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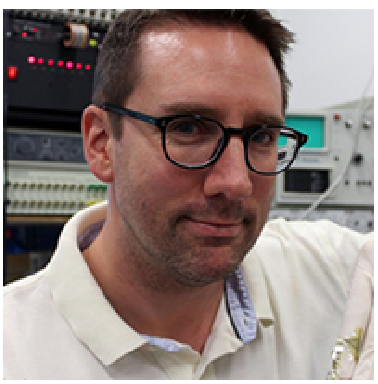

NEUROSTIMULATION FOR BLOOD PRESSURE CONTROL

Dr. Dennis Plachta

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INTRODUCTION

Millions of people worldwide take medication to control high blood pressure, but the treatment doesn't work for everyone. Kickstarting the brain into better controlling blood pressure using neurostimulation could help these patients. A group from the University of Freiburg, Germany recently showed that neurostimulation of the vagus nerve in five rats led to a 30% reduction in mean blood pressure (1). We talked to the lead author of the paper, Dr. Dennis Plachta, from the Department of Microsystems Engineering (IMTEK) about the development of this device.

IMPLANT

It has long been known that blood pressure can be modulated by the vagus nerve which wanders from the brain down the neck and into the abdomen, and researchers have often pondered whether hijacking this nerve could help lower blood pressure. However technology is only just catching up with theory, with researchers making use of the smaller, more reliable electronics of today to try this neurostimulation approach. Plachta's team has developed a neuroelectronic interface, or an electrode-studded cuff, that is wrapped around the vagus nerve in the neck. A wire leads from the cuff to a capsule in the armpit containing a microprocessor, a radiotransmitter and other electronics.

The device is named the BaroLoop; 'baro' meaning pressure, and 'loop' as a nod to the closed loop design of the implant. A closed loop, explains Plachta, 'is an intelligent device that gets feedback and decides on its own whether it's necessary to control a parameter', in this case blood pressure.

The BaroLoop wirelessly receives information on the patient's blood pressure, which is measured by another device. When high blood pressure is detected, the neuroelectronic interface is stimulated, explains Plachta, 'faking signals towards to brain' to trick it into instantly lowering blood pressure.

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>
> Dr. Plachta

This continual tweaking takes into account the natural daily variations in blood pressure, such as natural peaks in the morning and afternoon. This, as Plachta explains, is unlike pills. 'Once you swallow a pill, the agent is working on your complete physiology and the spectra of impact on your blood pressure is unchangeable, there's no way to reduce or increase the impact on blood pressure.

Our device is different because it continuously monitors the blood pressure and adapts towards whatever is necessary. For example, if blood pressure is relatively low, there's no need to reduce it further which would bring the patient into a form of hibernation!'

CHALLENGES

The vagus nerve doesn't just control blood pressure, it also manages many other functions including critical things like heart beat and respiration. A major technical challenge that Plachta and his team faced was how to 'you do not want the patient to vomit every time you stimulate the nerve!' The BaroLoop bypasses this problem by first sensing which of its multiple electrodes is closest to the nerve fibres that control blood pressure, and then stimulating only those fibres with the lowest level of stimulation possible.

A MOVE FROM BASIC SCIENCE

Plachta is a neuroscientist by training and spent his postdoc 'inventing all kinds of neuroelectronic interfaces to record from the brain.' The slow pace of basic research prompted him to dive into the world of medical devices. 'With basic research, you might only have moved the field forward by micrometres by the time you retire,' says Plachta, 'Engineering is completely different, you have a very dedicated aim and this makes your workflow much faster.' Close collaboration with the Neurosurgery department in the University of Freiburg helps keep up the pace of progress by allowing the team to quickly test devices that they have designed.

This fast moving form of research has brought its own set of challenges in the form of protecting their intellectual property and thinking about how to proceed in the future. 'We are using the university innovation office to inform us, and watching what other engineering guys did before us, to see what the typical beginner errors are, especially on things like IP and patenting,' says Plachta 'I'm in a learning process right now.'

All going well, Plachta estimates that the BaroLoop could be ready for a first-in-man study in 4 or 5 years. 'From this point on you have think in different scales and you can no longer operate in university so you must involve companies,' explains Plachta, 'A university can develop something but it cannot build something. We know we won't be able to do it on our own.'

PEARLS OF WISDOM

Plachta experienced no shortage of scepticism when he launched this project. A typical criticism he often heard was 'this is an old idea and you're going to be number one thousand and one to fail.' Even funding agencies were pessimistic, telling him 'So many scientists have already failed at this, what makes you sure that you're not going to fail?' Persistence paid off though and things changed when they obtained their first results and, as Plachta puts it 'we could actually show something'.

So what is Plachta's advice for researchers who are starting to develop a medical device?

'If everybody is against you, I recommend not giving up. Make sure that you have a different approach that no one has tried before. And don't listen too much to smart people who've been in the field so long that they know everything, because they might not know everything.'

REFERENCES

1. Blood pressure control with selective vagal nerve stimulation and minimal side effects. Avaialble at: http://www.ncbi.nlm.nih.gov/pubmed/24809832 Plachta DT, Gierthmuehlen M, Cota O, Espinosa N, Boeser F, Herrera TC, Stieglitz T, Zentner J. J Neural Eng. 2014 Jun;11(3):036011. doi: 10.1088/1741-2560/11/3/036011. Epub 2014 May 8.

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