ORIGINAL ARTICLE

Surgical Activity of First-Year Canadian Neurosurgical Residents

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ABSTRACT: ***Introduction:*** Surgical activity is probably the most important component of surgical training. During the first year of surgical residency, there is an early opportunity for the development of surgical skills, before disparities between the skill sets of residents increase in future years. It is likely that surgical skill is related to operative volumes. There are no published guidelines that quantify the number of surgical cases required to achieve surgical competency. The aim of this study was to describe the current trends in surgical activity in a recent cohort of first-year Canadian neurosurgical trainees. ***Methods:*** This study utilized retrospective database review and survey methodology to describe the current state of surgical training for first-year neurosurgical trainees. A committee of five residents designed this survey in an effort to capture factors that may influence the operative activity of trainees. ***Results:*** Nine out of a cohort of 20 first-year Canadian neurosurgical trainees that began training in July of 2008 participated in the study. The median number of cases completed by a resident during the initial three month neurosurgical rotation was 66, within which the trainee was identified as the primary surgeon in 12 cases. Intracranial hemorrhage and cerebrospinal fluid diversion procedures were the most common operations to have the trainee as primary surgeon. ***Conclusion:*** Based on this pilot study, it appears that the operative activity of Canadian first-year residents is at least equivalent to the residents of other studied training systems with respect to volume and diversity of surgical activity.

RÉSUMÉ: Activité chirurgicale des résidents canadiens en neurochirurgie au cours de leur première année de formation. ***Contexte :*** L'activité chirurgicale est probablement la composante la plus importante de la formation en chirurgie. La première année de résidence en chirurgie constitue une occasion de développer des habiletés chirurgicales tôt au cours de la formation, avant que les disparités entre les habiletés des résidents n'augmentent avec les années. Il est vraisemblable que les habiletés chirurgicales sont liées au volume chirurgical. Il n'existe pas de lignes directrices publiées qui quantifient le nombre de cas chirurgicaux requis pour parvenir à la compétence en chirurgie. Le but de cette étude était de décrire les tendances actuelles concernant l'activité chirurgicale dans une cohorte récente de résidents canadiens en neurochirurgie au cours de leur première année de formation. ***Méthodologie :*** Nous avons procédé à une revue rétrospective d'une base de données et à une enquête pour décrire la situation actuelle de la formation en chirurgie chez les résidents de première année en neurochirurgie. Un comité composé de cinq résidents a conçu cette enquête afin d'identifier les facteurs qui pourraient influencer l'activité chirurgicale des résidents. ***Résultats :*** Neuf de 20 résidents canadiens en neurochirurgie qui ont commencé leur formation en juillet 2008 ont participé à cette étude. Le nombre médian de cas complétés par un résident pendant les 3 premiers mois de la rotation en neurochirurgie était de 66, dont 12 cas au cours desquels le résident était identifié comme étant le chirurgien principal. Les types les plus fréquents d'interventions au cours desquelles le résident était identifié comme le chirurgien principal étaient des interventions pour hémorragie intracrânienne et des dérivations du liquide céphalorachidien. ***Conclusion :*** Selon cette étude préliminaire, il semble que l'activité chirurgicale des résidents canadiens au cours de leur première année de formation est équivalente à celle de résidents participant à d'autres programmes de formation quant au volume et à la diversité de l'activité chirurgicale.

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Surgical activity is perhaps the most important aspect of neurosurgical training[1]. The Royal College of Physicians and Surgeons of Canada mandate that training programs provide an "adequate number of cases" in different categories for residents[2]. The adequate number of cases is not numerically defined[2]. There is no literature that guides residents or program directors to the minimum or average number of surgical cases required to graduate a competent neurosurgical trainee in Canada[3-5]. Currently, the program director must judge that the trainee can practice independently for successful graduation[3,4]. One aspect of this decision is based on evaluating the surgical competency of that trainee. There is no data available to verify a reliable prediction model of competency[3]. Although it is likely that most trainees completing an accredited residency program in neurosurgery are competent, there are a small but significant number of 'to-be-certified' trainees whose surgical skills may be

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of question[4]. In a study carried out by the Society of Neurological Surgeons, the outcome of training was examined by exit interviews with trainees and program directors at the completion of their residency training[6]. A significant proportion (upwards of 10%) of those interviewed possessed “questionable competence” in the candid opinions of both the program director and trainee. The authors’ attributed this to a lack of exposure to specific diseases and procedures[6].

