

## **The Contemporary Practice of Psychiatric Surgery II: Results from a global survey of functional neurosurgeons**

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## **Abstract**

*Background:* Interest in surgery for psychiatric disease has grown globally. We previously reported the results of a survey of North American functional neurosurgeons that evaluated general attitudes towards psychiatric surgery and the future directions of the field.

*Objectives:* The purpose of this study was to expand on our previous work, and obtain a snapshot in time of global attitudes towards psychiatric surgery, among practicing functional neurosurgeons. We measure general and regional trends in functional neurosurgery, and focus specifically on surgery for mind and mood, while exploring the future prospects of the field.

*Methods:* We designed an online survey and distributed it electronically to 881 members of the following international organizations: World Society for Stereotactic and Functional Neurosurgery, European Society for Stereotactic and Functional Neurosurgery, Asian-Australasian Society for Stereotactic Functional Neurosurgery, and the South and Latin American Society for Stereotactic and Functional Neurosurgery. Subsequent statistical and thematic analysis was performed on the data obtained.

*Results:* Of 881 surveys distributed, 106 were returned (12.8%). Eighty-one (81) percent of functional neurosurgeon respondents are fellowship trained, with movement disorders and pain making up the majority of their practice. Psychiatric indications are the most frequently encountered conditions for 34% of survey respondents, with over half of participants (51%) reporting involvement with at least some epilepsy surgery. Of the psychiatric conditions, OCD and depression are the most common surgical indications. The overwhelming majority of respondents felt optimistic about the future of psychiatric surgery, although nearly two-thirds cited the reluctance of psychiatrists to refer patients as the greatest obstacle facing the field and a large majority reported a cultural stigma surrounding psychiatric disease exists in their community. In response to hypothetical situations involving cognitive and personality enhancement, opinions varied although more respondents opposed enhancement interventions.

*Conclusions:* Surgery for psychiatric conditions is an expanding field within functional neurosurgery. The opinions of international functional neurosurgeons were grossly in line with their North American colleagues. Optimism towards the future of psychiatric surgery predominates and future editions of this survey can be used to track neurosurgeons attitudes towards psychiatric surgery and neuroenhancement.

## **Introduction**

Advancements in functional neurosurgery have led to an expanding array of both clinical and research indications. This is particularly true in the realm of surgery for disorders of mind and mood, where trials are currently underway for a diverse range of psychiatric conditions, including depression, Alzheimer's Disease, addiction and anorexia nervosa (1). The increased interest today in psychiatric surgery is particularly interesting given that surgical management of psychiatric illness in the early and mid 20<sup>th</sup> century, with prefrontal leucotomy for example, was marred by a lack of clinical evidence, and harmed thousands of patients, eventually leading to legislation restricting these procedures [1,2]. Modern deep brain stimulation (DBS), the most frequently used tool for surgical neuromodulation, has been proposed as a relatively safe means of interfering in putatively abnormal circuits driving psychiatric symptoms. Although early results have been promising, it remains unclear at this stage what role DBS will play in the management of patients with psychiatric illness and where neurosurgery fits into the treatment algorithm. What is clear, is that as experimental indications expand, careful implementation of clinical trials that are both ethically and socially conscientious will be crucial. As the providers of these procedures, functional neurosurgeons are the 'front-line' of responsibility for ensuring that they are developed and offered to patients in a socially accountable manner.

Neuroenhancement is defined as performance improvement in the absence of medical need [3]. Case reports of memory enhancement following DBS suggest the possibility that surgical neuroenhancement for non-pathologic states may one day become a reality [4]. Surgical enhancement raises a number of ethical concerns including the

alteration of personal identity and the potential for inequality in society [5,6]. Neuroethics is a field exploring the ethical implications of these neurosurgical advances [6].

Commentators have called for increased public engagement in the discussion surrounding the uses of neurosurgery for treating psychiatric illness and for neuroenhancement [7-9]. In an attempt to elucidate the contemporary practice of psychiatric surgery and functional neurosurgeons attitudes towards these issues, we previously surveyed North American functional neurosurgeons [10]. The purpose of this study was to characterize the practice of global functional neurosurgeons and their views on psychiatric surgery and hypothetical future applications of neuromodulation.

