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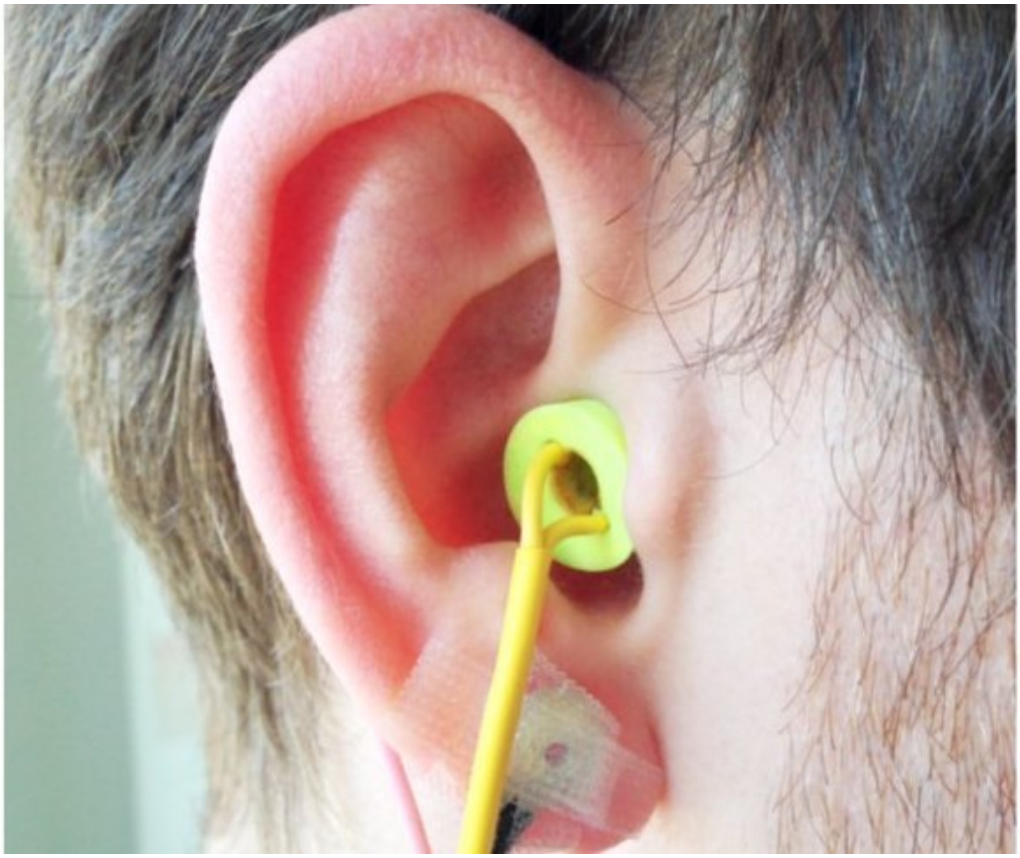
Prototype ear plug sensor could improve monitoring of vital signs

November 16 2017, by Caroline Brogan



Credit: Imperial College London

Scientists have developed a sensor that fits in the ear, with the aim of monitoring the heart, brain and lungs functions for health and fitness.

In previous pilot studies that involved trialling the device with 24 people, the researchers from Imperial College London have demonstrated the prototype's potential for monitoring brain, heart and breathing activity.

Now, the latest study from Professor Danilo Mandic's team from Imperial has shown that their 'Hearable' technology also has potential as a heart monitor. In the preliminary study, the new in-ear heart monitoring device was found to accurately capture heart data in six people.

The device detected heart pulse by sensing the dilation and constriction of tiny blood vessels in the ear canal, using the 'mechanical' part of the electro-mechanical sensor. The electrode part of the sensor is used to detect a full and clinically valid electrocardiogram, which records the electrical activity of the heart.

