WORLD'S FIRST TOTAL-BODY SCANNER

Dr Ramsey Badawi discusses a medical imaging scanner that can capture a 3D picture of the whole human body at once.

Among the usual displays, lectures and workshops at the recent annual meeting of the Radiological Society of North America in Chicago, delegates found it hard to ignore one display in particular – a collection of the first 3D scans of a whole human body.

The ground-breaking images had been produced by a full-sized positron emission tomography (PET) scanner called Explorer. The sensitivity of this new machine is said to be 40 times higher than any other existing PET scanner, which means it can capture images with much more detail and far more quickly. It also emits significantly lower levels of radiation and can follow radioactive-tagged tracers for longer. As a result, it has the potential to open up new avenues for biomedical research and clinical practice.

Explorer is the creation of two British scientists working at the University of California (UC) Davis: Dr Ramsey Badawi, Chief of Nuclear Medicine, Vice-Chair for Research in the Department of Radiology, and Professor of Biomedical Engineering; and Dr Simon Cherry, Professor in the Department of Biomedical Engineering and Department of Radiology.

The seeds of Explorer were sown in 1999 during Badawi's postdoctoral work in Seattle.

"They had a piece of software that simulated PET scanners," he says. "I was playing around with it and wondered what would happen if you made the scanner much longer. It raised the sensitivity, which was interesting."

Five years' later, working at UC Davis, Badawi was sat in an office with Cherry, knocking around ideas for a joint project. "I suggested we should try to build a longer PET scanner, and Simon said if we going to do that we should not take any half measures and just build one that could scan the whole body at one time. I was quite taken aback. It was bold thinking, but it felt right."

Not everybody saw it that way. "We got a measure of ridicule," says Badawi. "Nuclear medicine is a bit of a Cinderella field. It's much smaller than CT or MRI, and the research budgets are smaller. Most people said it was far too ambitious."

Ambitious, perhaps, but not in terms of the science. "I had realised back in 1999 that it could be done with the technology we had. The difficulty was going to be dealing with the data. You would need quite powerful computers and fast data transport mechanisms. But, intrinsically, there needn't be anything clever on the detector side or even on the electronic side to make it work. It was just a scale-up problem."

The other big hurdle was getting other people to have faith in the idea. "It is so hard to get the momentum going in nuclear medicine, to get people to believe it is worth doing a project of this scale. It took us 10 years to get to get the money."

The turning point was the introduction of a new funding mechanism, which got the idea in front of a panel at the National Institutes of Health, who could see the bigger picture and the promise of the project. In autumn 2015, they awarded Badawi and Cherry a research fund worth $15.5m.

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Their first impulse was to build the machine themselves. But, says Badawi, they soon realised that the actual construction of this potentially boundary-breaking device would be less important to them than the result. "We felt it would be better to work with a commercial manufacturer, who would have much better quality control and software than we could. Factors such as those could make all the difference. So we looked for industrial collaborators and settled on United Imaging Healthcare (UIH)."

UIH's commitment to turning the idea into an actual product that they would market swung the decision. "It's one thing to build a one-off and have it sitting in a research basement, but quite another to have it out in the field. We can't think of all the different things you could do with this scanner, but once we get some machines out there, we can answer the key question: does it really make a difference to human health? If the answer is yes, I think there will be a serious impetus for reengineering it to bring the costs down. I can already think of several ways to do that."

The prototype built by UIH produced the full scans that debuted in Chicago. "The results have been exciting," says Badawi. "When you plan these things you have a certain idea of how they might pan out. Often in engineering it doesn't work out the way, but this really has met our expectations so far. I think it might be able to help us answer all sorts of questions."

The key selling points for Explorer are the high-resolution images that allow medical practitioners to detect smaller lesions and low-grade disease, and the faster imaging that means they can scan more patients in any given period. "The low-dose radiation is also important, especially for long-term conditions, such as diabetes or arthritis," says Badawi. "PET scans wouldn't normally offer much, but frequent scanning is now a possibility. It would also be suitable for children and adolescents."

One potential drawback is that the sheer detail of the images might bamboozle doctors and technicians. "These new scans don't really look like normal PET scans. The level of detail is much greater, and we have colleagues wondering how on earth they are going to read them! I imagine we'll start by giving them very high-quality 20-minute scans, then the one-minute scans, which would offer more normal quality. But with this level of detail we need to work out a new normal."

All this work begins later in 2019, when the prototype, currently in Shanghai, is due to be shipped to UC Davis. "Then we can start doing some extensive testing, research and clinical work," says Badawi. "There's some really exciting science to be done."

DR BADAWI

- ✔ BSc in Physics with Astronomy in 1987, MSc in Astronomy in 1988 from the University of Sussex
- ✔ PhD in PET Physics at the University of London in 1998, specialising in normalisation and data corrections for fully 3D PET
- ✔ Postdoctoral fellowship at the University of Washington, Seattle
- ✔ Joined the Dana Farber Cancer Institute in Boston in 2000 – helped to set up their first clinical PET service
- ✔ Moved to UC Davis in 2004.