Epilepsy Essay

28/06/2013

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The human brain – an electrochemical communicator

Electricity is the body's medium of choice for communication. It's a fast and universally understood common language - every cell has the potential to create or transfer electrical messages. To send these messages a complicated chemical process is needed to change a cell's resting negative electrical charge. Although used throughout the body, as the brain is the main communications hub, this electrochemical process is key to understanding how the brain works - and epilepsy's causes and treatments.

Seizures – a disturbance in the force

The brain cells generally transfer electrical messages at a rate of 80 Hertz (times sent per second). In the case of a seizure the rate of signalling changes, often increasing to 500 Hz (hyper-excitation), and the pattern of signalling changes, as groups of cells next to each other start sending messages together (synchrony).

This electrical disruption can affect a part of the brain (known as partial or focal seizures) or the whole of the brain (generalised seizures) resulting in strange sensations, emotions, and behaviour or sometimes convulsions, muscle spasms, and loss of consciousness. The location in the brain will have a direct relationship to the experience of the seizure. Some seizures may begin as a focal seizure, then spread to other locations.

Figure 1: Alice
It has been suggested that author Lewis Carroll may have experienced temporal lobe seizures. The symptoms of micropsia /macropsia (sensation of the body becoming smaller or larger) changed perception in taste, smell, emotion and memory all feature in his work Alice's Adventures in Wonderland.

Epilepsy – multi-factorial, multi-faceted

Epilepsy is a neurological disorder, diagnosed when a person has two or more unprovoked seizures. It is commonly referred to as the epilepsies or epileptic syndromes, representing a huge range of features and clinically distinct groups.

There may be many possible causes of seizures - genetic, illness such as meningitis, lack of oxygen at birth, brain injury - but in around half of cases, the exact cause is unknown.

Treatments

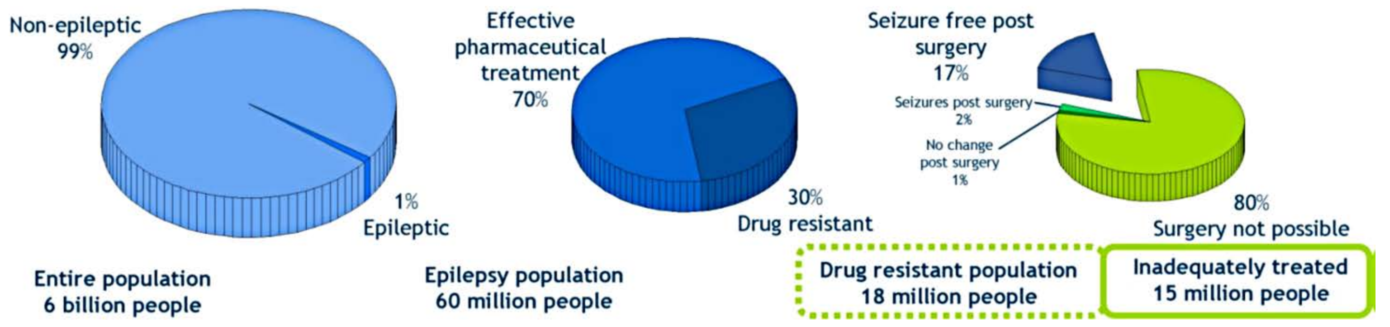

Figure 2: Worldwide statistics for epilepsy treatments

Drug Therapy

For 70% of patients drug treatment is effective in stopping seizures. Drug therapies work by changing the chemical processes that are needed for electrical communication in the brain. Some chemicals retard the brain cells' ability to send or receive messages (sodium and calcium channel blockers), others have an inhibitory effect on the brain's electrical activity (GABA). Some side effects experienced from drug therapy are the result of the chemicals not being targeted specifically to the potential seizure site, but affecting the whole brain, resulting in general lethargy.

Surgical Resection

Resective surgery means a small piece of brain tissue is removed. This process is inherently invasive, irreversible, technically challenging, and computationally intensive, requiring the continuous and coordinated input of a large team of hospital staff. However, the success in eliminating debilitating seizures is high.

Of the 30% of patients who do not respond to drug therapy only one fifth are suitable for resective surgery (see figure 2).

Vagus nerve stimulation (VNS)

VNS is a relatively new treatment for epilepsy. In 1997, the United States Food and Drug Administration (FDA) approved the use of Vagal Nerve Stimulation (VNS, Cyberonics) as an adjunctive therapy for focal epilepsy. On average, about 50% of VNS patients experience a 40% or greater reduction in seizure frequency and severity. It is believed the stimulation of the leads to the by the widespread release of two inhibitory agents - GABA and glycine.

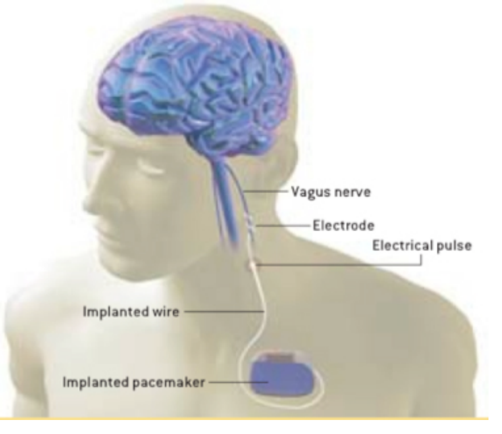

Figure 3: VNS system

Deep Brain Stimulation (DBS)

A new epilepsy treatment, DBS was originally developed for movement disorders such as Parkinson's.

The DBS system consists of three components:

- The lead (also called an electrode)—a thin, insulated wire—is inserted through a small opening in the skull and implanted in the brain. The tip of the electrode is positioned within the targeted brain area.
- The extension is an insulated wire that is passed under the skin of the head, neck, and shoulder, connectng the lead to the neurostimulator.
- The neurostimulator is the third component and is usually implanted under the skin near the collarbone. In some cases it may be implanted lower in the chest or under the skin over the abdomen.

Unlike resective surgery, DBS does not damage healthy brain tissue by destroying nerve cells. Instead the procedure modulates abnormal electrical signals from specific brain regions. Presently this treatment is experimental and not widely available.