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Setting standards of performance expected in neurosurgery residency: A study on entrustable professional activities in competency-based medical education

Jessica E. Rabski [a, b, *], Ashirbani Saha [a], Michael D. Cusimano [a, c]

[a] Injury Prevention Research Office, St. Michael's Hospital, Toronto, Ontario, Canada
[b] Division of Neurosurgery, Department of Surgery, University of Ottawa, Ottawa, ON, Canada
[c] Division of Neurosurgery, Department of Surgery, University of Toronto, Toronto, ON, Canada

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ABSTRACT

Background: Competency-based medical education requires evaluations of residents' performances of tasks of the discipline (ie. entrustable professional activities (EPAs)). Using neurosurgical Faculty perspectives, this study investigated whether a sample of neurosurgical EPAs accurately reflected the expectations of general neurosurgical practice.

Method: A questionnaire was sent to all Canadian neurosurgery Faculty using a SurveyMonkey® platform.

Results: The proportion of respondents who believed the EPAs were representative of general neurosurgery competences varied significantly across all EPAs [47%–100%] ($p < 0.0001$). For 9/15 proposed EPAs, ≥75% agreed they were appropriate for general neurosurgery training and expected residents to attain the highest standard of performance. However, a range of 27–53% of the respondents felt the other six EPAs would be more appropriate for fellowship training and thus, require a lower standard of performance from graduating residents.

Conclusion: The shift towards subspecialization in neurosurgery has implications for curriculum design, delivery and certification of graduating residents.

Introduction

The ongoing rapid advancements in medical knowledge, diagnostics and treatments have presented an ongoing challenge for learners and educators to navigate and cover such a large breadth of curriculum during residency training. As such, there has been a shift over the last half a century towards increasing subspecialization resulting in increasing numbers of medical postgraduates choosing to pursue fellowship training following completion of residency.[1–5] In some specialties, residents are even choosing to pursue two fellowships prior to entering independent practice.[6] The reasons for pursuing fellowship prior to commencing independent practice include intellectual interests, mentorship, marketability, the pursuit of careers in academia or research focused positions, and concerns about a lack of preparation for independent practice.[7–15]

In surgery, the shifting culture to subspecialize has created tensions across different specialties and even within some specialties themselves when defending their scope of practice.[16,17] For example, the development of the subspecialty of spinal surgery has created competition between neurosurgeons and orthopedic surgeons for patients and as a result of their specialty orientations, differences in residency educational goals and expectations exist.[18] For example, this has been reflected by orthopedic spinal surgeons performing more spinal deformity correction surgery and neurosurgeons doing more intradural spinal tumors in practice.[19–22] Although concerns regarding lack of resident preparedness have been dismissed by some,[23,24] ongoing efforts to ensure residents receive necessary training in order to provide the public with the highest standards of safe and quality of care, have been embodied into educational approaches like competency-based medical education (CBME).

The introduction of CBME into many residency programs has presented the opportunity to define the standards of technical and

* Corresponding author. The Ottawa Hospital, Civic Campus-Department of Neurosurgery, 1053, Carling Avenue Ottawa, Ontario, K1Y 4E9, Canada.
E-mail address: jrabski@toh.ca (J.E. Rabski).

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non-technical performance of graduates. In Canada, entrustable professional activities (EPAs) have been introduced as part of CBME curriculum and function as opportunities to assess residents performing tasks required of independent professional practice. EPAs have been defined as "units of professional practice, defined as tasks or responsibilities to be entrusted to the unsupervised execution by a trainee once he or she has attained sufficient specific competence".[25] As such, EPAs have essentially formalized previous practices of supervisors entrusting residents to discrete tasks arising in day-to-day medical practices, as deemed appropriate by their level of competency. The EPA process is therefore essentially an act of creating a transparent set of tasks that define the scope of practice of a specialty at a given period of time. A major responsibility of Faculty in CBME-based residency programs is to ensure that residents, through direct observation of performances, are assessed with respect to the standard of performance required of independent practice of that specialty on each of these EPAs.