Although not mandatory, most Canadian residents generally maintain a personal operative log. The number and type of procedures performed can vary considerably between residents[7]. The early emphasis on surgical activity in first-year residents, where differences in surgical skill between trainees are relatively low, is important for the establishment of good surgical habits.

The purpose of this original study was to describe the surgical activity of a cohort of first-year Canadian neurosurgical trainees. This paper does not attempt to describe the quality of neurosurgical training in Canada, nor does it compare the different Canadian training programs. Furthermore, it does not describe other aspects of neurosurgical training. Surgical activity in isolation is not an accurate reflection of the quality of a training program[8]. The most important aspect of a high quality surgical training program is a continuous escalation of a resident’s surgical responsibility until competency is achieved[3,4,7,9,10]. This must be monitored through early recognition of deficits and frequent feedback from mentors.

Methods

This study utilizes a survey methodology and a retrospective review of prospective databases to determine the surgical activity of a cohort of Canadian neurosurgery residents that began training in July 2008. All PGY-1 neurosurgical residents enrolled in accredited neurosurgical training programs in Canada were contacted via electronic mail to participate in the study. Each trainee was asked to complete a short survey of his or her initial neurosurgical rotation and to submit an operative log detailing their surgical activity during this period. Each database was maintained by the individual trainee and was not standardized. Participants were asked only to forward their operative logs from the initial three months of neurosurgical service. This was done to ensure uniformity in the data as some programs offer more than three months of clinical neurosurgery during the first year.

A committee of five residents from five different Canadian neurosurgical training programs was selected to design the survey that was used in this study. The aim of this survey was to obtain demographic data and identify factors that might influence the surgical activity of trainees. Participants were requested to only reflect on their neurosurgical rotations while responding to the questions.

The data points extracted from each database included operative procedure and trainee’s role (i.e. primary surgeon or assistant). For the purposes of this study, we defined the primary surgeon as the one who performs the physical maneuvers that are most important for that specific operation. ‘Scrubbing’ for the operation and participating in a single maneuver that directly affects the surgery was considered the least activity required to

Table 1: Demographic data

Variable	N	% of Total	Comment
Participated in study			
Yes	9	45.0	
No	11	55.0	
Gender			
Male	7	77.8	
Female	2	22.2	
Age			
Below 25	4	44.4	
25-30	3	33.3	
Above 30	2	22.2	
Graduate Degree			
Yes	3	33.3	2 PhD, 1 MSc
No	6	66.7	

Table 2: Survey results

Variable	N (%)	Mean (SD)
Residency factors		
Total number of residents in program		
6-10	2 (22.2)	-
11-15	2 (22.2)	-
>30	5 (55.6)	-
Presence of fellows at neurosurgery program	8 (88.9)	-
Presence of nurse practitioners at neurosurgery program	9 (100.0)	-
Total months of clinical neurosurgery in first year		
2	1 (11.1)	-
3	7 (77.8)	-
4	1 (11.1)*	-
Total months of surgical rotations prior to start of neurosurgery	-	3.7 (±2.0)
Neurosurgical rotation began prior to midpoint of first year	4 (44.4)	-
Stay to operate “post-call” greater than 50% of time	5 (55.5)#	-
Other factors		
Access to cadaver, animal or simulation laboratory	8 (88.9)	
Routine attendance at this laboratory	0 (0.0)	
Average hours a week reading neurosurgery while on service		
<3	1 (11.1)	-
3-6	6 (66.7)	-
>6	2 (22.2)	-

* This trainee only forwarded their surgical activity log during the initial 3 months of neurosurgery service. # Four residents stayed to enhance their operative experience. One resident stayed due to inadequate coverage of the operative cases

