Nonpharmacological Therapies for Neurologic Devices

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Introduction

There are a number of compelling reasons to consider a role for medical devices in addition to pharmacological, cellular, and biological therapies in treating disorders of the central nervous system.

1. Implanted devices can be targeted quite precisely to affect subcircuits of the brain so that their use in engaging targets and avoiding off-mark effects is often more favorable than therapies that are given systemically.
2. The therapeutic window of use of modern devices is increasingly advantageous. Because these devices can be adjusted, their outputs can be tailored to maximize clinical benefits and to reduce adverse effects.
3. Another important emerging development is the increasing role for so-called noninvasive or minimally invasive procedures. This includes, for example, gamma knife radiosurgery or focused ultrasound.

This issue of *Neurotherapeutics* is devoted to highlighting some of the advances in medical devices used to treat neurological disorders. It focuses on both implanted devices and the transcranial application of therapeutic radiation and ultrasound to treat various disorders.

The first theme involves the use of deep brain stimulation (DBS) and spinal stimulation. Over 100,000 patients

worldwide have now received DBS, predominantly to treat Parkinson's disease. Its use in movement disorders is reviewed in this issue by Larson [1]. With the success of DBS in treating movement disorders, the possibility of taking on other disorders is now in sight, and clinical studies in various phases of development are underway in a number of disorders, including depression (Morishita et al. [2]), obsessive compulsive disorder (Lapidus et al. [3]), pain (Pereira and Aziz [4]), epilepsy (Laxpati et al. [5]), and even disorders of memory and cognition (Sankar et al. [6]). There is also the realization that other peripheral targets may be useful. In particular, spinal stimulation may be useful not only to treat pain as is often used (Slavin [7]), but also that this is an area of opportunity, and there may be a role for spinal cord stimulation in treating other disorders, including movement disorders, with the view of disrupting pathological rhythms in the brain by stimulating the spinal cord (Thiriez et al. [8]).

A second theme revolves around specific technical advances, including the emerging use of implanted cortical electrodes. With advances in stimulation, the increasing sophistication of these procedures will continue. We will see, for example, closed loops stimulation systems, as outlined by Sun and Morell [9], and an increasing number of electrode designs and feedback mechanisms, including the examination of implanted cortical electrodes to treat a variety of disorders (Panov and Kopell [10]), and to enhance plasticity and recovery after stroke (Plow and Machado [11]).

The third component of this issue involves the intracranial application radiosurgery, as well as focused ultrasound. While gamma knife radiosurgery is well known, its use in functional neurosurgical procedures, including epilepsy, pain, movement disorders, and psychiatry, is increasing, and this is expertly reviewed by Regis [12].

Finally, an exciting new area that may be important in future therapeutics is magnetic resonance-guided focused

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ultrasound. This can be done both to place focal pinpoint lesions or ablations in the brain, and to open selectively and temporarily the blood–brain barrier for the delivery of chemotherapeutic agents and biologicals. This exciting area is reviewed by Lipsman et al [13].

Overall, there is a tremendous amount of activity in the field and many promising new therapies, and it has been very satisfying to be able to collect these expert reviews and advances in this issue.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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