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Review Article

Interventional Psychiatry and Neurotechnologies: Education and Ethics Training

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ABSTRACT: The last two decades have seen dramatic growth in the application of procedurally based interventions for treating refractory psychiatric conditions, leading to interest in developing the foundations for the subspecialty of "Interventional Psychiatry." However, there is cause for concern that the rate of expansion of clinical advances in this field may be outpacing the ability of postgraduate curricula to provide sufficient exposure to and teaching and supervision of these treatments. The paucity of adequately trained practitioners in Interventional Psychiatry further exacerbates inequities in the ability of eligible patients to access and benefit from these approaches. This paper explores the rates of utilization of Interventional Psychiatry treatments, the current state of education in these treatments, and the role that training can play in translating scientific advances in this area to ensure equitable access and maximum impact at a population level. The majority of the discussion is centered on electroconvulsive therapy (ECT), the most established and available of these treatments, highlighting how enhancing education and training in ECT can reduce barriers to its utilization. It is argued that innovations in pedagogical approaches for disseminating the learning of these procedures are needed to increase the current low rates of competency in these treatments and can facilitate the more rapid dissemination of other Interventional Psychiatry approaches and neurotechnologies, such as repetitive transcranial magnetic stimulation, ketamine, deep brain stimulation, and focused ultrasound.

Résumé: **La neurotechnologie et la psychiatrie interventionnelle : formation et éthique**. Le traitement des affections mentales réfractaires connaît, depuis les deux dernières décennies, un essor considérable du nombre d'interventions fondées sur différentes techniques, tant et si bien que cette expansion technologique est en voie de jeter les bases d'une nouvelle surspécialité, la psychiatrie interventionnelle. Toutefois, cette prolifération de nouvelles applications est aussi source de préoccupation compte tenu du fait que la vitesse à laquelle se développent les progrès cliniques dans le domaine puisse dépasser la capacité des curriculums de cycle supérieur à donner une formation suffisante en la matière, formation qui touche à la fois l'exposition, l'enseignement, la supervision et les traitements comme tels. Par ailleurs, le peu de praticiens adéquatement formés en psychiatrie interventionnelle aggrave encore davantage l'iniquité d'accès à ce type traitement et empêche, par le fait même, les patients admissibles de profiter de ses bienfaits. L'article porte donc sur le taux de recours aux traitements appliqués en psychiatrie interventionnelle, sur l'état présent de la formation dans ce type de traitement et sur le rôle que peut jouer la formation pratique dans l'application des progrès scientifiques dans le domaine afin d'assurer à la population un accès équitable et d'offrir le plus d'avantages possible. La discussion porte principalement sur l'électroconvulsivothérapie (ECT), la forme de traitement interventionnel la plus reconnue et la plus appliquée; en effet, cet exemple permet de montrer comment l'amélioration de l'acquisition des connaissances et des compétences en ECT peut lever les obstacles à son utilisation. On y fait valoir que de nouvelles approches pédagogiques s'imposent en matière de diffusion de l'apprentissage de ces techniques afin d'accroître le faible taux courant de compétence dans ce type de traitement, et d'accélérer la diffusion d'autres méthodes thérapeutiques en psychiatrie interventionnelle et en neurotechnologie, telles que la stimulation magnétique transcrânienne répétitive (SMTr), l'administration de kétamine, la stimulation cérébrale profonde (SCP) et les traitements par ultrasons focalisés (UF).

Keywords: Interventional Psychiatry; Neurotechnology; Postgrad medical education; Education; Neuromodulation; Psychiatry

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Introduction

Similar to Interventional Cardiology or Radiology, the term Interventional Psychiatry was proposed in 2014 to describe treatments that are more procedural than general medical care within Psychiatry.[1] Early descriptions of this burgeoning subspecialty focused on anatomically guided treatments which deliver energy

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Highlight Box: Opportunities for Action

- Ethical innovation in the clinical neurosciences requires incorporation of a neuroethics educational plan during physician training
- Responsible development of new neurotechnologies requires increasing competency rates across all regions of Canada equitably and with timely training and discussion on neuroethics
- Innovative pedagogical approaches to teaching interventional psychiatric treatments are needed
- Simulation-based training of interventional psychiatric treatments may be effective in ameliorating competency concerns and enhancing access
- VR simulators are a sustainable form of simulation-based training amid the constantly evolving pandemic, allowing standardized training and promoting safe administration of interventional approaches
- Funding to provide clinicians with better interventional tools earlier on in training is sufficient
- The combination of simulation-based and clinical training is key to producing specialized and adept clinicians