## **Methods**

A computerized, Internet-based survey used in a previous study [10] was distributed to non-North American members of the World Society for Stereotactic and Functional Neurosurgery (WSSFN), European Society for Stereotactic and Functional Neurosurgery (ESSFN), Asian-Australian Society for Stereotactic and Functional Neurosurgery (AASSFN), and Sociedad Latinoamericana de Neurocirugía Funcional y Esterotaxia (SLANFE). Mailings lists were obtained from the WSSFN head office and 831 e-mails containing links to the survey were sent. Additional reminder e-mails were sent 4 and 6 weeks later. Responses to the survey were voluntary and anonymous.

The survey was divided into four sections: basic demographics, functional neurosurgery practice, psychiatric surgery practice and attitudes towards enhancement technologies. The clinical sections were combinations of questions and scenarios that progressed from commonly encountered topics (depression and OCD) to more

hypothetical situations (enhancement). The time required to complete the survey was approximately 10-15 minutes.

### *Statistical Analysis*

Descriptive statistics are reported as frequencies and percentages. Responses from surgeons who practice psychiatric surgery and responses from those who do not were compared and differences in proportions were assessed using the Pearson X2 statistic. Responses obtained from a study of North American functional neurosurgeons were compared to international functional neurosurgeons responses using the Pearson X2 statistic. Data were analyzed using SPSS 20.0.

## **Results**

### *Demographics and General Practice*

One hundred and six survey responses were obtained, giving a response rate of 12.8% (106/831). Of 82 participants who commented on their location, 29 (35%) were in Europe, 25 (31%) were in Asia, 13 (16%) were in Latin America, 7 (9%) were in Japan and 1 (1%) were in Australia and Africa (table 1). Exactly one third of respondents indicated they have at least 10 years of experience in the field with 29% indicating greater than 20 years of operative experience. Further, the majority of surgeons had formal fellowship training in stereotactic and functional neurosurgery (81%). Of the surgeons with fellowship, 47 (58%) had obtained a fellowship had obtained it locally, in the country in which they currently practice and 34 (42%) obtained their fellowships elsewhere.

Functional neurosurgery is predominantly practiced at academic, university-affiliated hospitals (81/99 or 81% of respondents), with only a small minority practicing independently in the community. Movement and pain disorders represent the majority of current practice; 87% and 72% of responders indicated that these two indications make up most of their daily practice. Thirty-four percent (34/99) reported that psychiatric indications are the most frequently encountered conditions, with epilepsy making up at least some part of their practice in 51% of respondents. When further asked which single procedure is performed most commonly in their practice, 67% (60/89) freely volunteered DBS, usually for movement disorders. From a technical perspective, 69% (68/98) reported using microelectrode recording to help identify deep brain targets for lesioning or stimulation. When asked for the proportion of DBS in their functional practice, 17% (17/99) indicated they used it exclusively; however, well over half of the respondents reported that the use of DBS accounts for a minimal to moderate proportion of their surgical practice (58%, 56/99).

### *Psychiatric Surgery*

Half of the respondents indicated that psychiatric surgery is a component of their functional practice (53.8%, 56/104). Most surgeons who perform psychiatric surgery further reported that psychiatric indications account for a small (<25%) part of their practice (86.3%, 44/51) (table 2). DBS is used exclusively in psychiatric patients by 45% of those surveyed, with an additional 39.2% reporting a combination of lesioning and stimulation. The most common conditions referred for surgical treatment are OCD (39.2%), depression (15.7%), Tourette's syndrome (9.8%), Schizophrenia (7.8%) and

aggressiveness (7.8%). Pre-operative psychiatric evaluation is common, with 74.5% of respondents reporting that it is a mandatory component of their practice.

Most respondents who currently perform psychiatric surgery indicated that it will be a larger component of their practice in the future than it is now (86.3%). There was also almost a unanimous belief that the volume of psychiatric surgery globally will significantly increase in the years to come (94.7%).

