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The Beneficial Amalgamation of Technology and Neurology

By Danielle Long

Every second thousands of lightning-fast electrical impulses are being transported across synaptic connections between neurons in the brain. For the millions of people worldwide who suffer neurological conditions, such as epilepsy, each one of these electrical signals carries with it the harrowing threat of triggering a life-threatening seizure. Serving as a volunteer at Carle Foundation Hospital in Urbana, Illinois for the past four summers, I have had the privilege of working with several resilient epilepsy patients who are desperate for reprieve from their condition. Communicating with these patients and hearing their stories sparked my curiosity about the treatment of epilepsy. As an aspiring nurse practitioner, I asked myself, *what if these patients were able to eradicate this threat by acquiring the ability to predict, control, and even prevent these seizure-causing impulses?* In researching this profound question, I made an intriguing discovery.

Astonishingly, technology with these miraculous abilities does indeed exist in the form of a neurologic implantation device with the power to monitor brain activity and forestall the onset of a seizure. This neoteric, innovative technology is known as the NeuroPace Responsive Neurostimulation Device, or the NeuroPace RNS System (“The RNS System”). The device is a small appliance, about the size and shape of an oversized flashdrive, which is surgically implanted on the surface of the skull or the outer tissue of the brain (Scott). Once inserted, the device immediately begins scanning brain activity, and if abnormal activity is sensed by the NeuroPace RNS system, the device fires electrically stimulating impulses to impede the onset of the seizure and prevent the injurious electrical impulses from triggering other irregular neural activity in surrounding regions of the brain (“The RNS System”). Miraculously, physicians have harnessed the device’s functionality to bring alternative treatment, in the place of intrusive

prescription treatment plans, to epilepsy patients suffering from unremitting, recurrent seizures. This has brought about an exciting movement in the neurology field and afforded hope to patients (Scott). In this manner, the NeuroPace RNS System exemplifies a revolutionary technological innovation in which epilepsy patients are able to reap tremendous benefits, both medically and psychologically.

With its unique design and its preventative abilities, the NeuroPace RNS System is unlike any electrical stimulation device of its kind, being comparable only to the cardiac pacemaker. Much like the cardiac pacemaker regulates irregularities in the electrical impulses that allow for the rhythmic beating of the heart, the NeuroPace device combats perilous electrical activity in the brain and responds to the threat of a seizure. However, unlike the cardiac pacemaker, the NeuroPace RNS System has the additional ability to store the monitored brain activity (“FAQ: NeuroPace”). This data can be digitally uploaded, shared, and viewed by patients and their physicians using computer software called the Patient Data Management System, or PDMS (“The RNS System”). Before the fabrication of the NeuroPace RNS system, neurologists had to rely on patient accounts for the details on the duration and severity of the seizures, since there was no way for the physician to continually monitor the patient without having them hooked up to an external brain monitoring device such as an electroencephalogram, or EEG (Scott). Therefore, because of the constant monitoring capabilities that the NeuroPace device offers, it serves as an invaluable advancement in neurological technology.

In addition to providing constant monitoring and targeted neurostimulation, the NeuroPace device significantly improves the quality of life for epilepsy patients who have previously been on a regimented treatment plan that required taking potent anti-seizure medications. Unfortunately, anti-seizure medications can have serious side effects, depending upon the patient and his or her specific medical background (“The RNS System”). I found this to

be the case for many of the patients I have spoken with while volunteering. Many of the patients reported that oftentimes the side effects of their medication are so severe that they are unable to leave their house until the medication dosage has been titrated down. The most commonly reported side effects of seizure-combative drugs are dizziness, headaches, drowsiness, reduced cognitive abilities, and even memory loss (Cass). Epileptic patients that experience these hampering side effects, including patients that I have worked with, are unable to participate in many of the activities of daily life, such as driving. The NeuroPace RNS System alleviates this burden by reducing the frequency of seizures and providing an alternative to potent medications so that epilepsy patients are able to feel in control of how they live their lives. Whereas anti-seizure medications deliver treatment continuously in the bloodstream when the patient takes them, the NeuroPace device only provides treatment when it deems necessary to prevent the initiation of a seizure (Cass). This makes the NeuroPace device evolutionary in the process of preventing seizures in patients that have previously struggled with severe, unpredictable seizures that disrupt their lifestyle.