Thus, accreditation and governing bodies of postgraduate medical training have recommended lists of specialty-specific EPAs meant to reflect professional tasks required of independent professional practice for a particular specialty. By demonstrating a particular standard of competence for each of the listed EPAs, the expectation is that the resident is ready for practice and has amassed the necessary clinical knowledge, technical skills and professional abilities to navigate independent professional practice effectively and safely.[26]

As of July 2020, the Royal College of Physicians and Surgeons of Canada (RCPSC) has introduced CBME principles into their neurosurgery residency programs. The purpose of this study was to determine whether a sample of recommended EPAs reflect the necessary tasks required of current neurosurgical practice and to determine the standards of expected performance on each of the selected EPAs for graduating residents.

Methods

An online survey was sent to all Canadian neurosurgery Faculty with publicly available email addresses using SurveyMonkey®. This study reports on a subset of data from a 55-item questionnaire. The data pertained to Faculty perspectives on a sample (15 out of 61) of EPAs proposed by the RCPSC's EPA guide document as part of their Competence By Design (CBD) curriculum resources.[27] The decision to select fifteen out of a possible 61 EPAs was based on feasibility (to ensure completion of the survey in 15 min), so as to not overburden faculty and encourage participation. One of the EPAs was designated as a Neurosurgical Foundations EPA, "Performing burr hole drainage of a chronic subdural hematoma". The remaining fourteen were designated as Core Neurosurgical EPAs and were selected to address the large breadth of the subspecialty. Thus, a trauma, two oncological (basic and complex tumors), two spine (basic and complex instrumentation), a pediatric, a functional neurosurgery, two cerebrovascular (aneurysm and arterial venous malformation), a skull base and finally, a peripheral nerve-related case were selected. To cover more humanistic and administrative skills of the profession, a communication EPA (leading discussions in emotionally charged situations), a dealing with surgical complications EPA and a documentation EPA were also selected. To promote uptake, three emails (an initial invitation and subsequent reminders) were sent over a four month period. Participation was voluntary and safeguards were implemented to ensure anonymity of responses (e.g. other than practice-related information and years of experience, no other identifiable information was requested). The survey allowed participants to stop prematurely and resume the survey at a future time. Once a questionnaire was completed, its link was de-activated. Study approval was obtained through the local Research Ethics Board at St. Michael's Hospital, Toronto, Canada. Survey questions pertaining to the results of this study are included as a Supplementary material.

Statistical analysis

Responders' (a) experience and (b) province of practice were summarized. For questions with categorical answers, the proportion of responses for the questions were calculated. Median, interquartile range (IQR), and ranges for responses to questions with numerical answers were calculated as applicable. Tests of proportionality were conducted to compare responses across related questions. For sub-group analysis related to the (a) respondent's province of practice (Ontario versus non-Ontario) and (b) respondent's experiences (up to 10 years versus more than 10 years); and comparison of existing and necessary number of forms and assessors, Fisher's exact test and Wilcoxon rank-sum test were used for categorical and numerical responses respectively. The level-of-significance considered was 0.05 for all tests.

Latent profile analysis (using package *tidyLPA*)[28] was conducted on using variables calculated for each individual as follows: (i) mean number of responses that considered EPAs appropriate for general neurosurgery (ii) mean number of responses that considered the EPA as not too broad (iii) mean number of responses that considered entrustment level "E" (iv) mean number of assessors, and (v) mean number of forms. These variables represent each individual based on their responses for the EPAs. R was used to carry out all analyses.[29]

Results

Analysis of 15 neurosurgery residency EPAs

A total of 67 survey responses were received resulting in an overall survey response rate of 39% (172 publicly available emails found from a possible of 333 practicing neurosurgeons).[30] Thirty-eight responses were considered complete for section five of the survey, which involved questions pertaining to the study's 15 sample EPAs. Respondent demographics can be found in Table 1. The distribution of responses, remained highly correlated (Pearson's correlation coefficient 0.93) to the total number of Faculty neurosurgeons practicing in the corresponding province.[30] In addition, a high correlation was found between the number of responses received and the number of emails sent to that provincial faculty (Pearson's $r = 0.96$). Forty-two percent of respondents had been in their Faculty position for less than 10 years and 58% for 11 years or greater, which did not vary significantly across provinces. Respondents were asked to reference this study's proposed resident entrustment scale when responding to questions pertaining to the 15 sample EPAs (seen in Fig. 1).

