Epilepsy Devices – A New Window to Seizure Control

Researchers and doctors began their quest to end seizures in the early 20th century and, in the process, gave birth to the field of neuroengineering. Today this field offers new hope for people with epilepsy, especially for the nearly 400,000 Americans who live with uncontrolled seizures. Since the 1970s, a growing number of researchers in neurology, neurosurgery and neuroscience have focused their efforts on actively modulating neuron functions, networks and behaviors. Knowing when a seizure might happen – or stopping it before it happens – could dramatically improve the quality of life and increase the independence of people with epilepsy.

Neuroengineering, while still a relatively young field, is a rapidly emerging avenue for collaboration among clinicians, neuroengineers and others in the technology industry. These collaborations continue to uncover novel strategies for the treatment and continued study of epilepsy and other neurological diseases.

Major Advances in the Past 15 Years
Implantable devices have garnered widespread attention in recent years. These innovative devices are designed to predict, detect, prevent and abort seizures. Clinical trials of these technologies are yielding exciting results and, once FDA approved, these tools could potentially change the lives of people with uncontrolled epilepsy as part of standard clinical care.

Vagus nerve stimulation (VNS) therapy involves implanting a small device, similar to a heart pacemaker, in the upper chest and connecting it to the left vagus nerve in the patient’s neck. The devices, approved by the Food and Drug Administration (FDA), send regular electrical stimulation via the vagus nerve into the brain. Some patients find that this reduces the number, length or severity of their seizures. Often, VNS is used in conjunction with anti-epileptic drugs (AEDs).

Responsive Neurostimulation System (RNS) was approved by the Food and Drug Administration in 2013. Electrodes are placed on the surface of the brain or deep inside the brain at the site where the seizures are thought to originate. The device is trained, through a process known as ‘machine learning,’ to detect the patient’s specific abnormal electroencephalography (EEG) patterns. It then delivers a burst of stimulation to the area to abort the seizure.

Deep brain stimulation (DBS) therapy involves implanting electrodes into specific areas of the brain. These electrodes give direct electrical stimulation to the part of the brain that modulates seizure activity and seizure spread. Like VNS therapy, DBS aims to reduce the number, length or severity of seizures and is usually used alongside anti-epileptic drugs. This device also helps treat Parkinson’s disease, anorexia and some sleep disorders.

Work on the Horizon
Scientists are working on a device that can be implanted between the skull and brain surface to monitor electrical signals in the brain via EEG. A second device, implanted under the chest, transmits signals from electrodes in the brain to a hand-held device, providing a series of lights that warn patients of a high (red), moderate (white), or low (blue), likelihood of a seizure in the hours ahead.

Another device is worn in the ear canal, similar to a hearing aid, and measures the brain’s electric signals over several days using a process called EEG. This device is currently in development and may lead to applications for people with epilepsy.

In addition to these devices, scientists are applying findings from epilepsy research to the development of computer-brain interfaces that allow for artificial speech or for the development of treatments for certain speech disorders and face blindness, a condition that prevents a person from distinguishing one face from another.

The technologies underlying these devices are improving every day. To advance neuroengineering in epilepsy, the American Epilepsy Society (AES) has teamed with the National Institute of Neurological Disorders and Stroke, and Epilepsy Foundation to launch the Seizure Detection Challenge. This international competition is challenging the best minds in the field of machine learning to develop and improve devices to track and treat epilepsy. The winners of the competition will be announced in December at the 68th AES Annual Meeting.

Sources: