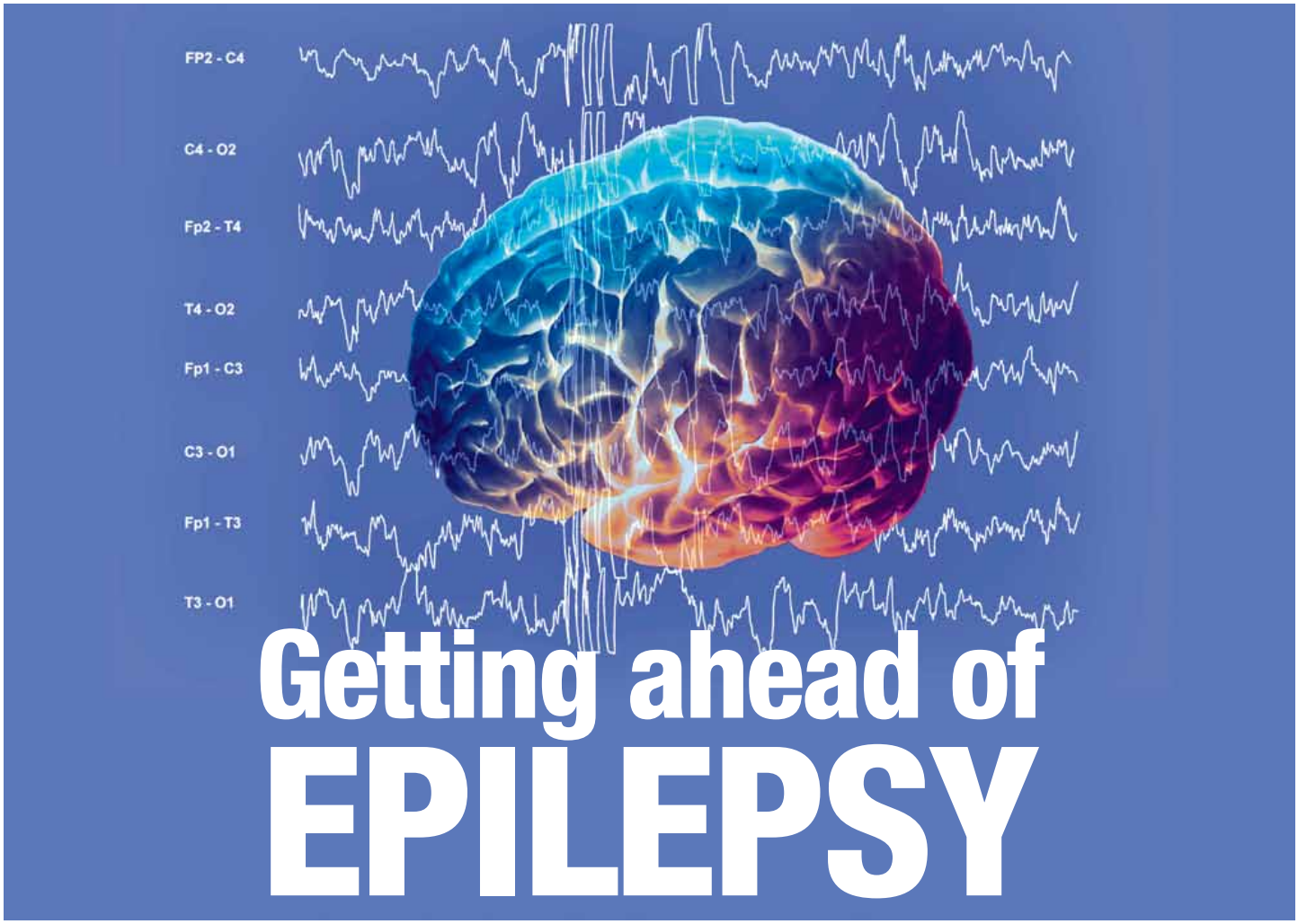

Getting ahead of EPILEPSY

Could developments in medical bionics lead researchers to the 'Holy Grail' for treating epilepsy?