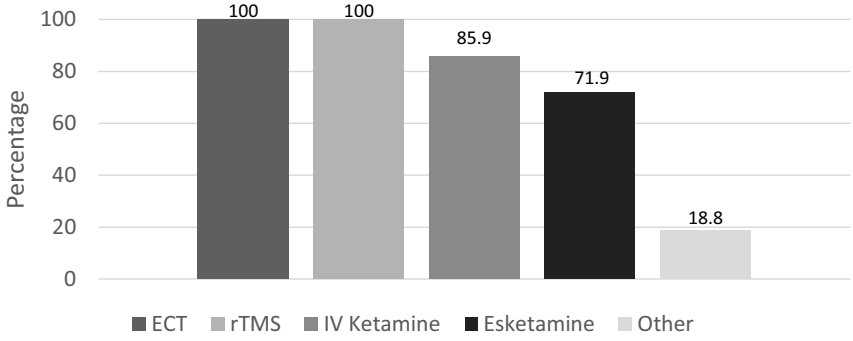


Figure 1: Rates of agreement on which treatments should be considered within a competency diploma in Interventional Psychiatry.

to the brain, such as electroconvulsive therapy (ECT) and repetitive transcranial magnetic stimulation (rTMS). Since that time there has been a virtual explosion in evidence for a multitude of procedural approaches to treat psychiatric illness, increasing the breadth of potential treatments that could fall under Interventional Psychiatry. To date, there has been a lack of unanimity about the name of this subspecialty, with the terms neuromodulation, brain stimulation, or noninvasive brain stimulation,[2] being most commonly used.

However, multiple lines of converging evidence bring into question whether the terms neuromodulation or brain stimulation adequately capture existing and emerging treatments under a unified framework. First, emerging evidence suggests all effective psychiatric treatments for major depressive disorder (MDD) can modulate brain activity in the same neuroanatomical circuit.[3,4] Second, effective brain stimulation treatments can exert inhibitory effects in the brain (e.g. low frequency rTMS, deep brain stimulation (DBS) effects include inhibition at the site of stimulation),[5,6] and there are durable clinical improvements with lesional psychiatric neurosurgery.[7] Third, there exist a variety of other procedural or device-based approaches such as intravenous treatments[8] that are not delivered directly to the brain. Therefore, a fundamental issue in this area is defining the name and scope of this putative field.

After delineating its scope, the subspecialty needs to establish an educational framework encompassing both the development of technical competence and ethical practice. In particular, the subspecialty needs to consider how to promote geographic distribution of professionals and technology so that new neurotechnologies are equitably accessible and responsibly used among marginalized and remote populations.

Key Issues

Toward the goal of defining the scope of this subspecialty and as part of an initiative to establish a competency-based diploma in this area, we distributed an anonymous and voluntary questionnaire to members of the Department of Psychiatry at the University of Toronto. Recipients were asked whether they agreed with the name "Interventional Psychiatry" to define the treatments they feel should be covered under such a Diploma and to provide characteristics of their current practice. For participants who completed the survey ($n = 64$), 89% agreed with the term, with identical rates of agreement among those who currently deliver ECT or rTMS ($n = 27$; 88.9%) and non-interventionalists ($n = 37$; 89.2%). There was universal agreement that the Diploma should provide training in ECT and rTMS, but the majority also felt that IV ketamine (85.9%) and intranasal esketamine (71.9%) should be covered (Figure 1). For the ketamine treatments, there was no demonstrable impact of being a current ketamine or other interventional practitioner on the likelihood of recommending its inclusion. A minority (19%) believed that other approaches, most commonly surgical treatments such as DBS, MRI-guided focused ultrasound (FUS), and vagus nerve stimulation, should also be covered under the auspices of an Interventional Psychiatry Competency Diploma, consistent with results from a recent Canadian study by Cormier and colleagues.[9]

The results of this survey suggest that there is wide acceptance of the term Interventional Psychiatry amongst academic psychiatrists even in those who currently do not deliver procedural or device-based treatments in their practice. Additionally, it charts an academic mission extending the scope of this field beyond treatments which deliver energy directly to the brain, to include ketamine treatments that have similar peri- and post-procedural monitoring requirements as ECT.[8] The training implications of this needs assessment would be the requirement to develop an Interventional Psychiatry core curriculum based around ECT, rTMS, IV ketamine, and esketamine. Although there are competency-based frameworks that have been recently proposed for ECT and rTMS,[10–12] none currently exist for the other interventions.

