There is confusion regarding whether to identify brain injuries as a traumatic brain injury, an acquired brain injury, or a combination of both. No matter what you call it, brain injuries are a major public health problem. This article demonstrates the power of the Low Energy Neurofeedback System, a form of electroencephalography biofeedback/neurofeedback, with a 71-year-old woman who had a sudden cardiac arrest and was without pulse or respiration for 8 to 10 minutes. NeuroField and hyperbaric oxygen therapy were added later on in the treatment process.

Brain injuries are a major public health problem. Whether to classify brain injuries as a traumatic brain injury (TBI), an acquired brain injury (ABI), or a combination of both differs from organization to organization. Injuries to the brain caused by birth trauma or congenital or degenerative disorders are not classified as TBI or ABI. Much of the data on brain injuries has been focused on TBI, as seen in the Centers for Disease Control and Prevention (CDC) surveillance summaries of hospital discharges (Langlois, Kegler, & Butler, 2003), the Report to Congress on Mild Traumatic Brain Injuries (National Center for Injury Prevention and Control, 2003), and the Standards for Surveillance of Neurotrauma (World Health Organization, 1995). TBI, as defined by the CDC, is an injury to the brain "caused by a blow or jolt to the head or a penetrating head injury that disrupts the function of the brain." Most TBI is the result of falls (leading cause), motor vehicle crashes, being hit by someone or something (e.g., sports injuries), being thrown against something, assaults/firearms, suicides, and blast injuries while on active military duty (Rutland-Brown, Langlois, Thomas, & Xi, 2006). The definition for TBI does not include the number of brain injuries caused by stroke, sudden cardiac arrest, anoxia/hypoxia, toxic exposure, viral/bacterial infection, or other disorders. In my experience, these injuries, which we categorize as acquired brain injury (ABI), can be just as significant. No matter what caused the injury to the brain, the symptoms and resulting disability are similar.

EEG Biofeedback and Brain Injuries

There is no doubt that electroencephalography (EEG) biofeedback can change the brain and make a difference in brain injuries. Reports from Ayers (1987, 1999), Harper (2005), Thornton and Carmody (2008), Hammond (2007), Larson (2006), Larsen, Esty, and Ochs (2006), and others clearly demonstrate the power of this technique.

Both traditional EEG biofeedback and the Low Energy Neurofeedback System (LENS) are noninvasive techniques that give information to the individual so that the brain can repair itself as much as possible. Both systems use the International 10–20 electrode placement of sensors on the scalp. The difference between the two systems is the manner in which the feedback is provided. The feedback in traditional neurofeedback is provided in the form of an auditory or visual signal when the brain reduces or increases the amplitude of selected EEG frequencies. The feedback with the LENS (a Food and Drug Administration–approved Class II medical device) is provided directly to the brain in the form of a tiny radiofrequency signal. The strength of this signal is of less intensity than that coming from a baby monitor, digital watch, or by holding a cell phone to the ear. The LENS feedback signal lasts about 1/400th of a second (Ochs, 2006). However, this very small amount of information is enough for the brain to change itself in positive ways.

LENS is a monopolar system using linked ears with one reference electrode and one ground electrodes for the ears and one active electrode. Ten-twenty electrode paste is used on the electrodes. NuPrep is used to prepare the scalp. A LENS map is different from a quantitative EEG (QEEG) map. The LENS map is a treatment process, as well as an information-gathering process, and conducting the map provides a guide to training. When obtaining a LENS map, each site of the 19 sites of the 10–20 International System receives 4 seconds of feedback: 3 of these seconds as background hum (no treatment) and 1/400th of a second of active feedback. After all 19 sites have been evaluated one at a time and treated, five topographic maps and bar graphs are created by the system. These data are presented in the...
form of mean delta, theta, alpha frequencies and amplitudes, as well as total frequencies and total amplitudes of all the sites evaluated. The bar graph presentation is described as a site sort. Here, each site for each map is arranged in sequence starting with the site with least amplitude and moving to the site with highest amplitude in the four amplitude maps. The fifth map is presented as the mean dominant frequency of each site and arranged from lowest to highest frequency. Data for the topographic maps are presented in various colors for the four amplitude maps and dominant frequency map. Here, the darker colors represent a quieter brain, whereas the brighter colors represent a more active brain. A brain can be too quiet or too active in all frequencies or in one or two frequencies. Some brains need to wake up, and other brains need to quiet down.

**Case Study: P.B. and Sudden Cardiac Arrest**

This story is about P.B., a patient who suffered an ABI after experiencing a sudden cardiac arrest (SCA). With an SCA, the heart suddenly and unexpectedly stops functioning. The electrical signals controlling the contraction of the ventricles become fast and chaotic. This is known as ventricular fibrillation. SCA is different from a heart attack. It is an electrical problem in which the heart stops pumping blood, whereas a heart attack is a plumbing problem caused by an occluded vessel. There are approximately 6 million deaths each year worldwide from SCA, with less than a 5% survival rate in the United States and less than 1% survival rate globally (Mehra, 2007).