Surgeons engaged in psychiatric surgery viewed reluctance on the part of psychiatrists to refer patients as the number one obstacle impeding more widespread use of surgery for psychiatric indications (64%, 32/50) (table 3). Other reasons included cultural stigma surrounding psychiatric disease (48%), the perceived experimental nature of currently available treatment options, such as DBS (30%), as well as the historic misuse of neuromodulation (24%). The lack or unavailability of funding was the most common volunteered comment.

When surgeons who do not perform psychiatric surgery were asked about the trends of the field, they had a decidedly different answer than those who perform it routinely. Only 43% of respondents, as opposed to 86% of psychiatric surgeons, foresaw more psychiatric surgery at their institution in the future, although both groups believed that global trends for the indication would increase substantially in the years to come (91% and 98%) (institution:  $X^2 = 21.642$ ,  $p < 0.001$ ; global:  $p > 0.05$ ). Further, these surgeons agreed with those in the other group that a reluctance of psychiatrists to refer represented the largest impediment to more widespread use of psychiatric surgery, followed by the cultural stigma surrounding psychiatric disease. Nearly no responding surgeons in either group reported an absence of obstacles to more widespread psychiatric surgery, with lack

of appropriate funding making up the majority of volunteered comments. Perceptions of obstacles to more widespread application of psychiatric surgery between surgeons who do and do not perform these procedures were not significantly different ( $p > 0.05$ ).

Nearly all respondents indicated a generally positive view of surgery for psychiatric disease (90%), with 63% reporting positive views with some reservations (table 4).

Psychiatric and non-psychiatric surgeons demonstrated equivalent levels of optimism ( $p > 0.05$ ). The view was less clear when asked to assess the views of other neurosurgeons in their community; 40% of respondents felt the neurosurgical community's view was varying with no clear consensus. Psychiatric surgeons were more optimistic, with 52.1% believing those views to be generally positive, with or without minor reservations compared to only 21.4% of non-psychiatric surgeons ( $X^2 = 14.121, p = 0.015$ ). The view was less optimistic with respect to perceived psychiatrists' attitudes, only 3 surgeons (3.4%) reporting a complete acceptance of the field by their psychiatrist colleagues, and 47.3% believing that psychiatrists in their community are generally not accepting such procedures, with few exceptions.

Survey participants were asked their opinion regarding the management of hypothetical scenarios in the realm of psychiatric surgery for indications not yet explored or established. With regard to the validity of proxy consent by a caregiver to allow a presumably safe and effective surgical treatment of severe psychosis, 68.2% of respondents believed that it was ethical to proceed with such consent. When asked about a procedure to dampen sexual impulses in sex offenders requesting the operation, over half of responding surgeons (55.1%, 49/89) believed such surgery was ethically justified, given a safe and effective procedure; 23.6% believed such surgery would violate the patient's



autonomy, and 21.3% were unsure about their beliefs. The views of surgeons who practice psychiatric surgery towards these hypothetical scenarios were not significantly different from those that do not practice psychiatric surgery (all p values > 0.05). In contrast, more neurosurgeons believe a surgical procedure to erase memories in a patient with severe refractory PTSD was not ethically justified (42.7% vs 31.5% believing it was ethical).

A large majority of those surveyed (91.3%) think that a cultural stigma surrounding psychiatric disease exists in their community. Twenty-eight percent further believe that the stigma is such that it impedes appropriate access to care (26/92). Overall, however, 80.4% (74/92) of respondents believe that sufficient scientific justification exists to continue pursuing neurosurgery for psychiatric indications (table 5).

