Company profile

neuroloop GmbH: how the manipulation of neuronal information can lower blood pressure

Millions of people worldwide suffer from high blood pressure. However, taking medicines to control high blood pressure does not work for everyone. Dr. Dennis Plachta and Prof. Dr. Thomas Stieglitz from the Department of Microsystems Engineering's (IMTEK) Laboratory for Biomedical Technology at the University of Freiburg, and Dr. Mortimer Gierthmühlen and Prof. Dr. Josef Zentner from the Freiburg University Medical Center, have now developed a neurostimulator to control blood pressure. Together with Dr. Michael Lauk, an experienced company founder, the two researchers set up a company called neuroloop, which is funded by Aesculap AG and aims to turn the stimulator into a marketable commodity.

With their newly established company, neuroloop, the two managing directors Dr. Michael Lauk (left) and Dr. Dennis Plachta hope to place the Baroloop neurostimulator on the market so that patients can benefit from their invention.

Human blood pressure is not static; it changes with changes in daily activities. Older people usually have higher blood pressure than younger ones and blood pressure also increases when people are exercising or under stress. It falls when we are sleeping. Around twenty-five percent of the German population suffer from arterial hypertension. However, around 20 percent of sufferers do not respond to medicines designed to lower blood pressure. Researchers around the world are therefore looking for alternative ways of treating hypertension. In the course of progress made in the field of individualised medicine, patients suffering from Parkinson's, epileptic seizures, chronic pain and incontinence have had neurostimulators the size of a stopwatch implanted to control the disease symptoms. These neurostimulators are implanted under the skin and deliver weak electrical impulses to targeted nerve fibres, thus modulating abnormal nerve signals that cause tremor and other symptoms before they reach the tissue or brain.

Company establishment with the support of Aesculap

A few years ago while he was working as a scientific assistant at the University of Freiburg, Dennis Plachta was involved in a project to find a neurotechnological solution for regulating blood pressure that led to the development of a neurostimulator (Baroloop). In 2015, Plachta was awarded the FAIM Prize by the Applied Computer Science and Microsystems Technology Forum for this development. "High blood pressure stimulates the neuroelectronic interface, which then fakes signals to the brain and makes it instantly lower the blood pressure," explains the scientist. Together with Prof. Dr. Thomas Stieglitz, Dr. Plachta is in charge of the scientific work at the start-up, while Dr. Mortimer Gierthmühlen and Prof. Dr. Josef Zentner deal with the clinical aspects. Dr. Michael Lauk, a physicist and co-founder of several medical device companies was persuaded to join the venture to manage the company and deal with finances and market analysis.

"Finding investors is always the most difficult part of company foundation," says Lauk, talking from experience. "Placing the neurostimulator on the market is very expensive and the costs cannot be entirely covered from bank loans or money from your aunt, so to speak." The Tuttlingen-based medical device company Aesculap AG, a subsidiary of B. Braun, will inject the financial resources required to ensure that the company remains independent and does not need to borrow from a venture capital company. The neuroloop team consists of 15 well-trained engineers and scientists.

The neuroloop team consists of scientists and engineers who work together to optimise the product.
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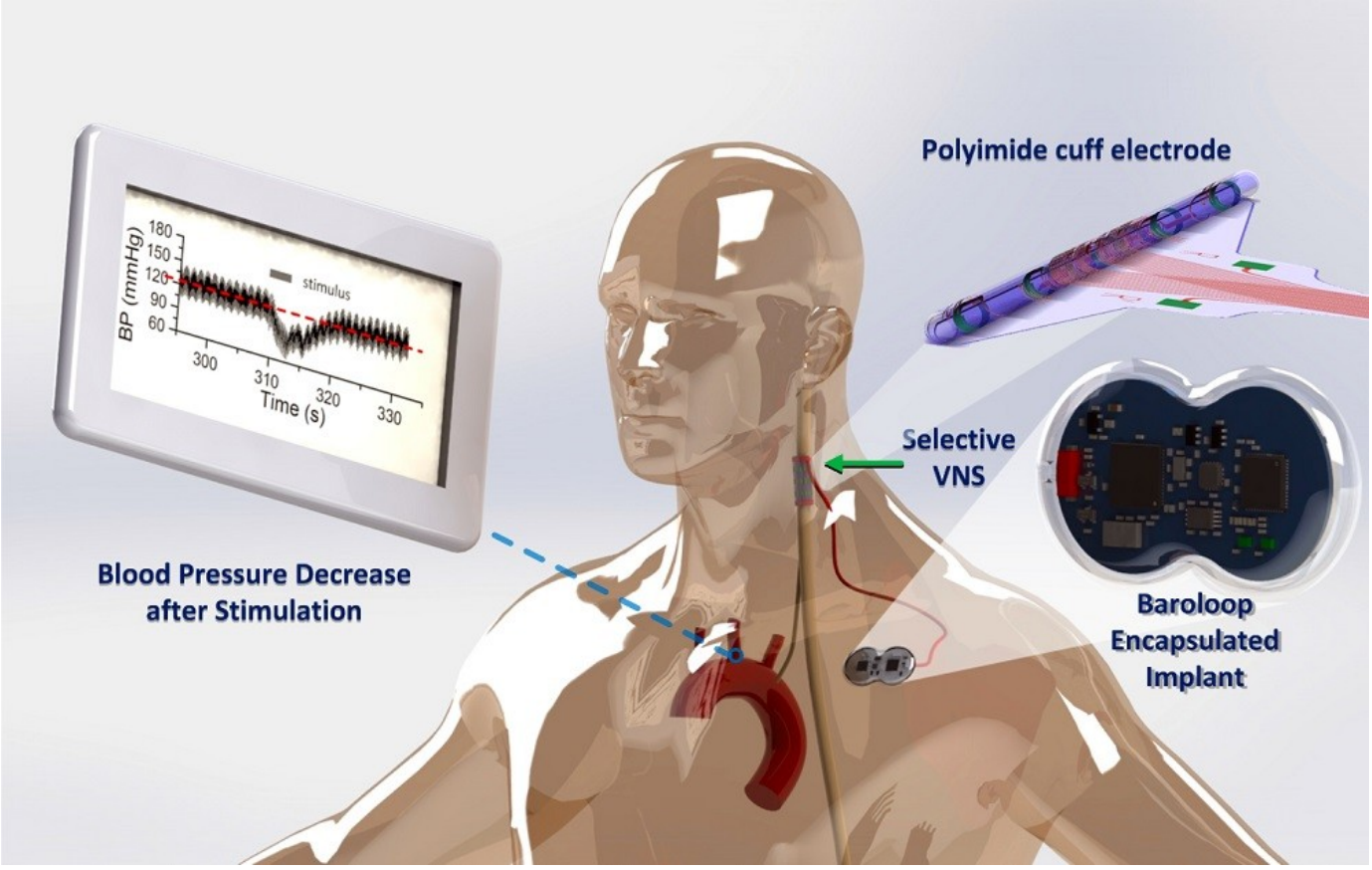
Selective nerve stimulation using a cuff electrode