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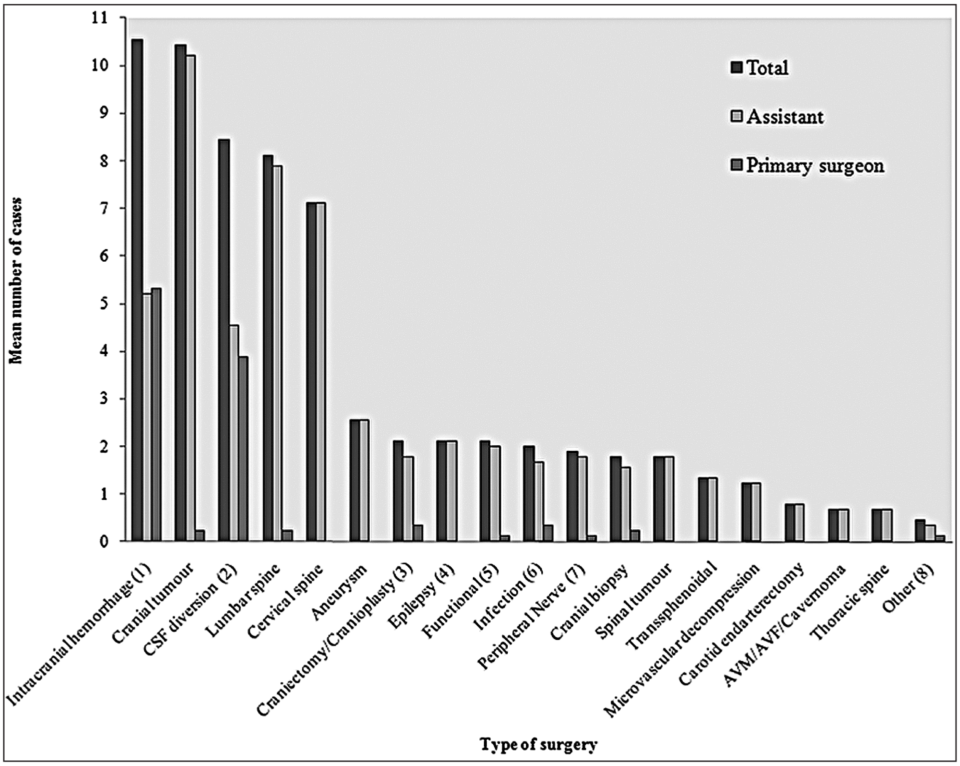

Figure: *Surgical activity of first-year Canadian neurosurgical trainees in 2008. [1]Includes chronic subdural hematoma, acute SDH, epidural hematoma and intracerebral hemorrhage; [2]Includes external ventricular device, ventriculoperitoneal shunt, endoscopic third ventriculostomy and lumboperitoneal drains; [3]Includes decompressive craniectomy and posterior fossa decompression; [4]Includes insertion of subdural electrodes; [5]Includes internalization procedures; [6]Includes all abscess and infected hardware cases regardless of location; [7]Includes median nerve release and ulnar nerve transpositions; [8]Includes muscle biopsy and cranial hardware removal. CSF=cerebrospinal fluid; AVM=arteriovenous malformation; AVF=arteriovenous fistula*

be included as an assistant. We did not differentiate between the 'first' or 'second' assistant. Two authors (A.F. and S.E.) extracted information from the operative logs to construct a uniform database. Neurosurgical cases were classified into general categories due to the modest number of specific operations.

Results

We identified a cohort of 20 first-year residents from 12 Canadian neurosurgery training programs that commenced residency in July of 2008. We contacted all trainees electronically for participation in the study. Three trainees were interested in the study but were excluded due to inadequate record keeping. Three trainees were interested in the study but did not forward their operative logs in a timely fashion. Four trainees did not reply despite several attempts. One refused participation in the study. Nine trainees were included in this study.

Demographic data and survey results are presented in Table 1-3. It is important to note that one participant only completed two months of neurosurgery in their first year. The average number of cases in major categories is presented in the Figure.

Nine of 20 eligible trainees participated in this study. Two respondents were female and three had a graduate degree prior to start of residency. No resident was previously enrolled in a surgical residency program. An average of 8.4 ± 4.6 weeks of elective time was spent on neurosurgery during medical school. Eight residents completed a neurosurgical elective at their current residency program. Only two residents are in the same medical school as their current residency program. Five residents graduated from a four-year medical school while four residents graduated from a three-year medical school. Eight residents reported the presence of fellows and all reported the presence of nurse practitioners at their program. Five residents voluntarily stayed post-call (more than 50% of the time) to

Table 3: Total case numbers for first-year Canadian neurosurgical trainees in 2008

Number of operations	Median (Standard Deviation)	Range
Primary surgeon	12 (±5.4)	1-16
Assistant	53 (±15.5)	29-79
Total	66 (±14.9)	46-85

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operate. Four reported that they stay to enhance their operative learning. One stayed due to "inadequate" number of residents available to cover the operative cases. The residents who stayed post-call to operate had a median number of 12 primary surgeon, 70 assistant and 79 total cases compared to other residents who had a median number of 12.5 primary surgeon, 46.5 assistant and 55 total cases. Six residents reported an average of 3-6 hours a week of neurosurgical reading while on service. There were a total of 595 cases in the collective database. During a three-month rotation, residents were involved in a median number of 66 cases, in which they were the primary surgeon and assistant in 12 and 53 cases, respectively.