Faculty perspectives on the sample of fifteen proposed EPAs are summarized in Table 2. For each EPA, Faculty were asked whether it was appropriate in reflecting the activities required of general neurosurgery practice (ie. discrete task required of that specialty's professional practice that is suitable for focused entrustment decisions) and whether it was too broad or not (ie. does it represent a unit of practice that allows for feasible assessment).[31] Though the median of all percentage values reported in Table 2 is 76, we chose 75 or three-quarters as a cut-off for convenience (without any appreciable loss in generalization) for our evaluation and interpretation. Three quarters or more of respondents agreed that 9/15 proposed EPAs were appropriate and thus reflected the activities required of general neurosurgery practice. A range of 27–73% of the respondents felt that the remaining six EPAs (EPA04, EPA05, EPA08, EPA11, EPA12 and EPA15) represented activities requiring

Table 1
Demographics of respondents (N = 38).

Province of Practice	Percentage of Respondents	Faculty Neurosurgeons Practicing at Respondent's Hospital (median [Range])	Residents on Neurosurgery Service at Respondent's Hospital (median [Range])	Residents Supervised by Respondent per day (median [Range])
Alberta	10.5	15 [15–16]	6 [4–10]	2 [1–2]
British Columbia	10.5	8 [3–8]	3 [1–4]	1 [1–2]
Manitoba	10.5	10 [10 - 10]	4 [4–8]	4 [2–5]
Atlantic Provinces	5.2	9 [9-9]	5 [5-5]	1 [1-1]
Ontario	44.7	10 [3–32]	6 [1–32]	2 [1–4]
Quebec	18.4	14 [3–17]	3 [1–14]	1 [1–2]

*Please note that emails were sent to Saskatchewan (9) and New Brunswick (4) but no responses were received.

additional fellowship training. Respondents felt that the majority of EPAs (12/15) were not too broad and only three EPAs (EPA04, EPA11 and EPA13) received less than 75% of respondents' approval. When asked the standard of performance expected for each EPA, 70%–79% of respondents felt that targeting an entrustment level of "E" (being able to adapt performance or decisions in response to contextual complexities of the activity and perform the activity independently and safely) was appropriate for 7/15 EPAs. A range of 32–43% of respondents felt that targeting D or C was more appropriate for the remaining 8/15 EPAs and at least 21% targeted C or D for every EPA.

When asked how many evaluation forms documenting a resident's standard of competence attainment of an EPA should be required, for all 15 EPAs, respondents indicated a significantly higher number of evaluation forms (paired Wilcoxon rank-sum test p-value < 0.004) and number of assessors (paired Wilcoxon rank-sum test p-value <0.00072) from those recommended by the RCPSC (See Table 3). When factoring respondents' Faculty experience, those with less than ten years of experience considered EPA10 ($p = 0.03$) and EPA12 ($p = 0.02$) to require additional fellowship training and were significantly more concerned with EPA10 being too broad ($p = 0.01$) than Faculty with more than ten years of experience. Faculty with less than ten years of experience recommended a significantly more ($p = 0.03$) number of forms (median = 6.5) required to demonstrate competence attainment of EPA02 than those with more than ten years of experience (median = 3.5). When factoring respondents' province of practice, respondents practicing in Ontario recommended significantly higher number of assessors required for confirming competence attainment for EPAs 04, 07, 09 and 10 (median number of assessors: 3 from Ontario, 2 outside Ontario for each of the four EPAs) with $p = 0.01$, 0.04, 0.02, and 0.02 respectively.