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This paper explores the rates of utilization of Interventional Psychiatry approaches, the current state of education in these treatments, and the role that training can play in their dissemination to ensure equitable access. The majority of the discussion will center on ECT, the most established and available Interventional treatment. Understanding how enhancing education and training in ECT can reduce barriers to its utilization will likely prove helpful in blazing the path toward more rapid dissemination of other Interventional Psychiatry approaches, such as rTMS, ketamine, DBS, and FUS.

Rates of Utilization

Practice guidelines, such as those from the Canadian Network for Mood and Anxiety Treatments (CANMAT), recommend Interventional Psychiatry treatments as first-line options for MDD.[13] rTMS is a first-line treatment for MDD after non-response to at least one adequate trial of an antidepressant, while ECT can be considered first-line in situations where a rapid clinical effect is warranted, such as in cases of psychotic depression or physical compromise due to the effects of MDD and suicidality.[13] DBS is considered investigational, and esketamine/ketamine was not represented in the 2016 CANMAT guideline because randomized controlled data of its clinical effectiveness for MDD was published only in the last 5 years.

After nearly a century of use and despite being considered the gold standard acute antidepressant, ECT is underutilized and barriers to wider adoption remain present. According to a survey of ECT accessibility across Canada, ECT is geographically accessible to most Canadians, with approximately 84% of the population living within a 1-hour drive of an ECT center.[14] However, in the absence of a national-level registry of ECT utilization, data from Ontario and Quebec suggest that significant interprovincial variation exists. Rapoport reported that from 1992 to 2004, approximately 12 per 100,000 Ontarians received ECT per year, without any significant change in utilization over this period of time.[15] Even in people over age 65, the most common cohort to receive ECT (~32/100,000), this treatment was underutilized, with over 500 people receiving an antidepressant prescription for every 1 who received ECT.[15] Administrative data from Quebec over the period of 1996–2013 determined a similar annual ECT prevalence rate of 13 per 100,000, however with a decline in utilization over time in that province.[16] In an analysis of all psychiatric inpatients in Ontario admitted to hospital between 2009 and 2017 with a diagnosis of a major depressive episode, 9% of admissions involved the use of ECT, although concerns of inequitable access to this treatment were raised as a number of non-clinical factors such as marital status, level of post-secondary education, and neighborhood income influenced rates of use.[17]

Current Barriers to Utilization

Three main barriers have been identified that prevent greater ECT utilization: stigma, funding/advocacy, and training.

Stigma

Stigma toward ECT remains present among both the medical community and general public. In one study from the United Kingdom, both medical students and the general public reported receiving most of their knowledge about ECT from movies and television.[18] This source of bias may be especially relevant in an era of ubiquitously available videos, such as YouTube,[19] and the use of nontraditional media for sharing peer-reviewed medical information about ECT may be needed to reach a broader demographic of people.[20] There are data showing that education about ECT during training reduces the stigma among psychiatrists and increases the likelihood of patients being referred for this procedure.[21]

Ethnic minorities may be especially less likely to receive ECT, despite an absence of data to suggest inferiority of clinical outcomes based on racial background.[22] In a study conducted in the USA, African Americans were over three times less likely than Caucasian patients to receive ECT for severe depression.[23] Parker has argued that to reduce disparities in access to ECT in ethnic minorities, clinicians must validate their unique personal lived experiences to reduce stigma to the procedure, especially geriatric minorities who are more likely to have accumulated negative experiences navigating the medical system during their lifetimes.[24]