In this study, the most common operations were performed for intracranial hemorrhage, cranial tumour, cerebrospinal fluid diversion, cervical spine pathology and lumbar spine pathology accounting for 68% of all procedures. Operations for intracranial hemorrhage (epidural hematoma, subdural hematoma and intracerebral hemorrhage) and cerebrospinal fluid diversion (ventriculostomy, ventriculoperitoneal shunt and endoscopic third ventriculostomy) were procedures that trainees were most likely to be the primary surgeon; 3.9 (46%) and 5.3 (50%) respectively. Other types or categories of operations that residents reported to have been the primary surgeon include cranial biopsy, cranial tumour, craniectomy, cranioplasty, lumbar spine, peripheral nerve, abscess drainage, battery internalization and muscle biopsy. Trainees assisted on an average of three aneurysm, one arteriovenous/cavernous malformations, one microvascular decompression and one transsphenoidal surgery. Finally, although observation of surgical cases is an important learning encounter, we did not report these cases as it was not uniformly captured in the databases.

Discussion

At the time of this study, Canadian neurosurgical residency training was a six-year program that consisted of at least 36 months of mandatory clinical neurosurgery. In 2010, it will be revised to 42 months with the primary goal of more adequately preparing competent residents to perform basic neurosurgical procedures given the changing 'work-hour' and training restrictions[9-11]. Similarly, American neurosurgical training is a minimum of six years with a minimum of 42 months of clinical neurosurgery[12]. In contrast, the European neurosurgical programs consist of six years with a minimum of 48 months dedicated to clinical neurosurgery[7,13]. However, greater importance is being placed on 'competency-based' training compared to a traditional 'years-in-training' program[3,4]. There is no objective evidence that the chosen number of years in training is appropriate for neurosurgical training[3,4].

In this cohort, first-year residents participated in a median number of 66 operative cases over a three-month span. If extrapolated, this accounts to 264 operations during a one year span. No minimum number of cases is specified by the Royal College of Physicians and Surgeons of Canada. For perspective, the German neurosurgical board requires a minimum of 305 total surgical cases in various categories to be completed throughout the residency program to be eligible for graduation[7]. A study at the University of Utah demonstrated that junior (first and second year) residents participate in an average of less than 20 cases per month for 2003-2004[14]. During the same year, junior residents participated in an average of 242.5 cases per year at the University of Oklahoma[15]. Expert opinion suggests 250-300 operations a year are required to adequately train a neurosurgical resident[7,16]. The surgical case numbers of first-year residents are generally lower than residents in more senior years of training as they are often relied upon for intensive care unit activities, outpatient clinic or with other non-operative duties. Also, they are often the most expendable member of the team when there is a paucity of surgical cases[6,7].

Another important factor in operative training is the degree of supervision a resident receives. A resident must successfully transition through the following stages of learning an operation: 1) observation 2) doing the surgery under supervision 3) doing the surgery without supervision. This gradual escalation of responsibility is consistent with a competency-based model of training[3,4]. Lack of competency is likely not the result of the lack of exposure to specific procedures as suggested by a previous study[6]. It is more likely that there is a lack of delegated responsibility of surgical cases. A single operation, can be logged as a case by each of the faculty, fellow, senior and/or junior resident. However, this may represent a valuable educational encounter for all participants depending on the adequate division of responsibility.

The observation that this cohort of junior trainees was more likely to perform procedures for cerebrospinal fluid diversion and intracranial hemorrhage in the primary surgeon role is logical. Insertion of external ventricular drains and burrhole drainage of chronic subdural hematoma contribute to the majority of these cases. These procedures are commonly encountered, especially on call, and are amongst the more simple operations that can be appropriately delegated to junior trainees[1]. These results do suggest, however, that Canadian trainees have a greater amount of independence when compared to Spanish first-year residents and slightly below their second-year residents[1]. It is important to note that Canadian first-year residents are assisting on arteriovenous/cavernous malformation, aneurysm, microvascular decompression and trans-sphenoidal surgeries, which are amongst the most complex neurosurgical cases[1,10].

