About the Editor

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Jerrold L Vitek is an internationally renowned neurologist who specializes in the surgical treatment of movement disorders. He obtained his MD and PhD in neurophysiology from the University of Minnesota (USA) in 1984, he completed a neurology residency at the Johns Hopkins Hospital (MD, USA) in 1988 and served on the faculty at the Johns Hopkins Hospital, Emory University (GA, USA) and the Cleveland Clinic (OH, USA) before becoming Chair of Neurology at the University of Minnesota in 2010. He has been a pioneer in the field of deep brain stimulation (DBS) and surgical therapies for the treatment of movement disorders. His primary research interests include the development of DBS and other surgical techniques for the treatment of neurological (Parkinson's disease, dystonia and tremor) and psychiatric disease. His work in understanding the physiological mechanisms that underlie the development of Parkinson's disease and dystonia and how DBS works to improve movement in these patients has led to the advancement of novel brain targets and new applications for DBS in the treatment of these and other brain disorders.

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Foreword

Deep brain stimulation: technology and applications

Jerrold L Vitek

Next to the discovery of dopamine-replacement therapy, never has any single approach impacted the treatment of patients with Parkinson's disease (PD) as much as deep brain stimulation (DBS). Conceived as an alternative approach to lesioning for the treatment of patients with tremor, DBS has evolved from a single target (the thalamus) for a single disorder (tremor) [1], to multiple targets for a variety of movement, psychiatric [2,3] and, most recently, cognitive disorders [4–7]. DBS has revolutionized our approach to the treatment of patients with advanced PD, with documented benefits as long as 10 years postimplant [8]. Children and adults with dystonia have gone from marked disability and unable to care for themselves to full independence [9]. The evolution of DBS from the treatment of tremor and other movement disorders to the treatment of epilepsy, depression, obsessive–compulsive disorder and tics associated with Tourette's syndrome, however, has not gone as smoothly. Although highly successful for some, reducing tics in a high percentage of patients with Tourette's syndrome [10], it has not been as successful for other disorders; a recent DBS study for epilepsy showed a treatment difference only in the third month of the blinded phase and it did not get US FDA approval [11]. Multiple factors including an outlier and the dependence of therapy on the region of seizure origin were complicating factors. Results may vary even for disorders where its utility has been well established (i.e., tremor, PD and dystonia). Its mechanism of action remains under debate [12], as does the role of microelectrode recording in defining the target

site for lead implantation. There is still a great deal to be learned about this tool even as its role in the treatment of new disorders, such as obesity and addiction, is being explored [13].

Unlike ablative procedures, DBS therapy is titratable and reversible, allowing one to explore its effect on a disorder with relatively low risk, which is primarily that associated with the initial surgical placement of the device. This has led to its application for a variety of neurological and psychiatric disorders at a pace that far exceeds our understanding of the disease process, optimal target identification or how DBS elicits its beneficial effect. There are those who see the application of DBS not only as a means by which to improve the symptoms of a given disorder, but also to slow its progression. This is a tool that begs technological advancement and optimization but is highly dependent on the integration of multiple disciplines, including biomedical engineering, imaging, neurology, neurosurgery, psychiatry and the neurosciences. Although initially slow in coming, technological advancements in DBS have now gained momentum with new approaches utilizing new lead technology and stimulation paradigms [14,15], current sculpting and closed-loop programming [16] being wedded together to form a new generation of DBS devices.

Volume I of this book will highlight key features of DBS techniques, technology and mechanistic theories. Moving from principles and technology, to implantation techniques and computational modeling. Moreover, it will provide an overview of the principles associated with programming DBS devices, how this can be adapted in real time using physiological biomarkers, and it will revisit the literature with a critical eye giving some insight into what DBS holds in store for us in the future. Volume II addresses the multiple applications that have now been studied, are currently being explored or have been proposed for treatment with DBS. Starting with PD and evolving through other movement and psychiatric disorders, as well as addiction, epilepsy, obesity, headache and pain, this volume provides a comprehensive overview of the current and potential role of DBS in the treatment of neurological, psychiatric and other disorders. Taken together this two volume set will bring together the basic principles and current understanding of DBS applications and technology, while looking ahead to the future of neuromodulation and the next generation of therapies beyond DBS. This book will give an overview of where DBS stands as a therapy for various disorders and where it is headed.

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