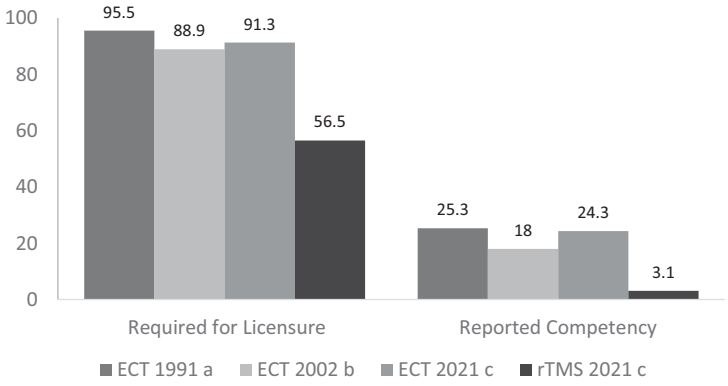
Although the comparison of ECT to other Interventional Psychiatry approaches has not been formally studied, it would be expected that this barrier may be further heightened, as proposed treatment progresses toward the more invasive psychiatric neurosurgeries of DBS and FUS. However, there is evidence that in those who do receive ECT, the experience improves both their knowledge and attitudes toward this procedure. Aoki and colleagues have also noted positive change in family members of patients,[25] suggesting that increasing accessibility to ECT is an important means of reducing the stigma associated with it.

Funding/Advocacy

Results from the preceding section suggest that eliminating institutional barriers to providing ECT may represent a way forward to increase the public sentiment toward this treatment. Compared to other treatments for psychiatric disorders, such as prescribing antidepressant medication or delivering psychotherapy, ECT is a more costly treatment involving coordination of teams of multidisciplinary healthcare professionals.[26] It is not surprising, then, that many of the variables contributing to ECT utilization reflect social and economic factors.

In a study comparing published rates of ECT and antidepressant medication utilization across nations, and the impact of health, social, and economic indices, Rakita et al. found that government expenditure on mental health was the only significant contributor to global variation in ECT use worldwide, while the Human Development Index, a composite index of life expectancy, education rates, and per capita income indicators, significantly correlates with global antidepressant utilization.[27] These findings suggest that across the globe, ECT, and as an extension, other Interventional Psychiatric approaches that also require equipment and multiple personnel for delivery, can be a bellwether measure of the degree to which a nation financially invests in mental health care for its citizens. Although there are no population data available on rTMS utilization across Canada, the ability to access this Health Canada approved treatment varies by province as a function of whether it is publicly funded. While some provinces and territories provide funding for rTMS,[28] funding models vary with procedural fee codes available to any rTMS practitioners in Saskatchewan and Yukon, while there is restricted funding to specialty rTMS clinics in Nova Scotia, Quebec, and Alberta. Further advocacy is needed to ensure that funding for this treatment does not impede equitable access across the country.

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(a) Goldbloom and Kussin (1991); (b) Yuzda et al., (2002); (c) Giacobbe et al., (2021)

Figure 2: Percentage of Canadian trainees endorsing competency in delivering Interventional Psychiatry procedures over time. (a) Goldbloom and Kussin[32]; (b) Yuzda et al.[33]; (c) Giacobbe et al.[34]

Training

Research has consistently revealed that training and education in Interventional Psychiatry are a rate-limiting step to greater utilization and implementation of these treatments. In a nationwide survey of ECT practitioners in the U SA, the lack of trained ECT practitioners was identified as the top barrier to the implementation of an ECT program.[29] In Canada, the existing literature has indicated that only a minority of psychiatry residents receive adequate training in ECT. The majority of ECT programs indicated that they did not have a formal teaching program for psychiatry residents and in the programs that did provide teaching, methods varied widely.[30] This lack of uniformity is perhaps not surprising given that, up until recently, there have been no specific recommended structured approaches put forward to teach ECT in Canada and the common methods of pedagogy have been indirect observation without experiential learning and supervision.[10]

In a recent survey of 162 residents preparing for licensure in psychiatry, 91% agreed that familiarity with the theory and administration of ECT should be a requirement to be a psychiatrist in Canada; however, fewer than 1 in 4 (24%) felt competent to provide it at the end of their training.[31] Unfortunately, these rates have been stagnant over the past three decades (see Figure 2). In 1991, Goldbloom and Kussin reported that 25.3% of residents endorsed competency in ECT, and this rate dipped to 18% in 2001.[32,33]

What specifically appears to be lacking are opportunities to receive supervision in the delivery of ECT. Although 86% of respondents felt that they received adequate didactic teaching in ECT rates equivalent to reported adequacy of teaching for the use of psychotherapy and pharmacotherapy in the treatment of MDD, only 69% endorsed having adequate supervision in using ECT, in comparison of rates of 81% and 90% for psychotherapy and pharmacotherapy, respectively.[31] However, this study showed that administering ECT more than 10 times in residency was significantly associated with perceived ECT competence, providing evidence that the means to achieve increased competency in ECT is through curriculum change to allow more opportunities to receive supervision in the hands-on delivery of this treatment.