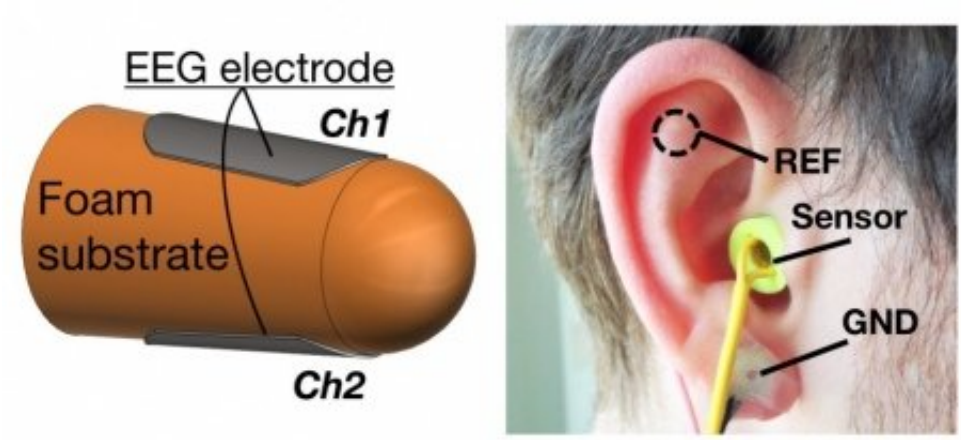
The new research was published in the journal *Royal Society Open Science*.

Based on these results and previous preliminary findings, the researchers suggest Hearable may in the future go on to identify and manage heart conditions such as heart attack or irregular heart beat, and also serve to observe the general health state of body.

They suggest the device for heart monitoring may also be easier and more convenient for patients and clinicians to use. Traditional electrocardiogram (ECG) testing involves wearing a chest belt for 24 hours. However, the in-ear device fits discreetly in the ear, meaning it can be worn for longer, providing a longer-term picture of the patient's heart activity.

Hearable is made of foam and moulds to the shape of the ear like a conventional ear plug. As well as mechanical sensors, it uses electrical

sensors to detect brain activity.



Credit: Imperial College London

Professor Mandic, lead author of the study from the Department of Electrical and Electronic Engineering, said: "This is the latest piece of research on what we think could be a versatile new piece of wearable technology. We've now completed a number of tests on our sensor that focused on detecting vital signs within the body. Our early results are proving interesting and, although we are still a way off from seeing it used outside of experiments, we have many exciting avenues to explore."

Future applications

The technology is still in its early development, but the researchers say the device also has other potential applications such as in sleep science and monitoring fatigue, epilepsy, drug delivery, and person authentication. By monitoring the brain, the device could be used as a new method for cyber security, where brain signals, much like the fingerprint lock on a smart phone, are used to activate a device. Unlike a

fingerprint, brain waves are impossible to forge.

It may also be useful in other settings such as in the health and fitness industry. By monitoring the heart and lungs, the researchers believe that the sensor could perform similar functions to wrist-worn fitness trackers.

However, unlike wrist-worn trackers, which monitor from the arm at the body's extremity, the ear-worn sensor, despite a relatively weaker signal, may get more stable results because the position of the ear relative to the internal organs is nearly always the same.

During previous pilot trials in humans, the researchers showed that the prototype can be used to monitor a combination of vital signs and brain function, which could be used to screen for and monitor stress, anxiety, sleep disorders, and heart disease.

Ultimately, the researchers are aiming for the device to wirelessly transmit the data to clinicians in real-time to provide immediate results and analysis. This could open up new possibilities in patient care.

For example, patients who are monitored overnight in sleep clinics are usually asked to wear lung, heart, and brain monitors, all of which provide an unnatural sleeping environment. The earpiece would mean patients could be monitored for a number of days and sleep in their own beds, while transmitting data in real time, to improve monitoring.

Professor Mandic said: "This is a very exciting piece of technology but its evidence in humans is limited. We will now work to put these preliminary results into practice and could eventually use this in real life situations."

More information: Wilhelm von Rosenberg et al. Hearables: feasibility of recording cardiac rhythms from head and in-ear locations,

Royal Society Open Science (2017). DOI: 10.1098/rsos.171214