MEGAN HOWE

YOU'VE no doubt heard about the bionic eye and the cochlear implant — some of the most famous developments in the fast-growing world of medical bionics.

But Professor Mark Cook is quietly optimistic that an even bigger group of patients — the 15 million people worldwide whose lives are disabled by uncontrolled epilepsy — have reason to hope they could be offered new, more effective therapies in the not-too-distant future, thanks to developments in neurobionics.

Currently, of the one in 100 people worldwide who suffer recurrent seizures throughout their lives, about one-third cannot be adequately treated with available medications or surgical therapies, the Melbourne neurologist and world leader in epilepsy treatment told the recent TEDx Wollongong event at the University of Wollongong, NSW.

"A lot of the problem with epilepsy relates to its unpredictability. We have to soak people in medications to prevent seizures that might be occurring for only a few minutes a year," says Professor Cook, head of neurology at St Vincent's Hospital, Melbourne and chair of medicine at the University of Melbourne.

"It prevents them driving, stops them from working, threatens their safety, costs their life sometimes."

But imagine if people with epilepsy could know when a seizure was going to occur. And what if the drugs to treat the seizure could be delivered directly to the affected part of the brain, exactly when they are needed. Or, even better, what if the seizure could be averted completely?

A compact, driven man with the knack of explaining exactly what his complex research could mean to patients, Professor Cook told the conference that groundbreaking Australian research into implantable devices is now making that kind of control over this unpredictable condition a real possibility.

One of the first implantable devices to be trialled in humans — including 15 Australian patients — is the Seizure Advisory System, which predicts when a seizure is likely to occur.

Developed by US company NeuroVista, the system involves permanently implanting electrodes on the surface of the brain to monitor electrical activity 24 hours a day. A pacemaker-like device implanted under the clavicle records the information and transmits the records, analyses and real-time ambulatory iEEG data to a small pager-sized device that the patient carries with them. It has a series of coloured lights: blue indicates a very low risk of seizures, white indicates a medium risk and red indicates a very high risk.

"If effective, it would remove a lot of the disability from people with seizures — it might let them get to work, play sport, conceivably even drive. It might be that you can provide therapies when their status changes on the recording," Professor Cook says.

While the device hasn't proved the answer for all the Australian trial participants — some have had it removed and some have gone on to have surgery — for young Tasmanian Jason Dent it has been life-changing.

In an interview with Epilepsy Australia 10 months after the device was implanted, Jason said that when a red light appeared on the monitor, he took fast-acting medication. As a result, the seizures that had previously dom-

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Neurologist Professor Mark Cook tells the Wollongong TEDx event how neurobionics could help people with epilepsy.

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inated his life — occurring suddenly and without warning — had completely stopped.

"I feel more confident in the things that I do from day to day and I enjoy the fact that I am not having seizures every fortnight," he said. "I feel like I have more control over my life, as before the seizure would come with no warning and stop me doing the things that I love doing, like my cricket and timekeeping at the local footy games."

Professor Cook says Jason's implant remains in place and, hopefully, can stay there forever. "Suddenly this changes everything."

In fact, the potential of these devices goes beyond simply predicting the onset of a seizure. "Conceivably you could use devices like these to actually control the release of drugs," says Professor Cook.

To try and make this vision a reality, he approached nanobionics pioneer Professor Gordon Wallace, founder and director of the University of Wollongong Intelligent Polymer Research Institute, and told him he wanted to "put drugs where they work".

Not having to give antiepileptics systemically could avoid the damaging side effects medication has on the CNS and elsewhere in the body.

"So that's what we do. We put the drugs we have in polymers and we implant them — at the moment in animals only … over the surface of the brain in the part where the seizures come from."

The potential of these devices goes beyond simply predicting the onset of a seizure.