### *Enhancement*

Participants were asked several questions and presented with several scenarios regarding surgery for nonpathologic states or cognitive enhancement. When asked whether it would be ethical to provide surgical memory enhancement to a patient should they request it, 54.5% of respondents (48/88) said it would not be ethical. The most common reason cited is that neurosurgery should be reserved for the treatment of pathologic states (79.2%). Other reasons included introducing artificial imbalances into society (35.8%) as well as interference with personal identity (49.1%) and 'natural variation' (37.7%). In contrast, 26.1% (23/88) believed it would be ethical to provide a non-essential memory enhancement operation and the remaining 19.3% (17/88) were unsure. Of the respondents who were in agreement, 72.4% (21/29) felt individuals have a right to access any form of enhancement technology and 34.5% (10/29) believed cognitive

enhancement is morally equivalent to plastic surgery. An additional scenario proposed altering a maladaptive, non-pathologic trait, such as selfishness or greed, and in such cases 67.0% of respondents (59/88) stated this was not ethical. Again, reserving neurosurgery only for pathologic states was stated as the main objection to this (71.0%) as well as interference with personal identity (50.0%) and 'natural variation' (43.5%). In another hypothetical scenario pertaining to a technology that allows a rapid acquisition of a skill or knowledge, the majority of respondents were opposed (56.3%), 23.0% believed it would be ethical and 20.7% unsure. Fewer respondents agreed with personality alteration than memory enhancement; 19.3% (17/88) found such a procedure ethical and 13.6% (12/88) were unsure. Of those who agreed, again the most commonly cited reason was the individual's right to access any form of enhancement technology (81%, 17/21). Consistent with the opposition to the use of brain-machine interface technologies for enhancement, when asked to look into the future, and hypothesize about the possibility of surgical cognitive enhancement in 50 years, only 13.3% (37/75) believed that DBS or another neuromodulation technology will be used for that purpose by then. There were no significant differences between the number of surgeon respondents who do and do not perform psychiatric surgery, with regard to supporting or opposing surgery for memory enhancement or personality alteration (all p values > 0.05).

### *Future Directions*

Survey participants were asked several questions regarding the future of their field and the challenges that lay ahead. With regard to their belief about the future of psychiatric surgery, 56.8% of respondents (50/88) reported they were somewhat optimistic, and that

there will be a small but important role for neurosurgeons in the management of these patients. Surgeons who perform psychiatric surgery were significantly more optimistic than surgeons who do not; 47.9% believed neurosurgeons would be heavily involved in the treatment of psychiatric illness compared to only 17.5% ( $\chi^2 = 15.938, p < 0.001$ ). In addition, no psychiatric surgeons endorsed a pessimistic view of the future of psychiatric surgery, but 15.0% of non-psychiatric surgeons were somewhat pessimistic. Consistent with general optimism towards to the future of psychiatric surgery, 73.9% (65/88) believed that specific training in psychiatric surgery should be a component of any fellowship in stereotactic and functional neurosurgery.

Technology has been intimately linked to functional neurosurgery, and the survey respondents agreed that DBS likely represents the greatest advance in the field in the last generation (75.0%, 66/88). Accordingly then, it followed that participants foresaw DBS for psychiatric indications as being the area holding the most promise in the years to come (35.2%), followed by the brain-machine interface (20.5%), functional neuroimaging (18.2%), and advances in seizure prediction (17.0%). When asked which conditions they believe surgeons will be helping to treat in 15 years, nearly every listed condition was endorsed, with depression, OCD and pain supported by 80%, followed by addiction/alcoholism (55.1%), eating disorders (43.8%), obesity (42.7%), coma (34.8%) and Alzheimer's disease (30.3%). Clearly, those surveyed believe the field will grow both in depth and scope in the years to come.

### *Regional Differences in Attitudes*

The respondents were grouped into three regional categories: i) Europe (Europe and UK), ii) Asia (Asia and Japan), iii) Elsewhere: Latin America, Australia, and Africa. The latter category included only one respondent from each of Australia and Africa. There were no significant regional differences in sentiments towards the future of psychiatric surgery or in responses surrounding the stigma of psychiatric illness (all p-values > 0.05).

