Medical Xpress

Predicting epileptic seizures in advance is possible, research says

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Twenty minutes' advance prediction of an impending seizure for people with epilepsy is possible using advanced mathematical modelling, according to research published in a leading international science journal.

The research suggests this could be particularly valuable for patients with types of epilepsy that are currently very difficult or impossible to treat and where the only available option is to minimize the effects of the seizure.

The research by Professor David Corne of the Intelligent Systems Lab at Heriot-Watt University's Department of Computer Science and PHD student, Negin Moghim (published in *PLOS ONE*) used all the available Electroencephalography (EEG) data from an existing dataset [see note 1] and modelled it in ways never done before.

The results of their research indicate that by using predictive mathematical modelling, it is now possible to give up to 20 minutes' advance prediction of a seizure with considerable accuracy, in most patients.

Unlike earlier EEG analysis-based studies, where they tested their approach on one or two patients, the Heriot-Watt team tested their work on the datasets of 21 patients, all with types of epilepsy that are difficult or impossible to treat at the moment.

Epilepsy affects some 50 million people worldwide and while it can be managed in some patients using prescription drugs, the remainder are likely to have a relapse after the initial remission and some may even develop drug resistant epilepsy.

Patients with uncontrolled epilepsy can be suffer accidents or even death as well as a multitude of side effects such as memory loss, depression and other psychological disorders.

Speaking about his research Professor Corne said, "EEG datasets are increasingly being generated from scientific studies and made available to all. Such 'big data' that relates human activity to neural, neuromuscular or physiological signals, becomes useful when the right mix of advanced mathematics and computing is applied.

"Building predictive models from such data, gives rise to many exciting possibilities, both in terms of applications and by providing insight into how the brain works including predicting future mental or physical states some time before they occur.

"This could relate to both intentional events, such as predicting when a person who is standing still is about to start walking and unintentional events, for example predicting when someone is about to suffer an epileptic seizure."

With the wide use of digital EEG recording tools, these types of data are becoming more accessible for electronic manipulation. While EEGs were formerly used as a diagnosis and treatment specification tool , access to the digitised form of this information has helped generate new fields of research, from neonatal seizure detection to understanding how seizures unfolds in the epileptic brain.

Professor Corne commented "Being able to predict seizures and coupling this information with state of the art medical device technology, we should soon be able to provide unobtrusive wearable devices that provide accurate advance warning of seizures and allows patients to take prompt action to minimise the risk to themselves."

Background

Before a seizure happens, a number of characteristic, clinical symptoms occur. This concept has allowed researchers to study EEGs in a different way, to find correlates of such processes and identify the pre-seizure state.

The main question researchers have been addressing is whether characteristic features can be extracted from an EEG which correlate with the occurrence (and time of the occurrence) of seizures.

In that case, treatments could move from therapeutic and long-term preventive plans to on-demand
strategies (i.e. immediately before the seizure occurs), such as fast-acting anticonvulsant substances,
or deep-brain stimulation technology in order to reset the brain as soon as seizure activity is detected, to prevent the seizure happening.

How advance warning would work

People with epilepsy that is very serious or difficult to treat sometimes undergo invasive EEG, i.e. implanted monitoring electrodes (the dataset the Heriot-Watt team have worked with, comes from such invasive EEG) for a better understanding of where exactly in the brain the seizures start.

Monitoring of invasive EEG usually happens as a pre-surgical procedure for these types of patients. The approach developed by the Heriot-Watt team works with the data from this process to develop specific algorithms for advance prediction, personalised for that patient.

The next step in making this a practical reality for people with epilepsy is to incorporate these algorithms with a deep brain stimulation device that captures the brain signals and can effectively re-set the state of the brain when a seizure is predicted to happen, via a neurostimulator.

This could eventually be something as small as wristwatch or potentially even an App that's incorporated into a smart watch.

More information: Moghim N, Corne DW (2014) "Predicting Epileptic Seizures in Advance." *PLoS ONE* 9(6): e99334. DOI: 10.1371/journal.pone.0099334

The Freiburg EEG dataset epilepsy.uni-freiburg.de/freib … project/eeg-database

Provided by Heriot-Watt University

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