for the purpose of integrating them into the same SOA framework.

As a research activity, WeSC and the DRU have also been examining how pattern matching can help recognise how a person's condition develops and on the basis of this, hope to create predictive tools.

"If you look at diabetes, there are a number of risk factors that have been identified as contributing to the way your condition will develop. For example, if you have a waist size in excess of 36 inches, then your outlook may be much worse than if you are a slim, lithe person. For every outcome, there are many potential risk factors and a clear focus of our research is to describe a generic methodology that identifies which factors are important in specified outcomes". Severe complications of diabetes can include retinopathy, kidney failure, circulatory failure leading to amputation of the lower limbs and/or cardiac failure and increased risk of stroke. The preventative principles of Healthcare@Home try to ensure that different bits of information, especially those critical to disease progression, are well managed.

At this point it may seem odd to compare diabetes management to aircraft engine maintenance, but the work being done by the Healthcare@Home team has parallels to that done by Rolls Royce in the DAME project ([link to case study](#)).

"We can take data streams, monitoring the patient for a month or a year and apply evidence-based risk equations to the data and make predictions on outcome. In a clinical research setting, these predictions then can be tested by separately acquired data. Like the DAME project, we look for specific patterns of events within time series data. For example, specific coincidence of rising blood pressure and changing glucose concentration in the blood (over a defined stretches of time, or with certain periodicity) might indicate something untoward. If you can spot those trends early (and reliably so not to create false alarms) one can trigger interventions that minimise risk according to best practice. It's not within the scope of Healthcare@Home, but follow-on projects will allow us to develop this predictive capability to a much greater level of detail," Hardisty said.

While much of the current project is likely to be taken forward by the companies involved, the risk quantification, stratification and pattern matching work creates considerable intellectual property for the University. "We have a strong interest in ethically exploiting that for sustaining the translational research programme of the University", Hardisty says.

If integrated information and communications technology programmes can help reduce risk for diabetes and other serious conditions then that is a hugely positive impact for both patients and healthcare providers. While developing these solutions for the UK, it is true diabetes is actually an overwhelming problem worldwide - including countries that aspire to Western lifestyles. The diabetes epidemics in these countries need individually-targeted education and evidence-based healthcare services that are scaleable. The approaches embedded in the workflows of Healthcare@Home therefore have future potential to help such services respond to increased demands in a scaleable manner.

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