Interestingly, respondents did demonstrate regional differences in their attitudes towards psychiatric surgery and enhancement. Significantly fewer Europeans believed a surgery for severe refractory psychosis was ethical (Europe: 46.9%, Asia: 82.8%, elsewhere: 84.6%,  $X^2 = 11.904$ ,  $p = 0.018$ ). With respect to memory enhancement, significantly more respondents from Asia thought surgically enhancing 'normal' memory was acceptable (Europe: 9.1%, Asia: 44.8%, elsewhere: 15.4%,  $X^2 = 12.779$ ,  $p = 0.012$ ). General attitudes towards memory enhancement revealed significantly more Europeans were completely against the proposed intervention (Europe: 48.5%, Asia: 17.2%, elsewhere: 15.4%,  $X^2 = 21.475$ ,  $p = 0.001$ ).

Similarly, for the personality enhancement scenario, significantly more respondents from Asia believed surgically decreasing greediness or selfishness was acceptable compared to Europeans (Europe: 3.0%, Asia: 31.0%, elsewhere: 25.0%,  $X^2 = 9.864$ ,  $p = 0.046$ ). The general attitudes towards personality alteration revealed the same trend: significantly more Europeans were completely against the hypothetical surgery (Europe: 66.7%, Asia: 32.1%, elsewhere: 38.5%,  $X^2 = 12.781$ ,  $p = 0.047$ ). In line with these regional differences in attitudes towards surgical enhancement, more respondents from Asia believed an implantable chip for "rapid downloading" of information was acceptable compared to European respondents (Europe: 3.1%, Asia: 37.9%, Elsewhere: 23.1%,  $X^2 = 12.187$ ,  $p = 0.016$ ).

### *Comparisons between North American and International Functional Neurosurgeons*

The present results were compared to the results from our previous survey of North American functional neurosurgeons. For the purpose of these comparisons, international functional neurosurgeons refers to practitioners outside North America. Significantly more international functional neurosurgeons had a functional neurosurgery fellowship than North Americans (82% vs 56%,  $X^2 = 13.416$ ,  $p < 0.001$ ). In addition, significantly more international functional neurosurgeons thought psychiatric surgery should be a component of functional neurosurgery fellowships (73.9% vs 45%,  $X^2 = 5.13$   $p < 0.001$ ). A larger proportion of North American psychiatric surgeons obtain pre-operative psychiatric assessments than international psychiatric surgeons (94% vs 74.5%  $X^2 = 4.56$ ,  $p=0.033$ ). Significantly more international psychiatric surgeons believed that the psychiatric community was generally not accepting of psychiatric surgery (57.1% vs 40.5%,  $X^2=4.50$ ,  $p=0.034$ ). There were no significant differences in views towards presented hypothetical scenarios on the ethics of surgically treating severe refractory psychosis, PTSD or surgically dampening sexual impulses in sexual offenders between North American and international functional neurosurgeons. However, significantly more international functional neurosurgeons were opposed to the brain-machine interface scenario, the implantation of a chip for “rapid downloading” of information into the human brain (56.3% vs 38.4%,  $X^2 = 5.13$   $p = 0.024$ ).

## Discussion

We investigated the attitudes of functional neurosurgeons globally towards their current surgical practices with an emphasis on psychiatric indications. Half of respondents engaged in some form of psychiatric surgery, predominantly for OCD and depression. The majority of functional neurosurgeons surveyed were optimistic about the future of psychiatric surgery, although psychiatric surgeons were more optimistic about future case volumes at their institutions.

Our findings regarding international functional neurosurgeons general practices closely matched the results of a previous survey of North American functional neurosurgeons [10]. The majority of international functional neurosurgeons surveyed practice in academic centers. Interestingly, more international functional neurosurgeons had functional neurosurgery fellowships compared to North Americans. Possibly related to this is the fact that a higher proportion of international functional surgeons felt that psychiatric surgery should be a component of functional neurosurgery fellowships. DBS is a widely used surgical procedure around the world. Most surgeons perform DBS at least part of the time, with close to 1 in 5 international functional neurosurgeons using it exclusively. Notwithstanding the ubiquity of DBS, a significant proportion of functional neurosurgery for psychiatric conditions is still ablative (41.2%, 21/51), in much of the world. With respect to psychiatric surgery, the majority of international functional neurosurgeons believed a reluctance of psychiatrists to refer patients and the cultural stigma surrounding mental illness were obstacles, a finding consistent with our previous study. Interestingly, fewer international psychiatric surgeons obtain psychiatric pre-operative psychiatric assessments than their North American colleagues.

