EDITORIAL

Surgical Experimental Neurotherapeutics

There are many devices currently being used to treat neurological diseases and psychiatric disorders. Although spine instrumentation is more commonly used than any of the devices covered in this issue, we have decided to focus on devices used for neuromodulation due to our personal interests and our belief that such devices are especially suited to experimental neurotherapeutics.

A major advantage of such devices is that their settings can be varied in a range that includes no output or outputs that are not associated with perception by the patient. For many such stimulation therapies, this means that efficacy can be rigorously tested in a randomized double-blind manner. Even spinal cord stimulation (the efficacy of which was thought to be dependent on the patient's experiencing paresthesias in the area or areas affected) has been shown to improve cardiac function at levels that are subthreshold for paresthesias.¹

Many of these therapies, such as deep brain stimulation (DBS) of the subthalamic nucleus (STN), have been developed from basic science experiments. In addition, much has been learned about the structure and function of the human brain from intraoperative electrophysiologic recording during implantation of these devices. With the ability to vary stimulation parameters, we can learn about the structure and function of various brain nuclei and pathways. The new horizons opened by the development of neuromodulatory techniques and increased understanding of how the nervous system works is what prompted us to become functional neurosurgeons and what is driving the field.

It is indeed an exciting time in this field.² There are well-established therapies, such as DBS for specific movement disorders,³ spinal cord stimulation,⁴ intrathecal drug delivery,⁵ sacral nerve stimulation,⁶ and vagal nerve stimulation for epilepsy.⁷ Other therapies have FDA approval but are only now becoming more well known, such as peripheral nerve stimulation.⁸ Auditory brainstem implants are FDA-approved, but—at least for now—only for a very small patient population.⁹ There are expanding indications for use of well-established devices,^{7,10–12} and there are completely new types of devices, like the responsive neurostimulator RNS device by NeuroPace (Mountain View, CA), which is currently under trial.¹³ We have also solicited articles by leaders in the field who are actively developing new ways of delivering electrical stimulation, medications, and gene therapy into the

central nervous system.^{14,15} The issue concludes with reviews of ongoing translational research which is at an earlier stage, such as brain-machine interfaces for people who are locked in after stroke, traumatic brain injury, or spinal cord injury.^{16,17}

We hope you find the articles selected for this issue to be helpful in assessing the current state of functional neurosurgery. At the rate this field is progressing, this issue presents a snapshot of a rapidly evolving field.

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