Eventually, the electrically activated polymers might be able to actually drive drug release, he says. "Conceivably, we could construct polymer implants, which could not only release the drug but detect the seizure and use the energy in the seizure itself to release the therapy. This would be remarkable."

Marriage of two worlds

The epilepsy research he is conducting with the Intelligent Polymer Research Institute and the Bionics Institute at the University of Melbourne marks a long-overdue marriage of two scientific worlds, says Professor Cook.

"I have always been interested in how to join the medical sciences and the material sciences. It is difficult to understand what is possible if you have never had exposure to what people in this area can do."

While there are still big hurdles to overcome — the formation of suitable polymers for diffusing the drugs, finding the optimal medications and ensuring the implants are safe to use in humans — there is an air of optimism among those in the field.

Human studies of the drug-infused implants are a couple of years away but Professor Cook says it is entirely plausible that we could see such devices available to treat uncontrolled epilepsy within 5-10 years.

And if the polymer implants do not prove the answer, he says another approach to suppressing seizures — electrical stimulation of the brain — is also under investigation in a project run by the Bionics Institute in collaboration with St Vincent's Hospital, Melbourne.

Rather than predicting seizures, the implantable stimulator device will monitor the electrical activity of the brain via electrodes. If abnormal neural activity is detected, a therapeutic waveform is then delivered to the right part of the brain to stop the seizure (see image above).

"It might liberate us altogether of the need to take medications to treat epilepsy," he suggests.

The new research is finally shining a light at the end of a long tunnel for the many people who have unpredictable and debilitating epileptic seizures, says Epilepsy Australia chief executive Denise Chapman.

Those people face constant anxiety about when a seizure might occur, meaning both the loss of their independence and serious risks to their health.

"I think it's wonderful, it's a very exciting development," she says. "What promise it can hold for people with very difficult to control epilepsy to have that control and independence, to feel they can contribute and get out and work and participate in community life, "she says. "It could really open doors."

In a recently published paper on their research into drug-infused polymer-based implants, Professor Cook and fellow researchers stated: "The Holy Grail has so far eluded researchers in the field, however, strong progress is being made."

So are they truly within sight of epilepsy's Holy Grail?"

"I used that term about being able to predict seizures and people ridiculed me," Professor Cook admits. "We've got the old system where you ingest drugs and they soak the whole brain. Imagine if you could put the solution where the problem is. I think that is a bit of a therapeutic Holy Grail."

You can view the TEDx Wollongong conference talks online via www.tedxuwollongong.com, or watch Professor Mark Cook's presentation here: www.tedxuwollongong.com/Mark-Cook

Epilepsy: the impact

Among epileptic people and their family members

55% **had been injured as a result of a seizure, with 64% of those requiring hospital treatment for their injuries**

48% considered they had been unfairly treated because of their epilepsy at some stage in their lives

16% **had full-time jobs even though the majority were of working age**

49% were living below the current poverty line

78% **faced medicine costs between $11 and $300 per month**

61% were on multiple medicines for epilepsy

33% **reported full control (ie, no seizures over 12 months)**

Findings of survey of 343 participants on the Australian Epilepsy Research Register, 87% of whom were people with epilepsy and 13% were family members and carers.
Source: *'Out of the Shadows': Needs, Perceptions and Experiences of People Living with Epilepsy in Australia.* Findings from Wave 2 of the Longitudinal Survey, Epilepsy Foundation of Victoria, March 2012.

DIAGRAM OF A DEVICE (LEFT): Arrays of electrodes surgically implanted on the surface of the brain will monitor the complex patterns of brain activity. These signals will be sent to a processor (similar to a bionic ear stimulator) and proceed to detect/predict the epileptic seizure. Once a seizure is detected, a therapeutic electrical stimulus can be applied to the electrodes in the appropriate area of the brain to suppress the seizure.

Image courtesy of Bionics Institute.