Applying Latent Profile Analysis to the data, we tried to develop profiles of Faculty that described their collective set of views on EPAs as seen in Fig. 2. Based on several fitting indices, a two-class solution was found as optimal in latent profile analysis. These two profiles included 7 and 31 responders respectively. The first profile, consisting of 7 respondents, were more inclined to believe EPAs required additional fellowship training (mean: 67%), were too broad (mean: 60%), and required more number of forms (15) by more assessors (4) to demonstrate a resident's competence attainment. In contrast, the second profile, consisting of 31 respondents, considered the EPAs appropriate for general neurosurgery training (mean: 85%), were not too broad (mean: 86%), and required less number of forms (6) by assessors (2) to demonstrate a resident's competence attainment. However, both profiles showed similar inclination (profile 1: 69% profile 2: 68%) to choosing an entrustment level of E for demonstrating competence attainment. No significant differences between the profiles was found in terms of respondent's experience, province, number of staff or residents regularly working in their institution, or number of residents supervised.

Discussion

This study demonstrated the standards and expectations that Faculty have for neurosurgery residents across a variety of EPAs using the performance standards reflected in our entrustment scale. Establishing appropriate standards of performance that are EPA-specific allows for residents to continue to appreciate the breadth of neurosurgical exposure during training while creating realistic expectations of competence targets. The highest standard of performance, level "E" was designed to include important features of performance for demonstrating competence as described in the literature (performing independently and safely while also being able to respond to contextual complexities that could arise).[32–35] Though a majority selected "E" as the level of entrustment meant to represent a resident's competence attainment, about a quarter or more selected lower entrustment levels of "D" or "C". This could be due to the variations in the personal comfort

ENTRUSTMENT SCALE

The resident:

A- Observes only, as requires complete guidance or is not permitted to perform activity yet

B- Requires constant guidance and instruction when performing the activity

C- Requires occasional guidance or instructional prompting when performing the activity

D- Requires assistance or instruction only when responding to contextual demands of the activity to ensure patient safety

E- Adapts performance or decisions in response to contextual complexities of the activity and performs activity independently and safely.

Fig. 1. Resident EPA entrustment scale.

Table 2
Faculty perspectives on the appropriateness, broadness and entrustment level targets for 15 sample EPAs.

EPA #	Appropriate for general neurosurgery (%)	Not too broad (%)	Entrustment level E represents competence attainment (%)
EPA01: Leading discussions with patients and/or their families in emotionally charged situations	97	82	63
EPA02: Providing surgical management for patients with a head injury	97	84	76
EPA03: Performing posterior cervical or thoracic decompression	95	84	74
EPA04: Performing procedures utilizing spinal instrumentation including posterior subaxial, posterior thoraco-lumbar, occipito-cervical and anterior cervical	68	73	65
EPA05: Performing surgery for patients with an intracranial aneurysm	53	76	63
EPA06: Performing surgery for patients with spontaneous intracerebral hemorrhage with or without an underlying vascular malformation	97	79	66
EPA07: Performing surgery for patients with simple intra-axial brain tumors	95	87	71
EPA08: Performing surgery for patients with complex brain tumors	63	81	61
EPA09: Performing burr hole drainage of a chronic subdural hematoma	100	100	79
EPA10: Performing stereotactic procedures	89	78	70
EPA11: Performing craniotomy in an infant/toddler	53	62	68
EPA12: Performing transnasal surgery for patients with pituitary tumors	47	78	60
EPA13: Providing definitive management for patients with complications of neurosurgical conditions	100	74	71
EPA14: Documenting operative procedures	97	95	79
EPA15: Performing peripheral nerve decompression procedures	73	83	57

levels or attributes of the supervisor with entrusting residents for such activities.[36,37]

