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## Commentary

# Charting the Neuroethics Landscape for Neuromodulation in Canada and Beyond

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The last two decades have seen an exponential rise in the science of neuromodulation and neurotechnology. Driven by advances in imaging, safer and more effective technology, and demographic shifts that have made brain diseases among the most common human afflictions, novel ways to directly influence function have emerged as dominant themes in the clinical neurosciences. Alongside the hope with these advances, however, many questions exist. Among them: What are ethical ways to translate new knowledge about basic mechanisms to clinical utility? What is the influence of placebo effects? What are the correct definitions of clinically useful and culturally meaningful outcomes? Permeating the field, including these questions, are the ethical implications of a new science of the brain, one where technology is used to directly influence critical brain functions, ostensibly to treat, but with the potential to do more and be more intimately integrated into vital brain functions.

It is from this idea that neuroethics was developed; namely, that as the ability to interact with the brain, to image, measure, probe, and modulate its function, improves, critical questions will arise not only about *what* we can do, but *whether and how* we ought to in the first place. At its core, neuroethics is the study of how scientists and clinicians and patients view their relationship with the brain, and daily discoveries about its structure and function. These questions cannot be answered in a vacuum. Issues surrounding resource allocation, for example, are informed not only by the view of clinicians who administer the treatment and assess patients in follow-up but also by industry that markets and sells the technology, and allied health providers and patients who experience and need the interventions themselves. It is challenging, if not impossible to capture or understand the implications of a new device, for example, without viewing it in these various contexts.

Similarly, decisions in the clinical neuromodulation world are rarely made in isolation. For example, despite robust evidence for the efficacy of deep brain stimulation (DBS) for Parkinson's disease, where the procedure is standard of care, the decision to proceed with surgery is not the surgeon's alone. Every case is conferenced with a team consisting of neurologist, neuropsychologist, psychiatrist, and allied health, in addition to the surgeon; the decision is taken together with the patient at the center. Complex neuroethical issues, which have broader implications, should be approached in the same way.

It is in this context that the Pan Canadian Neurotechnology Ethics Consortium (PCNEC) was founded, "to create a forum for collaborative scientific and ethical discussion relevant to emerging neurotechnologies across Canadian health and social landscapes." We recognize that rapid advances in brain technology will alter how people understand brain disease but also who individuals are as human beings. We, as a group of neurosurgeons, ethicists, neurologists, psychiatrists, psychologists, legal scholars, and neuroscientists, hope that working together will help us tackle some of the most pressing issues in the neuroethics space. The goal, however, is more than fruitful and insightful discussion; it is action. The questions before us are actionable and can be tested empirically and, more so, can influence policy at regional, national, and even international levels. Indeed, the goal of PCNEC is to foster close collaboration with investigators beyond Canada and have a global impact. They affect all jurisdictions where neurotechnology is being considered, developed, and integrated into patient care and society.

We are at an exciting point in our field. At the interface of the brain and technology is where the most important advances will come. It is also where the most pressing issues and questions will be asked. These include how can we better understand the circuits driving common brain diseases and develop new ways to treat them. How do we ensure those treatments get to the patients who need them most? How do we respect the rights of vulnerable and at-risk populations to participate in research and benefit from novel treatments? How do we reconcile the needs of society with individual autonomy? How do we design high-risk, high-reward clinical trials when little is still known about either? How do we define and balance the relationship between industry, academia, society, and the individual? How will technology change our understanding of the most fundamental, yet ancient, questions of consciousness and voluntary choice? Will brain technology be

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destined to treat only brain disease or one day enhance normal function?

These are just the beginning and represent the gauntlet thrown before us: challenging questions, that are as important as they are fascinating, and which will help shape the landscape of neurotechnology in Canada and well beyond.

This special issue highlights a broad spectrum of ethical issues in advancing neurotechnology and comprises manuscripts written by members of PCNEC in close collaboration with others in their field. The subjects range from education, to resource allocation, from relationships with industry and their legal implications, to the use of neuromodulation in at-risk and vulnerable populations.

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