Our group has previously demonstrated that both functional neurosurgeons and other subspecialty neurosurgeons are generally supportive of psychiatric surgery [10,11]. The current findings parallel these opinions; international functional neurosurgeons were generally in favor of treating severe refractory mental illness with neuromodulation, provided it is safe and effective. However, regional analyses revealed less support among European functional neurosurgeons for the surgical treatment of psychiatric disease. It is unclear why this group of surgeons' attitudes differed compared to the other world regions. Nonetheless, the general consensus is relevant because neurosurgeons will remain continually involved in the development of DBS technologies for psychiatric indications and will become the providers of novel surgical therapies. Given psychosurgery's dark history, ethical and accountable investigation and implementation of DBS for psychiatric surgery is paramount [12].

Our study also sought to characterize neurosurgeons' views surrounding largely hypothetical scenarios of surgical enhancement. Consistent with previous studies [10,11], the majority of international psychiatric surgeons found the notion of improving cognitive function, or altering undesirable personality traits to be morally dubious. Common objections to neuroenhancement included the alteration of personal identity and natural variation. Most surgeons opposed neuroenhancement, believing surgery should be reserved for the treatment of pathologic states. Perhaps surgeons' experiences with treating only pathology in patients predisposes them to draw a line at non-pathologic states. Although enhancement is an accepted norm in other fields of medicine such as plastic surgery, functional neurosurgeons have a reluctance towards enhancement, possibly due to the brain's unique contribution to personal identity and a hesitance to interfere in the natural

variation of human traits. That being said, a fair minority of respondents, in some cases up to 26.1%, felt that alteration of non-pathologic traits, such as memory enhancement, is ethically permissible, in a voluntary patient, with a safe and effective procedure.

Interestingly, significantly more respondents from Asia including Japan found surgical enhancement to be ethically permissible. By framing these highly hypothetical scenarios in the context of a “safe, effective” procedure, we attempted to distill whether surgeons had any *fundamental* objections to the scenarios presented. Perhaps surprisingly, we found that every scenario was endorsed by at least some respondents, suggesting that within the global functional neurosurgery community there are no indications that we could identify that are absolutely unanimously forbidden.

Results of our survey suggest that the future is promising for functional neurosurgery as the number of indications that respondents believe that they will be involved in is predicted to increase substantially. This echoes the results of the North American survey. However, our results also suggest that caution is required in evaluating emerging indications, particularly as discussion shifts towards hypothetical non-pathological enhancement. The ability to intervene in and disrupt pathological brain circuits with surgery is an important responsibility, and it is up to the global community of functional neurosurgeons to discuss now, rather than later, what role they will play in the developing neuromodulation landscape.

## **Limitations**

This study has several important limitations. The first stems from the relatively low response rate at 13%. We made every attempt to boost the response rate of this study,



including timing the survey to coincide with a major stereotactic neurosurgery meeting, issuing several electronic reminders and reformatting and redesigning our survey invitation to maximize access to the survey itself. Our original survey also had a low response rate (28%), although not as low as this one. There can be several explanations for this, including limited access to the internet and the predominant language of the survey (English). The possibility exists that surgeons who do not perform psychiatric surgery were less inclined to participate and that the opinions of psychiatric surgeons are over-represented. However, given that half of respondents perform psychiatric surgery and half do not, the opinions of both groups were represented in our survey and these groups generally shared similar opinions to the issues addressed. In addition, the similarities in responses between international and North American functional neurosurgeons lends support to the generalizability of the results obtained.

