Clinical IT was set up by two NHS cardiologists to help physiologists and cardiology specialists, and it has a mission to transform both cardiology departments and patient care. With decades of experience in patient care gleaned during their work at NHS hospitals, founders Dr Alan Robertson and Dr Dougie Elder knew there was a real issue with the physical management of patient records, and a lack of satisfactory and secure means to transfer data securely from pacemaker programmers. The pair founded Clinical IT and set about filling an unmet need for efficient data management while also lowering the cost and increasing the speed of access to the thousands of patient records that were languishing in filing cabinets.

“Thanks to Raspberry Pi Zero W we’ve got a lovely compact, low-power solution that was spot-on for our requirements”

Inefficient paper-based records for patients with pacemakers and defibrillators presented an obstacle to effective care. Two NHS cardiologists set up EKORA to provide a streamlined system that protects confidentiality and saves clinicians time.

### Raspberry Pi solution
- Raspberry Pi Zero W

### Size of business
- SME

### Industry
- Healthcare

Customer story

EKORA cardiology device monitoring

Raspberry Pi is at the heart of EKORA’s user-friendly system for secure patient data management

EKORA cardiology device monitoring – Customer story
The challenge

Physiologists have huge patient lists, and need to assess data from pacemakers and other personal medical equipment easily so they can decide how well each patient is and make any necessary changes to their care. At present, this data is often output in the form of successive small sheets by a thermal printer integrated into a ruggedised laptop used solely for this purpose. NHS security protocols preclude more straightforward means of accessing and storing this data, which has led to a legacy of paper records still being kept and stored in filing cabinets in dedicated strong rooms in order to adhere to patient confidentiality requirements. With 7,000 cardiology patients on the books of the NHS Lothian region alone, paper record-keeping and laborious note-taking by specialist staff are very time-consuming. They can also easily lead to inaccuracies, and the resulting storage requirements take up significant areas of hospital real estate.

Furthermore, there are at least four manufacturers of pacemakers and defibrillators that patients may have fitted, so there is no single solution for conveniently accessing the electronic data using a single brand’s sensor reader. Details can, however, be downloaded to a USB thumb drive for access offline. Unfortunately, USB sticks are a known security risk, so hospital IT systems block their use for fear both of viruses and of leaking confidential data.

About a decade ago, consultant cardiologist Dr Alan Robertson of Ninewells Hospital in Dundee had been grappling with these issues and got talking to a colleague who was also a cardiologist. “We were basically fed up about not having an IT solution that helps us properly look after patients, so we decided to come up with something ourselves.”

Alan explains that some people get a defibrillator fitted because their heart’s response at times needs a strong electric shock to get them back to a normal rhythm. “That episode is the kind where you want to store what happened because it will actually show the heart rhythm during the episode and whether the treatment was appropriate. It’s something you don’t really want to lose. So therefore, we ended up having literally filing cabinets full of paper records”.

With plenty of non-networked devices that also held vital data he needed to read, Dr Robertson knew legacy hardware was another issue that would need to be overcome. “One of the pain points and issues we had was, when you have a patient who’s got a pacemaker, they come to get follow-up at the hospital and even though there is wireless connectivity there the information can’t be accessed due to security. They want to download information to a program on a special laptop and you want a way to get information out of that. You could get this information using a USB stick but in a hospital you can’t just use normal USB sticks due to NHS security. Our difficulty was how to get this information across.”

Faced with an ever-expanding patient list, Alan was delighted when he made the discovery that USB On-The-Go could be used in a similar way to a flash drive, and quickly realised that Raspberry Pi had the potential to provide a workable solution.
Support from the community and a well designed OS, Raspberry Pi OS Lite, made all the difference during development

Why Raspberry Pi?

Having been looking into Raspberry Pi for a while, Dr Robertson realised that it could play a role, especially as it can emulate a flash drive using USB On-The-Go. He then wrote code for Raspberry Pi Zero W "to pretend to be a flash drive"; when it is plugged in to the specially programmed pacemaker reader laptop, it is able to access the relevant information while this remains encrypted.

