Sarah Tucker was diagnosed with Type 1 diabetes when she was eight-years-old, but apart from a couple of “hypo’ hiccups” when her blood sugar dipped dangerously low, in those early years, she had — on paper — managed her condition well. During her teens, hormonal fluctuations were challenging, but by diligently logging her blood sugar readings, food intake and insulin doses, she managed to avoid major sugar spikes or troughs.

Yet when she was 28, a routine eye exam revealed the early signs of diabetic retinopathy, a common cause of blindness which affects more than 125 million people globally and is directly linked to poor glycemic (blood sugar) control. The fact that she was already showing signs of damage prompted Sarah to look for new ways to manage her diabetes more effectively. After searching patient forums, she discovered mySugr — an app which promises to “Make diabetes suck less!”

Both the tone and the technology were a world away from the paper records Sarah had used until then. The mySugr app streamlines the collection and management of diabetes data and provides an at-a-glance 24-hour overview of key metrics such as average blood sugar level, insulin used and activity. The app can be connected with other devices such as glucose monitors and fitness trackers, as well as external resources including Apple Health® and Google Fit, and it also provides estimates of HbA1c — an important long term measure which shows how well diabetes is being controlled.

Healthcare apps such as mySugr assist people with diabetes. Digital logging of metabolic control data is easier to manage than paper records.

Credit: mySugr

These features add an element of gamification which incentivizes patients by turning control goals into challenges instead of chores. Add-ons also include the ability to print out and send data to healthcare providers, so they also have a far more accurate and detailed picture of
each patient than paper records could provide.

Sarah, 32, who lives on the outskirts of London, says mySugr has made a “massive difference” in her life. “The app increases your attention to detail. It’s much easier to spot patterns and identify things you could be doing better. Before, I would never look back in my book unless something extraordinary had happened, but with the app you learn a lot more about how to balance your food and insulin.” As a result of being able to access and act on this data, Sarah’s diabetes is now so well controlled that the retinopathy which threatened her sight has been stalled. She is also now enjoying a second pregnancy free from any of the complications common to mothers-to-be with the condition.

**Giving patients valuable tools**

Bernard Vrijens, Professor of Public Health at Belgium’s University of Liege, believes apps like these are just one element in an Internet of Things (IoT) which will transform healthcare by linking a vast network of physical devices such as phones, fitness trackers, bathroom scales, medical devices and smart packaging via cloud-based platforms. This linkage allows enormous amounts of data to be collated, analyzed and made accessible to patients, clinicians and other stakeholders.

Being able to access this sort of real-time feedback gives patients the tools they need to help control their condition. It also ensures that treatment decisions, and conversations with healthcare providers, are based on complete and reliable data.
An obvious opportunity for improving health outcomes is tracking the way we take medicines. As Professor Vrijens explains, “For medicines to work effectively, they must be taken as prescribed — but non-compliance is a huge issue. 50% of patients with long-term conditions do not take their medications as advised.\(^2\)\(^3\) And as some have a very narrow therapeutic window, this can result in poor symptom control, or worse.” The European Union estimates that almost 200,000 people die every year because of non-compliance involving prescribed medicines.\(^4\) In the United States, it is thought that better adherence to anti-hypertensive treatments alone could save 89,000 lives a year.\(^5\)
The Internet of Things means healthcare professionals will soon be able to measure medical adherence.

**Bernard Vrijens**, Professor of Public Health at the University of Liege

Advances in sensors and connectivity mean it is now possible to create smart packaging which records the time a patient opens a blister-pack to take a prescription pill, or when – and how effectively – patients use an inhaler to prevent or treat asthma. Professor Vrijens adds, “We can use this information to give patients real-time feedback, via apps on their smartphones, reminding them to take their medication, or spelling out how much they have reduced their chances of getting better by not taking it properly. Studies show this sort of feedback improves compliance by nearly 20%.”

Being able to collate, access and manage patient metrics in this way improves compliance, and it also ensures that patients and their healthcare providers make treatment decisions through fully informed collaboration. With a patient’s consent, alerts and updates can also provide clinicians with an early warning of potential problems. “I think these should be part of the regulatory pathway for conditions such as schizophrenia or infectious diseases which are resistant to antibiotics,” says Professor Vrijens.
Getting smarter
How apps are used in healthcare

Since 2015, the percentage of apps used to manage the care and health conditions of patients has grown to nearly 40% of all health-related apps.

Using technology to treat tuberculosis

The potential benefits for both the individual and the healthcare system are enormous — as a groundbreaking project, pioneered in India, has shown. There, Operation ASHA is using this sort of real-time feedback to treat tuberculosis and combat the rise of drug-resistant infections in India, Cambodia, Uganda, Afghanistan, the Dominican Republic and Kenya. CEO Sandeep Ahuja explains, “Drug-sensitive TB is curable, but this requires daily medication, taken under
observation, for six to eight months. Symptoms usually clear after a couple of months, but if a patient does not complete their treatment, their disease is likely to become drug resistant and you will do more harm than good."

This risk and the danger of patients spreading drug-resistant TB to their family and friends is explained via a digital counselling program before treatment starts. Tablet computers carried by healthcare workers in the field are then used to ensure compliance.

The idea of Operation ASHA: A provider takes biometric fingerprints which track patients electronically, ensuring treatment compliance.

Credit: Operation ASHA

Every time patients attend an Operation ASHA treatment center to take their medication, their identity is confirmed via tablets connected to a fingerprint or iris scanner. This process automatically updates their medical records and, more importantly, sends an SMS text message to both to patients and their healthcare workers if a dose or meeting is missed. Healthcare worker have 48 hours to ensure the missed medication is taken. If this doesn’t happen, alerts are escalated to their managers and more senior staff. The collected data is also downloaded into individual Electronic Medical Records and made accessible to staff at all
levels for further analysis and planning.

So far, Operation ASHA has treated more than 75,000 patients with drug-sensitive TB and almost 400 with multi-drug resistant disease – and it has an unparalleled success rate of over 85%. Crucially, the drop-out rate is less than 4%, compared to more than 20% with treatment programs run by other NGOs and stakeholders. And Operation ASHA has already extended its applications to provide screening and treatment for hemophilia, diabetes, hypertension, heart disease and mental health. Company CEO Sandeep sees it as a powerful but low-cost tool which will transform healthcare by connecting people in the field with a vast network of physicians, educational materials, data and analysis.

**Health benefits through increased knowledge**

Besides monitoring sport and physical activities, fitness trackers have the potential to collect valuable health data.

Credit: Okapia/BSIP/B. Boissonnet

Professor Vrijens believes this Internet of Things will also have a huge impact on future drug development by ensuring far greater accuracy of data collected during clinical trials. “Healthcare providers currently monitor four main vital signs: body temperature, pulse rate, respiration rate and blood pressure. The Internet of Things means they’ll soon be able to measure a fifth – medical adherence.”

Operation ASHA shows that improving access to medical information and education can deliver real change and benefits without the need of enormous funding and infrastructure — a scenario that is as important for developed countries faced with rising healthcare costs and ageing populations as it is for less developed nations struggling to meet basic healthcare needs.

Its success is based on the simple idea that knowledge is power, whether this means educating patients about the importance of compliance and timely treatment, improving existing healthcare system capacity or using patient data to inform the development and delivery of new therapies. “Ultimately this will lead to more personalized and effective medicines,” says Professor Vrijens.

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