

Therapeutic Devices for Epilepsy

Robert S. Fisher MD, PhD

This talk will provide a brief overview of some interesting therapeutic devices being tested to treat seizure disorders. To date, only vagus nerve stimulation has come to market. Trigeminal stimulation: This is a vagus nerve stimulation-like therapy, but one that provides the opportunity to do a dry run with superficial stimulation of the supra-orbital nerves to identify responders before invasively implanting the electrodes. Uncontrolled experiments have suggested efficacy, but a controlled trial has not yet been completed. This therapy is in part supported by the Epilepsy Therapy Project. SUDEP monitor: Sudden unexplained death in epilepsy is a major problem and an individual tragedy. Researchers in the UK have developed an apnea monitor based on microphone pickup of breathing sounds. It can provide an alarm at 20 seconds of apnea. Seizure notification: Many parents of a child with epilepsy or children of a senior with epilepsy would like a wake-up call when their loved one is having a seizure. A wristwatch with a built-in accelerometer, called SmartWatch, can detect seizures and send Bluetooth signal to cell phones or other receivers. SmartWatch is in clinical trials at Stanford. Seizure prediction: much of the morbidity and even mortality of seizures might be reduced if people knew what they were going to happen. The future of seizure prediction is controversial, but research studies and preliminary clinical experience suggests that it may be useful for a subset of people with epilepsy. Brain cooling: Implantation of electrical cooling microplates on the surface of the brain can reversibly reduce neuronal excitation. Brain cooling has been effective in laboratory models of seizures. Several issues remain to be addressed, such as how to cool the deep folds of cortex, power consumption, heat dissipation and the invasive nature. Optical control: Proteins related to rhodopsin, which is found in retina can alter ion flow into neurons upon exposure to light. These proteins can be introduced by virus vectors injected into a seizure focus. Doing so renders the local excitability of brain controllable by implanted fiber optic light devices. This is a fascinating scientific tool, but whether it will be a therapy for epilepsy remains to be seen. Brain drug infusion: Local delivery of antiepileptic drug by a catheter pump could increase the therapeutic/toxic ratio by putting medication only where it is most needed. Animal experiments have been promising. Convection, utilizing slight injection pressure via the catheter, increases the distribution of the drug through brain tissue, which is important since drug distribution may be a limiting factor in this therapy. Hybrid neural implants: A laboratory in Purdue University is developing GABA-releasing neurons residing on microelectrode fibers. Electrical stimulation releases GABA. This can be incorporated into a closed-loop detection and stimulation device to release GABA. The concept is interesting, but the work is very preliminary. Transcranial magnetic stimulation: Magnetic stimulation can produce electrical currents in cortex near the magnetic coil. These currents might favorably influence a seizure focus. Unlike intense electrical stimulation, it is not painful. Initial trials of intermittent TMS have not been very encouraging, but the field is new. Deep brain stimulation: Over a dozen targets have been proposed for DBS to treat epilepsy. The two that are farthest along are anterior thalamic stimulation and responsive neurostimulation of cortex. Several other sites are being stimulated in pilot clinical trials. The SANTE trial (Stimulation of the Anterior Nucleus of Thalamus for Epilepsy, sponsored by Medtronic, with Robert Fisher as principal investigator) showed reduction of intractable seizures by a median 40% after three months double-blind stimulation, compared to 14.5% for sham stimulation. By three years of stimulation, seizures were reduced to one-third the baseline value. In this trial stimulation was given on a schedule of one minute on and five minutes off. Another trial, sponsored by NeuroPace, delivered stimulation in response to detected abnormal EEG patterns. This trial also had a positive outcome, and will be discussed in a subsequent talk. Device research in epilepsy is an active field and will likely generate some new products and new approaches.