An interesting observation that has arisen from this study is that more than half of the residents voluntarily stay in hospital 'post-call' to operate. This was reflected by the higher operative volumes reported by those residents. Although this wasn't the focus of our paper, the primary reason residents stayed post-call was to enhance their operative learning. One resident stayed due to "inadequate" resident coverage of operative cases. Alternatively, this may reflect a delay in "culture shift" as current trainees work the same long hours as the previous generation of trainees to demonstrate their commitment and willingness to learn. Recent surveys in the United States demonstrate that the majority of trainees and program directors believe work hour restrictions have negatively impacted operative experience especially for junior residents[14,17-20].

Ideally, trainees should acquire anatomic knowledge and surgical skills before performing a procedure on a patient[21]. Although cadaveric dissection provides the most realistic interaction with human anatomy outside the operating room, there are significant costs associated with the regulation and maintenance of these laboratories[22,23]. Animal models are a useful alternate to human models but are limited by the anatomical and biomechanical tissue differences[23]. Recently, there has been increasing interest and literature on the development of computer-based, virtual reality surgical simulators in teaching and rehearsing surgical skills[22,23]. At the time of our study, eight out of the nine residents had access to cadaveric, animal or simulation laboratories at their institution. However, no resident routinely attended these facilities. Given the established clinical utility of these learning opportunities, studies regarding factors that hinder residents from routine attendance at these laboratories are warranted so that they can be better integrated in a neurosurgery residency training program.

Another important observation from this study is that almost all cases of peripheral nerve surgery came from a single institution. This was not explicitly presented in the results to maintain anonymity. However, it highlights the possible lack of exposure to this subspecialty of neurosurgery amongst first-year residents. This finding has also been noted in the German neurosurgical training system[7]. An understanding of which procedures neurosurgical residents are exposed to will be necessary to better gauge whether existing training programs are addressing the essential competencies of general neurosurgical training.

There are several important limitations to this study: 1) Non-respondent bias is present in this study as 11 eligible trainees were not included in this study. 2) The retrospective nature of this study allows for inaccuracies in data retrieval. It is possible that cases participated in were missed as residents catalogued their own surgical activity. 3) The self-reporting nature of this study can allow for variation in a trainee`s perception of the surgical role, that is being the primary surgeon versus being an assistant in an operation. It is a complex task to accurately determine the exact role of a trainee during an operation[10]. Certain cases can be difficult to code by their very nature. For example, it is difficult to determine who the primary surgeon is if two surgeons each placed a burrhole on one side of the cranium to drain a bilateral chronic subdural hematoma. 4) Recall bias is potentially present in both the database and survey portion of this study. 5) Also, this study fails to capture the extent of involvement of the assistant. There is considerable variation in the tasks performed within the assistant's role. 6) A final limitation is that this data represents a snapshot of the surgical activity of a specific cohort of residents; these finding may not be applicable to the surgical activity of other cohorts, nor of the same cohort at a different point in time during training.

Surgical activity during a three-month rotation can be heavily influenced by a multitude of factors that we attempted to capture through our survey. A more comprehensive study would be required to study these factors in order to determine the surgical exposure that a training program can provide for its residents.

Conclusion

This pilot study has quantified the surgical activity of first-year Canadian neurosurgical trainees. It also provides useful information for program directors and first-year residents to compare institutional and individual activity, respectively[1,24]. It also provides a framework for a larger study involving residents from all years of training, to better gauge surgical activity throughout residency. Additionally, this study emphasizes the importance of accurate record keeping in prospective databases and highlights a need for a standardized comprehensive tool to record surgical activity[1].

Disclosure/Disclaimer

Aria Fallah and Shanil Ebrahim should be considered co-first authors as they equally contributed to designing, researching and preparing the first draft of the manuscript. They also contributed by revising several drafts of the manuscript. Faizal Haji contributed to the survey design and editing of the manuscript. Christopher Gillis, Fady Girgis, Kathryn Howe, George M. Ibrahim, Julia Radic and Mehdi Shahideh contributed through data collection and making significant contributions to the editing of the manuscript. M. Christopher Wallace contributed to the final editing of the manuscript.

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