nerves that control muscles and movement. Inaccurate targeting of SCS can cause unwanted limb movement or twitching. However, targeting isn't as simple as it sounds, because it depends upon posture. Wood explains, "When you have an electrode running along the spinal cord, if you bend over, turn or twist, the relative position of the electrodes to the nerves that you are trying to target can change. As a result, you can get changes in the location of the paresthesia or unwanted motor activation."

Spinal Modulation plans on addressing another drawback of current SCS systems: the very large amounts of energy required to compensate for the fact that the spinal canal is an energy sink, since it's filled with cerebral fluid or, in other words, conductive salt water. Wood says, "You place electrodes on the outside of the spinal cord because you are trying to drive electrical energy through the cerebral spinal fluid to hit the sensory nerves, but most of that energy is lost." Therefore, the amount of energy required to deliver therapy is high, he says, and from a medical device perspective, that translates into a product that either requires a very large battery, or small rechargeable batteries that require frequent recharging.

Last but not least on the list of drawbacks, are parts of the body that Woods says are simply difficult to target with spinal cord stimulation—for example, pain that radiates axially up the back, foot pain, or diabetic neuropathies. "There are large groups of patients for whom SCS doesn't work well simply because of anatomy." Adding all that up accounts for the rather disappointing overall results of SCS, Wood says.

Without disclosing the technical approach of Spinal Modulation, Wood says "Let's just say that if you go through that list of problems with SCS from the inability to target precisely, frequent muscle stimulation, and high energy requirements, there is a significant need for improvement."

Spinal Modulation is entering the chronic pain market at a good time in its evolution. For years dominated by Medtronic, in 2001 Advanced Neuromodulation Systems came in and was followed in 2004 by Advanced Bionics. These companies have increased the visibility of SCS and, as noted, have grown the overall market.

PERIPHERAL NERVE STIMULATION PLAYS EARLY ROLE IN PAIN INTERVENTION

Because there are regions of the body and types of chronic pain that spinal cord stimulation just can't help—for example, chronic post surgical pain following an amputation, thoracotomy, hernia or mastectomy, or the occipital nerve implicated in chronic headaches—Jon Snyder, a former CEO-in-residence at BioEnterprise (a regional incubator in Cleveland, OH) started up Neuros Medical in 2008 to create a platform suitable for peripheral nerve block stimulation.

Snyder had a great deal of familiarity with the neurostimulation markets, having served as a sales and marketing executive at **Cyberonics Inc.** (Most recently Snyder was head of marketing for the surgical instrumentation division of Cardinal Health.)

Snyder didn't need to look far for the company's core technology. At BioEnterprise, he happened to be right across the street from **Case Western Reserve University**, where Kevin Kilgore, PhD, and Niloy Bhadra, MD, PhD, both with the department of biomedical engineering, were developing a neurostimulation device called *Nerve Block*, to treat pain that originates in the peripheral nervous system. Neuros gained an exclusive license to that IP from Case Western Reserve University, and in 2009 raised a series A round of $1.8 million from North Coast Angel Fund, Glengary Ohio Tech Angel Fund, Queen City Angels First Fund III and individual investors.

Neuros is developing a device that consists of an electrode, which is attached at one end to a particular nerve in the peripheral nervous system and at the other to a small pacemaker-sized stimulator that can be placed in the lower leg, the outer thigh, the chest pocket or the abdomen, depending upon the particular pain application.

According to Snyder, Neuros is offering something very different from spinal cord stimulation. "We stimulate at a much higher frequency. Spinal cord stimulation fires at about 30-100 herz. We stimulate at about 5,000 herz, and as a result, block nerve activity at the focal point in the peripheral nervous system where the pain originates." Snyder explains that in contrast, SCS doesn't stop the pain signal in its tracks; instead, it masks it, creating a feeling of tingling along the spinal column.

Neuros plans to first enter the market with a focus on residual limb pain, for patients that continue to feel pain at the stump post-amputation. (This is distinct from phantom limb pain, where patients' pain seems to originate from the place where the limb used to be.) There are almost one million patients with intractable residual limb pain, according Snyder, which can arise when small benign tumors called neuromas develop on the tip of cut nerves. Only 30% of patients with residual limb pain respond to currently available treatments.

To increase its odds for success in the clinic and with payors, Neuros has adopted the model of SCS, screening patients to determine which can benefit from *Nerve Block* before the implantation procedure. Before the surgery, the pain physician will inject lidocaine or another short-acting local anesthetic into the treatment area. If the patient experiences pain relief, he or she will be a good candidate for the Neuros technology.

Snyder notes that in contrast to other companies working in neurostimulation, Neuros knows the mechanism of action of its therapy. "We are blocking the action potential of a particular nerve. Knowing the mechanism of action, then showing that it works in a clinical study, will be helpful in gaining adoption," he says.

Future large potential markets for the Neuros peripheral nerve blocking technology include post-surgical patients with chronic pain, of which there are 500,000, occipital neuralgia, perhaps chronic migraine, which afflicts 25-30 million patients in the US, and facial pain caused by trigeminal neuralgia. Neuros plans to begin clinical trials in 2010 and hopes to be on the market by 2012.

Both because the company can predict which patients might benefit from its treatment and because that treatment is easily reversible (simply by turning it off) Snyder believes that *Nerve Block* has the potential to move up in the treatment continuum, before opioid use. Of course, with a device in the $15,000-$16,000 range cost is an issue, but Snyder says in chronic pain, he thinks use of the device will yield an ROI in three years in terms of the medications a patient would have otherwise used in that time frame. In addition, lost days of work and the financial impact to the overall economy are hidden costs due to poorly managed pain, he says.