"You can save all information in an encrypted form and then it gets sent over the network back to the core system, which then is able to deal with it and process it," says Alan of the EKORA solution. This solved the problem of getting information from a standalone device into the network system.

The pacemaker programmers are, in effect, ruggedised laptops running custom software provided by the manufacturer, explains Alan. "Thanks to Raspberry Pi Zero W we've got a lovely compact and low-power solution that includes USB OTG functionality that was just spot-on for our requirements". Alan designed custom PCBs in KiCAD for touch control – an important factor was the sturdiness of the plastic casings and the fact they can be wiped down to reduce infections – with an OLED screen to feed back to the user "making excellent use of Raspberry Pi's GPIO capabilities (both I2C and SPI)".

The level of support available from the community and running on such a well designed OS as Raspberry Pi OS Lite made all the difference during development, he says.

The solution

In contrast to the patient-centric data reading devices that abound – Libre and Dexcom for glucose monitoring; Noom for calorie intake; others for cholesterol, heart rates, and other metrics – EKORA is specifically designed to be accessed and read by healthcare professionals. These specialists are able to securely access the patient information, but no one else can.

Code for the EKORA device has been developed and iterated over time using feedback from the physiologists who use it. No specialist computing knowledge on their part is required to operate it: once the Raspberry Pi Zero W inside has booted up, the device appears as a flash drive connected to the pacemaker programmer laptop. They can then save the data to it, and the data is automatically encrypted and securely sent over the network to the EKORA server.

Alan took charge of the EKORA box design himself, specifying the custom circuit board and working with a UK-based company, Custom Design Technologies, to create a case from "a particularly robust plastic since normal 3D-printed plastic wouldn't cut it" in a hospital environment. It was also important to minimise the risk of pathogens, so there is a ruggedised touchscreen with a wipe-clean surface rather than physical buttons for the user information screen.

Clinical IT has gradually evolved what was to become EKORA over the past six years, improving and refining their Raspberry Pi Zero W-based device. At present they are "investing money into other hospitals and places that use EKORA and trying to grow the business to continue to improve care for cardiology patients".

EKORA cardiology device monitoring – Customer story
The results

The system was trialled and rolled out in 2016 at the hospital in Dundee where Dr Robertson works and is now also in hospitals in Ayr and Edinburgh. During the Covid pandemic, the EKORA approach to holistic patient data really proved its worth. In fact, Alan says the broader purpose is being able to securely pull information from devices made by all of the five big pacemaker manufacturers, and from their different websites, to integrate it into one place. The aspect that Raspberry Pi helped with was “this important, in-person bit” when patients come into hospital for their check-up.

There was a risk with the previous, paper-based, system that urgent follow-up appointments were overlooked and learning from across the spectrum of cases could not easily be shared. Now, however, the secure and confidential EKORA system provides a central management system that can be set to flag urgent cases for follow-up and automatically schedule review meetings for each patient. This streamlines cardiology care, speeds up data downloads, automates readings, and stores records securely, while also freeing up physiologists to see more patients. Raspberry Pi USB On-The-Go secure data downloads from the cardiology programmers are the lynchpin for this setup.

The secure and confidential EKORA system streamlines cardiology care and frees up clinicians to see more patients

As well as hospitals in Scotland, Clinical IT are in discussions with a number of NHS trusts elsewhere in the UK and with health services in Finland and Sweden, and they also have an eye on expansion further afield. “At some point, I imagine all the programmers that we have in the hospital will start to go wireless. Already some companies have ones that are tablet-based but interestingly a lot of hospitals don’t like having things on wireless; they want to have it on a physical wired network.” This provides a new commercial angle for EKORA since it’s essentially a secure bridge between wireless devices and wired networks. The development of wireless programmers was something that might have made the uploader unit redundant, yet it appears in fact the opposite is the case. “It is slightly ironic,” says Alan, “but it looks like there will be an ongoing use for it for many years to come.”