## **Conclusions**

Psychiatric surgery is a growing field within the practice of contemporary functional neurosurgery. Greater collaboration with the psychiatric community along with proper oversight and regulations will further facilitate the ongoing development of psychiatric surgery. At the present time, the emphasis remains on reserving surgery for the treatment of pathological states although functional neurosurgeons have varying opinions on the ethics of surgical neuroenhancement. International functional neurosurgeons provided opinions that closely matched their North American colleagues. Future editions of this and other surveys will track the attitudes of functional neurosurgeons towards the role of surgery in mental illness and enhancement.

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## Psychiatric Neurosurgery Survey Study Tables

**Table 1. Demographic and practice information of survey participants.**

		Non-psychiatric Surgeons	Psychiatric Surgeons	Total
<b>Country of Practice</b>	UK	1 (2.6%)	5 (11.4%)	6 (7.3%)
	Europe	14 (36.8%)	15 (34.1%)	29 (35.4%)
	Asia	10 (26.3%)	15 (34.1%)	25 (30.5%)
	Japan	5 (13.2%)	2 (4.5%)	7 (8.5%)
	Latin America	6 (15.8%)	7 (15.9%)	13 (15.9%)
	Australia	1 (2.6%)	0	1 (1.2%)
	Africa	1 (2.6%)	0	1 (1.2%)
<b>Years in Practice</b>	Less than 5	8 (16.7%)	11 (21.6%)	19 (19.2%)
	5 to 9	8 (16.7%)	10 (19.6%)	18 (18.2%)
	10 to 14	8 (16.7%)	5 (9.8%)	13 (13.1%)
	15 to 20	11 (22.9%)	9 (17.6%)	20 (20.2%)
	More than 20	13 (27.1%)	16 (31.4%)	29 (29.3%)
<b>Fellowship Training</b>	Yes obtained in country of practice	18 (37.5%)	29 (56.9%)	47 (47.5%)
	Yes obtained in different country	18 (37.5%)	16 (31.4%)	34 (34.3%)
	No	12 (25.0%)	6 (11.8%)	18 (18.2%)
<b>Type of practice</b>	Community	8 (16.7%)	3 (5.9%)	11 (11.1%)
	Academic	36 (75.0%)	45 (88.2%)	81 (81.8%)
	Other	4 (8.3%)	3 (5.9%)	7 (7.1%)
<b>Proportion of practicing using DBS</b>	0-25% (minimal)	18 (37.5%)	14 (27.5%)	32 (32.3%)
	25-50% (moderate)	10 (20.8%)	14 (27.5%)	24 (24.2%)
	50-75% (majority)	12 (25.0%)	14 (27.5%)	26 (26.3%)
	75-100% (almost exclusively)	8 (16.7%)	9 (17.6%)	17 (17.2%)
<b>Conditions frequently encountered in practice</b>	Epilepsy	20 (20.4%)	29 (19.2%)	49 (19.7%)
	Movement disorders	39 (39.8%)	46 (30.5%)	85 (34.1%)
	Pain	33 (33.7%)	37 (24.5%)	70 (28.1%)
	Psychiatric disease	1 (1.0%)	33 (21.9%)	34 (13.7%)
	Other	5 (5.1%)	6 (4.0%)	11 (4.4%)

**Table 2. Practice information of psychiatric neurosurgeons.**

		<b>Number</b>	
<b>Proportion of practice devoted to psychiatric surgery</b>	0-25% (minimal)	44 (86.3%)	
	25-50% (moderate)	6 (11.8%)	
	50-75% (majority)	1 (2.0%)	
	75-100% (almost exclusively)	0	
<b>Use of lesioning and stimulation</b>	Lesioning exclusively	8 (15.7%)	
	Combination of both but mostly lesioning	13 (25.5%)	
	Combination of both but mostly stimulation	7 (13.7%)	
	Stimulation exclusively	23 (45.1%)	
<b>Most common psychiatric disease referred</b>	Obsessive-compulsive disorder	20 (39.2%)	
	Depression	8 (15.7%)	
	Pain	8 (15.7%)	
	Tourette's syndrome	5 (9.8%)	
	Aggressiveness	4 (7.8%)	
	Schizophrenia	4 (7.8%)	
	Addiction	1 (2.0%)	
	Alzheimer's	0	
	Personality disorders	0	
	Obesity	0	
	Eating disorders	0	
	<b>Frequency psychiatrics conduct pre-operative assessments</b>	Never	2 (3.9%)
		Occasionally	8 (15.7%)
Frequently		3 (5.9%)	
Always		38 (74.5%)	