Beyond ECT, gaps also exist in training for other Interventional Psychiatry techniques. In the first benchmark in the literature, 57% of the emerging psychiatric workforce in Canada indicated that rTMS should be required for licensure, but only 3% felt that they had achieved competency and 86% felt their exposure to this treatment during their training was inadequate.[31] With the rapid advances in evidence for rTMS in the past decade, including data for equivalent effects to ECT on patient-reported outcomes such as quality of life[34] and the favorable side-effect profile of rTMS in comparison to ECT, the shortage of psychiatrists who are adequately trained in providing rTMS should be a source of concern in the field.

When it comes to psychiatric neurosurgery, a similar mismatch exists between evidence for the efficacy of the treatments and training. In a survey of 99 psychiatrists and psychiatry residents from Quebec, Cormier et al. reported that 69% participants were interested in improving their knowledge on psychiatric neurosurgery and 83% felt that this subject should be included in the psychiatry residency curriculum.[9] The lack of significant uptake of DBS for psychiatric indications, in particular obsessive-compulsive disorder, has been attributed to a paucity of psychiatry referrals[35] and a lack of knowledge about psychiatric neurosurgery has been identified as the principal limiting factor. Psychiatry residents have indicated an interest in a more neuroscience-based education in their training[36] and curricular development toward greater inclusion of a broad array of Interventional Psychiatry treatments represents a natural step in this regard.

Neuroethical Implications of Interventional Psychiatry and Neurotechnologies

Concurrent with advancing therapeutic options and outcomes for those with psychiatric disorders, neurotherapeutic approaches also pose new and unprecedented ethical challenges for patients, clinicians, and society to navigate.[37] Key issues that have been identified include those of the privacy and consent for these treatments, their impact on individuals' personal agency and identity, and the potential for neurotechnologies to be used for "augmentation" rather than to treat defined clinical conditions.[38] From a medico-legal perspective, existing legal frameworks regarding the use of psychiatric neurosurgery have been identified to be inconsistent both within or across countries and are based on a concept of strict dualism between the mind and brain that does not reflect the current scientific understanding of the primacy of the nervous system in the genesis and expression of emotional disorders.[39] It has been proposed that attending to these and other neuroethical issues can complement and advance neuroscience by providing a critical lens on identifying and addressing the implications of discoveries in the basic and clinical neurosciences and their implementation, such as the new technologies and interventional approaches outlined in this paper.[40] Indeed, all major nationally endorsed neuroscience initiatives, including the Canadian Brain

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Research Strategy,[41] have prioritized funding for exploration of neuroethical issues.

Opportunities for Action

Potential Role for Simulation-Based Education in Interventional Psychiatry

This paper has outlined existing gaps in training and supervision for Interventional Psychiatry treatments and the importance for trainees to have direct experiences in their delivery to develop competency. However, given that access to the array of noninvasive and surgical procedures currently resides in select academic centers with the requisite equipment and multidisciplinary personnel skilled in their delivery, training the emerging psychiatric workforce through current educational models may be difficult. This is expected to exacerbate the previously described geographical and demographic inequities. Indeed, Wilkinson reported that a small number of residency programs ($n = 12$ of >200) train approximately a third of the ECT practitioners in the USA.[29] Innovations in pedagogical approaches for disseminating the learning of these procedures may increase the current low rates of competency in these treatments.

Simulation-based education is an important educational methodology in healthcare, serving as a bridge between medical theory and clinical practice. As an artificial representation of an actual clinical process, medical simulation has been used in various specialties for practice to help achieve educational goals. It does this by placing learners in an immersive setting replicating clinical scenarios, to allow acquisition of skills that can be applied in real-world scenarios.[42] Evidence has suggested that simulation facilitates the acquisition of knowledge, skills, and attitudes among learners, as well as reduces the risk of medical error and enhances patient safety. Studies have indicated that simulation-based learning, most often with simulated patients and role-play, can be effective approaches for psychiatry trainees to enhance their general clinical skills and knowledge.[43]

There is preliminary evidence that simulation-based training in ECT can facilitate skills acquisition. Psychiatry trainees performed better on the ECT clinical skills after receiving training on a mannequin patient simulator compared to traditional training methods.[44] Similarly, Raysin et al. reported that psychiatry residents who received augmented simulation training showed significant improvements in ECT knowledge, skills, and comfort compared to those who received a traditional didactic ECT curriculum.[45]

