EDITORIAL

Next Generation Programming

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Ever since the advent of deep brain stimulation (DBS), optimal programming of the DBS generator has been considered a challenge, embraced by some and avoided by others. The task of maximizing the potential of DBS therapy may be extremely time consuming and complicated by multiple confounding factors especially medication, the mental state of the patient, and the intrinsically empiric nature of the process. Recently introduced segmented electrode design and newer pacemaker technology enable the volume of stimulation to be individually tailored by way of directional current steering, and this has already been demonstrated to widen the therapeutic window. The increased number of electrode contacts and parameter permutations is, however, associated with an amplified level of complexity for the programming physician.

Hope is at hand! Several publications in this issue of *Movement Disorders* shed light on how programming may actually be made simpler, more efficient, and potentially even automated. Beta oscillations recorded by both local field potentials (LFPs) and spiking activity in the dorsolateral subthalamic nucleus, are considered to be a relevant biomarker for the akinetic and rigid symptoms of Parkinson's disease (PD). Tinkhauser and colleagues[1] report on how the optimal contacts on a segmented electrode may be selected utilizing intraoperatively recorded LFPs. In 12 PD patients, the 2-contact combinations that recorded the highest relative beta oscillatory activity were nearly always those chosen as the optimal contacts for long-term stimulation with the widest therapeutic window. This has been shown before for nonsegmented leads or "ring" contacts. The ramifications for surgery are that it may no longer be necessary to orientate segmented electrodes in any one particular direction. Beyond the spatial domain of which contact to use, Bouthour and colleagues[2] and Steigerwald and colleagues[3] address the temporal domain of stimulation. They both elegantly and convincingly demonstrate what has been suspected for a long time, that shorter pulse widths are associated with a wider therapeutic window while using considerably less energy.

Collectively, the potential application of these studies ties in with new capabilities of an emerging generation of "smart" implanted pulse generators that are able to detect and record LFPs. The anticipated scenario is that the implanted pulse generators will automatically select or suggest the optimal contacts to be used for stimulation. This approach will save time and because it is scientifically grounded in the detection of beta activity, will be most likely to achieve an individualized optimal outcome. Detection of beta activity in the STN of PD patients will not be the only application of such technology. Pathological synchronous oscillation has also been detected in the globus pallidus interna of both PD and dystonia patients and in the ventral STN of patients implanted for obsessive compulsive disorder. Closing the loop will then be just one very small step away. The most relevant features of pathological synchronous activity (amplitude, epoch length) will be sensed and extracted from the LFP signal to provide the necessary feedback for intelligent stimulation. Adaptive algorithms will be able to adjust for shorter pulse widths when appropriate. Alternative stimulation paradigms such as coordinated reset stimulation or optimized temporally nonregular stimulation may become options. Additional functional feedback may also come from wearable, smartphone based, or even implanted activity and speech sensors. ■

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References

1. Tinkhauser G, Pogosyan A, Debove I, et al. Directional local field potentials: a tool to optimize deep brain stimulation. Mov Disord 2018;33:159-164.
2. Bouthour W, Wegrzyk J, Momjian S, et al. Short pulse width in subthalamic stimulation in Parkinson's disease: a randomized, double-blind study. Mov Disord 2018;33:169-173.
3. Steigerwald F, Timmermann L, Kühn A, et al. Pulse duration settings in subthalamic stimulation for Parkinson's disease. Mov Disord 2018;33:165-169.

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