**Table 3. Perceived obstacles preventing more widespread use of functional neurosurgery to treat psychiatric illness.**

	<b>Non-psychiatric Surgeons</b>	<b>Psychiatric Surgeons</b>	<b>Total</b>
No obstacles exist	2 (4.5%)	1 (2.0%)	3 (3.2%)
Cultural stigma surrounding psychiatric disease	20 (45.5%)	24 (48.0%)	44 (46.8%)
The science is not convincing	17 (38.6%)	14 (28.0%)	31 (33.0%)
Reluctance of psychiatrists to refer patients	25 (56.8%)	32 (64.0%)	57 (60.6%)
It is an experimental therapy	12 (27.3%)	15 (30.0%)	27 (28.7%)
Historical misuse of neuromodulation	12 (27.3%)	12 (24.0%)	24 (25.5%)
Financial coverage	4 (9.1%)	3 (6.0%)	7 (7.5%)
Other	3 (6.8%)	7 (14.0%)	10 (10.6%)

**Table 4. General attitudes surgery for psychiatric disease. Asterisks indicate cells with significantly differing values ( $p < 0.05$ ).**

		<b>Non-psychiatric Surgeons</b>	<b>Psychiatric Surgeons</b>	<b>Total</b>
<b>Individual attitudes are:</b>	Very positive	10 (22.7%)	15 (30.6%)	25 (26.9%)
	Generally positive with some reservations	27 (61.4%)	32 (65.3%)	59 (63.4%)
	Generally negative	4 (9.1%)	2 (4.1%)	6 (6.5%)
	Very negative	0	0	0
	Unsure	3 (6.8%)	0	3 (3.2%)
<b>Neurosurgical community attitudes are:</b>	Very positive, with widespread support for the indication	1 (2.4%)	2 (4.2%)	3 (3.3%)
	Generally positive, with some skeptical of the indication	8 (19.0%)	25 (52.1%)*	33 (36.7%)
	Varying with no clear consensus	20 (47.6%)	16 (33.3%)	36 (40.0%)
	Generally negative, with some advocating the procedures	9 (21.4%)	4 (8.3%)	13 (14.4%)
	Very negative, with widespread lack of support for the indication	3 (7.1%)	0	3 (3.3%)
	Unsure	1 (2.4%)	1 (2.1%)	2 (2.2%)

**Table 5. Perceptions of stigma surrounding psychiatric disease. Asterisks indicate cells with significantly differing values ( $p < 0.05$ ).**

<b>Psychiatric disease is:</b>		<b>Non-psychiatric Surgeons</b>	<b>Psychiatric Surgeons</b>	<b>Total</b>
Not at all stigmatized and it viewed as a biological disease		5 (11.6%)	2 (4.1%)	7 (7.6%)
Somewhat stigmatized, but does not impeded the acquisition of necessary care		20 (46.5%)	38 (77.6%)*	58 (63.0%)
Highly stigmatized and this interferes with access to necessary treatment		11 (25.6%)	8 (16.3%)	19 (20.7%)
Generally not discussed and treatment is not sought.		6 (14.0%)*	1 (2.0%)	7 (7.6%)
Unsure		1 (2.3%)	0	1 (1.1%)

**Table 5. Beliefs regarding scientific justification to continue pursuing neurosurgery for psychiatric indications.**

		<b>Non-psychiatric Surgeons</b>	<b>Psychiatric Surgeons</b>	<b>Total</b>
<b>Do you believe there is sufficient scientific justification to continue pursuing neurosurgery for psychiatric indications?</b>	Yes	32 (74.4%)	42 (85.7%)	74 (80.4%)
	No	5 (11.6%)	5 (10.2%)	10 (10.9%)
	Unsure	6 (14.0%)	2 (4.1%)	8 (8.7%)