According to statistics from the Epilepsy Foundation, approximately one-hundred and fifty thousand people develop epilepsy each year; therefore, the NeuroPace RNS system can have a significant impact on the lives of many people living with the neurological condition (Shafer and Sirven). Take, for example, the case of a young man that I worked with while volunteering (let's call him Andy) who has recently received the NeuroPace device. Andy was diagnosed with epilepsy roughly six years ago when he was seventeen years old; he suffered several episodes of seizures a week, which meant that he could no longer live the life of a typical teenager. He often missed school when he had to seek medical attention, and he could no longer drive. The seizures were severe and he lost a significant amount of brain matter, which greatly

impaired his academic growth. When he began taking anti-seizure medication, the side effects were nearly unbearable.

While the medication was successful in reducing the frequency of his seizures, Andy reported that he felt as though he was in a perpetual hazy state in which his thoughts and memory were unclear. He eventually decided to stop taking the medication, but found that he relapsed into having recurrent seizures and was forced to begin taking the medication again. However, now, roughly six years later, Andy has decided to go forth with the implantation of the NeuroPace device. With the device, he has significantly fewer intermittent seizures and he no longer has to take his potent anti-seizure medication, which has allowed him to begin driving again and to go back to school to earn his bachelor's degree. Andy's story is just one example of the many noteworthy benefits that the NeuroPace device has had in the lives of epilepsy patients, and it is my hope that his story will encourage other epilepsy patients to consider the NeuroPace device as a means of improving the quality of their own lives.

Although the NeuroPace device has many benefits, there are some downfalls of the system in terms of its ability to serve as the primary treatment plan for seizure-prone patients. For some patients, the risk associated with the invasive aspect of the implantation of the NeuroPace device makes them hesitant or ineligible ("FAQ: NeuroPace"). Also, because the NeuroPace device is battery operated, the device must be replaced every two and a half to three years; however, this requires only a small incision near the scalp, only large enough to remove the old device and replace it with a new one, and it does not require the reinstallation of the wires ("The RNS System"). The cost of the initial surgery also poses a problem for some patients, seeing as the combined cost of the device and the neurosurgery is nearly forty thousand dollars (Singh). But there is hope for patients facing financial strain, as many major insurance companies are now providing coverage for the surgery. In addition, as noted by the CEO of

NeuroPace, Frank Fisher, the operation “pays for itself” in that it reduces the frequency of seizures, limits the number of hospital visits, and improves the quality of life for epilepsy patients (Cass).

There are of course risks associated with the surgery itself, as well, such as the chance of unintentionally damaging surrounding brain tissue, resulting in irreversible cognitive impairment. In addition, although there have been no severe cases in the implantations thus far, there is the chance that the device could fire ineffectively or, when treatment is not needed, cause inadvertent effects (Cass). There is also the question presented by many patients regarding the interaction between the device and other electronics, such as cell phones. The NeuroPace Company assures patients considering the installation of the device that there is no evidence in the research done thus far that indicates that electronics, other than the computer software program used specifically for the NeuroPace RNS system, have an impact on the device’s functioning (“The RNS System”).

Although the NeuroPace RNS system does not cure epilepsy, it does serve as a monumental technological movement in neurology. As chairman of the Epilepsy Foundation, Warren Lammert, avows, “The RNS System from NeuroPace integrates the best of technology and neurology, and is an important new treatment option for these individuals and their families” (Radcliff). The NeuroPace device not only provides patients with a sense of control over the treatment of their condition, but it provides them with hope for a better life, a life consumed less by seizures. Although (like life in general) there are no certainties in medicine, the NeuroPace device offers the chance of significantly enhanced quality of life.

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