Simulation through virtual reality (VR) has emerged as a novel, immersive, and effective high-fidelity training approach to procedural skill acquisition. A meta-analysis comparing pedagogical methods in pre- and post-skills outcomes revealed a superiority in learners who took part in VR interventions compared to traditional didactic teaching or other forms of digital learning.[46] While the use of VR in mental health education is in its infancy, a preliminary synthesis of results has suggested that it results in significant improvement in users' knowledge and attitudes related to mental illness.[47]

To our knowledge, however, no study has yet reported using a VR simulator as an educational technique for procedural skill training. In light of the shift in medical education toward competency by design and a series of recommendations that have recently been proposed for specific core and advanced skill proficiencies for both rTMS and ECT,[10,12] the adoption of the use of VR simulators can allow wide-spread dissemination of standardized training experiences in the proper and safe administration of these interventional approaches. The ability to provide unlimited on-demand training experiences to trainees in their home environment is especially important in situations where in vivo patient contact is not as readily available, such as during a pandemic.[48]

Funding and Advocacy

The need for advocacy in this emerging field has never been timelier. Data on the detrimental impacts of addiction and pandemic related mental health must be leveraged to lobby governments for increased funding and expedited clinical care program support. The potential for expanded philanthropic and industry support should also be considered; equipping clinicians with access to enhanced interventional tools earlier in their training, distributing them in more remote locations, or offering travel subsidies to patients qualifying may mitigate the social disparity among those treated. Support from industry for fellowship programs which could incorporate both simulation-based and clinical training could engage a new cohort of specialized clinicians in perhaps a more timely fashion than government can facilitate.

Incorporation of Neuroethics Training in Interventional Psychiatry

Although the importance of training in neuroethics for neuroscientists at all levels has been identified,[49] there is a lack of consensus on when and how this curriculum should be delivered. There are compelling reasons to embed neuroethics curricula in the early phases of exposure to the brain sciences[50] but it has been estimated that only approximately a third of undergraduate neuroscience programs in Canada as well as internationally offer any opportunity for training in neuroethics.[51,52] The rates of inclusion of neuroethics into clinical training programs for psychiatrists, neurologists, and neurosurgeons are currently unknown. When a curriculum in ethics has been employed for undergraduate neuroscience students and postgraduate medical trainees, a pedagogical approach emphasizing problem-based learning and discussion of real-world scenarios over didactic teaching has proven to be effective.[50,53]

As neuroethics is ideally considered as a driver of ethical innovation in clinical neuroscience research rather than simply a reaction to rapidly evolving discoveries,[40] the incorporation of neuroethics education is considered essential for responsible research in neurotherapeutics and the development of investigators able to translate these findings to the clinical realm in order to deliver Interventional Psychiatry strategies in the appropriate ethical and medicolegal frameworks. Given the range of neurostimulation methods and various range of invasiveness and the complex issues related to modulating brain function via energy, it would be essential to consider the short- and long-term impact of neurotechnology on patients and all stakeholders impacted by these tools.[54]

Conclusions

There have been rapid advances in research on neurotechnologies and procedural approaches to treating psychiatric conditions. The concept of *Interventional Psychiatry* appears to be embraced by current interventionalists and non-interventionalists equally who envision that this burgeoning field will go beyond treatments that deliver energy directly to the brain to include therapeutics with alternative methods of interacting with the nervous system, such as

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via intravenous and intranasal means. However, the rate of expansion of this field is outpacing the ability of postgraduate curricula to provide sufficient teaching, supervision, and exposure to these treatments. The result is a shortage of psychiatrists who are adequately trained in providing interventional treatments. This shortage further exacerbates inequities in the ability of eligible patients to access and benefit from these approaches based on geographic and socioeconomic factors.

Pedagogy in this area has been stagnant, and the use of simulation is a promising means of amplifying procedural skill training in Interventional Psychiatry. Additionally, the incorporation of neuroethics education during the period of acquisition of Interventional Psychiatry skills is vital for the responsible growth of this subspecialty. By simultaneously pursuing both a research and educational agenda in Interventional Psychiatry, the large and potentially growing gap between the evidence base for these approaches and clinical training in their delivery can be mitigated, maximizing the ability to translate research advances in this area to improve health.

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