The idea behind Baroloop is quite clever. The neurostimulator triggers the baroreflex, which is the fastest mechanism humans have to regulate acute blood pressure changes. Baroreceptors, which are present in the walls of the aorta and the carotid, react to pressure and transmit signals to the brainstem via the vagus nerve. If these sensors register a rise in blood pressure, the brain reacts reflexively, leading to changes in heart muscle power and the diameter of blood vessels. This is a negative feedback loop. Low blood pressure suppresses the baroreflex, causing the blood pressure and heart rate to rise again. "Our neuroelectronic interface does not penetrate the nerve, but is so selective that it primarily activates fibres that send a high blood pressure signal to the brain and makes them send fake signals to the brain, causing it to instantly lower the blood pressure," says Plachta. Care must be taken not to damage the protective sheath of the vagus nerve in order to avoid disturbing the sensitive neuron. "Due to the limited possibilities we have, we decided to wrap a cuff electrode around the vagus nerve," said Plachta. The neuroimplant needs to identify the baroreceptive fibres that carry blood pressure information in the vagus nerve (diameter: 2 mm) in order to select adequate stimulation sites and send signals that lower blood pressure via the baroreflex.

This is how the Baroloop works



Schematic showing how the neurostimulator reduces blood pressure via the vagus nerve. The polyimide cuff electrode is wrapped around the vagus nerve, stimulation of the nerve lowers the blood pressure. The cuff is connected to the titanium-encapsulated device implanted in the chest area.
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The technical challenge lies in detecting and selectively stimulating the baroreceptive fibres without interfering with other fibres in the vagus nerve. The largest parasympathicus nerve innervates the heart, gastrointestinal tract, kidneys and muscles of the vocal cords. Side effects such as hoarseness or nausea are not life threatening, but not particularly tolerable either. In order to selectively stimulate the fibres that transmit blood pressure information, the researchers have to find out where the fibres are located in the vagus nerve. They do so by carefully and selectively increasing the amplitude of the charge-controlled stimulation and observing whether this triggers a blood pressure change. "It is possible to find out from ENG (electroneurography/nerve conduction studies) and blood pressure whether the electrodes are located proximally to the correct fibres or not," says Plachta.

Selective neuromodulation is only possible through a special arrangement of the electrical channels inside the electrode. The cuff contains 28 channels, 24 (3 rings with 8 contacts each) of which are used to localise and stimulate the fibres. The cuff itself consists of a very thin flexible polyimide foil that is eleven micrometres thick in which the metal sheets of the electrodes are embedded. The cuff also has a shape memory; the metal expands when the nerve swells after surgery and later pulls together again. The cuff is connected with a titanium capsule containing the electronics and the battery. It can be exchanged after around five years, while the electrode remains in the body.

Market resonance and the pharmaceutical industry

Minor surgery is carried out to implant the Baroloop. Gierthmühlen implants the cuff in the neck area where stimulation is required. The titanium casing of the implant is implanted into the chest area and the two parts are then connected via a tunnelled cord. The advantage of Baroloop is that no irreversible changes are needed in the body and the implant can be switched off or removed at any time. The current Baroloop version still needs to be optimised and Lauk and Plachta hope to be able to launch a marketable version on the European market in 2021. Prior to that, clinical studies will need to demonstrate the effectiveness of the stimulator. Lauk and Plachta believe that market response will be excellent. The distress experienced by people who suffer from hypertension is often considerable, especially for those for whom drugs do not work and who need to take several pills to treat several diseases. These people would be delighted to be able to cut down the number of pills that they take. "It is estimated that several thousand people die in Germany every year due to overmedication," says Lauk. Lauk believes that the most effective treatment for high blood pressure is a combination of neurostimulation and medication.

Article

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Stephanie Heyl

Further information

neuroloop GmbH
Managing directors: Dr. Dennis Plachta, Dr. Michael Lauk
Engesserstr. 4
79108 Freiburg
Phone: +49 (0)761 154339-20 (Dr. Plachta)
Phone: +49 (0)761 154339-33 (Dr. Lauk)
E-mail: dplachta(at)neuroloop.de

E-mail: mlauk(at)neuroloop.de

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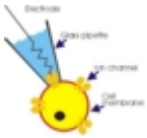

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