P.B. was diagnosed with breast cancer in 2000 and treated with chemotherapy and radiation. In April 2008, at the age of 71, she suffered an SCA in her home. It is not unusual for cardiac problems (Bird & Swain, 2008) as well as cerebrovascular disease (Katz & Segal, 2005) to occur as a side effect of breast cancer treatment. Paramedics arrived within 10 minutes of the 911 call, found her without a pulse or respiration and in ventricular fibrillation. She was defibrillated twice and taken to the emergency department. She arrived with cardiopulmonary resuscitation (CPR) in progress, unconscious, and without pulse or respirations. Her pupils were fixed and dilated. As CPR was not started prior to arrival of the paramedics, her admitting physician estimated that she had been without oxygen for 8 to 10 minutes.

She spent 2 weeks in the intensive care unit and was discharged to the first of two rehabilitation centers. After discharge from the second rehabilitation center, she was sent to a skilled nursing facility in July 2008. Her admission records at that time listed anoxic encephalopathy, cognitive disorder with impaired orientation, language disorder with limited speech, feeding tube due to inability to swallow, spasticity/extensor tone, and unable to follow commands as some of her problems.

**LENS Training**

P.B. was first seen in this office in September 2008. She arrived in a wheelchair, unable to offer any help with the chair, nonverbal with constant random movements of head and arms, unable to swallow, and nonresponsive to verbal cues. LENS training was started with the first map, using a J & J I 330 C2 Plus 6TM.

The training consisted of following the LENS site sort, using the total amplitude map, beginning with the lowest amplitude site and moving upward in sequence toward the highest amplitude site. When there is a brain injury, one of the things noted on the EEG is an increase in amplitude in the lower frequencies as the brain slows down. Training frequently consists of lowering that amplitude, which results in an increase in functioning. Following the work of Larsen, Harrington, and Hicks (2006) in the 100-person LENS study at Stone Mountain, a decrease in the amplitude at the highest amplitude site (HAS) on the mean total amplitude map and at CZ on the same map over the course of training was used as a criterion for a positive change, along with feedback from the family.

NeuroField, an experimental energy replacement and stress-reduction device with no published studies to date, was added to the treatment in March 2009. This system was developed by Nicholas Dogris, PhD, to be used in combination with the LENS or as a stand-alone piece of equipment. It is not EEG equipment but does appear to affect the EEG in positive ways. NeuroField sends energy to the body through a traditional QEEG cap. The cap can be placed on the head or placed loosely over other parts of the body. The NeuroField protocols used with P.B. were brain fog and central nervous system repair. Hyperbaric oxygen therapy (HBOT; a medical device whereby the patient breathes 100% oxygen in a pressurized chamber) was started 2 weeks after the addition of NeuroField.

**Results**

Between September 2008 and February 2009, P.B. progressed from no speech to jargon speech to coherent speech, thanking her family for their love, help, and understanding. Although she still had a feeding tube, she started eating and asking for beans, cornbread, salmon, and wine. She was walking with the assistance of her husband of 50 years. All of these physical and functional changes in P.B. are documented in a DVD presented at the LENS conference (April 2009) and International Society for Neurofeedback and Research conference (September 2009).
The family reported that P.B. was even more alert after adding NeuroField to the treatment regimen and that she appeared calmer after HBOT. She still had moments of jargon speech. Her HAS as measured in microvolts on the total LENS amplitude map at the beginning of training was noted at T6 at more than 30 μV and at CZ at 25 μV (Figure 1). After 70 sessions using LENS, 14 sessions of NeuroField, and 40 sessions of HBOT through April 2009, the amplitude at T6 was reduced to less than 20 μV and the amplitude at CZ was reduced to 6 μV on the total amplitude maps (Figure 2). P.B.’s moving from greater than 30 μV to less than 20 μV at T6 is considered a significant positive change. As this amplitude was reduced, an increase was noted in P.B.’s functioning. She asked to brush her teeth, became agitated when others tried to help her, and wanted to do more things herself.
Why was P.B. among the less than 5% survivors of SCA? There may be several reasons: She was in good physical health, she was not alone when the SCA occurred, and she lived in a small community where the paramedics knew where she lived and was close to a major medical center. Why has she progressed as far as she has? She had a husband who was not going to ever give up on her, she had a close family of children and grandchildren who were actively involved in her daily care, and the family had the financial resources to provide all the care she needed. And, most important, she had the LENS. There is no doubt that LENS played a significant role in the progress she made as documented by changes in her ability to function as well as changes in the EEG. The addition of NeuroField and HBOT added to these changes.

**Future Considerations**

Much work needs to be done for individuals with brain injuries. Very little is available to them now. There is no standard of care. For those individuals who survive a major brain injury and remain in a persistent vegetative state or are classified as minimally conscious/responsive, even less is available to them and their families. When there is a major injury to the brain, individuals are unlikely to ever be the same as they were before the event. However, they are alive, loved, and deserve the chance to recover as much as they can rather than to be sent to a nursing home to die. Future work with this population must promise very little to individuals and families, hope for much, and document what is accomplished as well as what cannot be accomplished. There is a tremendous amount to be learned regarding the injured brain. The LENS offers great promise. It is critically important to be clear with future brain injury work exactly what kind of injury is the focus of treatment as well as the type of EEG equipment used and any combination of other modalities. Additional research in this area might discover that EEG biofeedback results in a better clinical outcome, depending on the type of injury or the combination of techniques.

**References**


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