This study also demonstrated how with the trend of graduates increasingly pursuing additional subspecialty training, Faculty agreed on high standards of performance for a core set of EPAs representing general neurosurgical practice for all graduates (e.g. EPA01: "Performing burr hole drainage of a chronic subdural hematoma"). However, there was significant variability across EPAs, particularly for those where up to a quarter or more felt they were more appropriate for fellowship training. In particular, procedures involving spinal instrumentation, intracranial aneurysms, complex brain tumors, transnasal surgery for pituitary tumors and finally, craniotomies in an infant/toddler demonstrated the least consensus among respondents for both whether they were appropriate representations of general neurosurgery practice and for targeting "E" as a level of entrustment. One study has shown that practicing neurosurgeons worldwide believe they are less proficient in endovascular procedures and complex spinal procedures like percutaneous endoscopic lumbar discectomies, and that the most popular fellowships pursued were in pediatrics, spine, skull base and vascular neurosurgery.[38] In North America, the most popular fellowships were in spine (25.6%), pediatric (16.5%), and vascular (16.1%) with residents siting their "inadequate training during residency" as their fourth reason for pursuing fellowship training after "personal interest for knowledge," "job market demand," and "academic prestige".[10] In Canada, over 80% of neurosurgery trainees pursued fellowship training between 2004 and 2014 with the most popular fellowships being in spine, followed by endovascular.[39] Potential gaps in the training of neurosurgery residents with regards to endovascular neurosurgery, skull base and stereotactic radiosurgery have also been reported.[10,40,41] Interestingly, no endovascular neurosurgical procedures were included as part of this study's sample EPAs since there are currently none proposed by the RCPSC; thereby possibly demonstrating a potential gap in existing EPAs. Overall, our study's results similarly reflect how the trend to subspecialize has altered expectations for demonstrating competence attainment during residency and scopes of practice for general neurosurgery. As such, we saw these values reflected in lower standards of expected performance for graduating residents in the more subspecialized EPAs.

Table 3
Comparison between faculty perspectives and currently recommended number of forms and number of assessors for demonstrating resident competence attainment for specific EPAs.

EPA #[b]	Faculty's Recommended Number of Forms				Currently Required Number of Forms[a]	Faculty's Recommended Number of Assessors				Currently Required Number of Assessors[a]
	Median	IQR	Min	Max		Median	IQR	Min	Max	
01	4	3	1	29	2	3	1	1	5	1
02	6	5	2	25	3	3	1.75	1	10	1
03	5	7	2	25	2	3	1	1	10	1
04	5	7	3	40	8	3	1	1	10	2
05	5	7	0	30	2	2	1	0	10	2
06	5	7	2	20	2	2	1	1	10	1
07	5.5	6	2	50	4	3	1	1	10	1
08	5	6.5	2	40	4	2	1	1	10	1
09	5	5	1	30	2	2	1	1	6	1
10	5	7	1	40	2	2	1	1	10	1
11	5	7	1	25	1	2	0	1	10	1
12	5	7	0	30	2	2	1	0	10	1
13	5.5	5.75	0	40	5	3	2	0	10	2
14	5	5.75	0	50	3	3	2	0	5	1
15	5	5	2	25	2	2	1	1	10	1

[a] Number of forms and number of assessors proposed by the RCPSC's document entitled: "EPA guide: neurosurgery".[27]
[b] These EPA numbers correspond with the EPAs presented in Table 2.

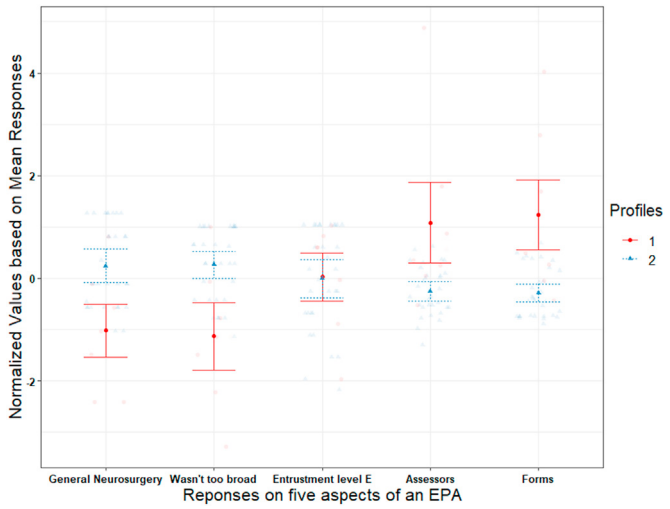

Fig. 2. Latent profile analysis of respondents revealed two separate profiles of respondents. Values in Y-axis are normalized (mean-centered and divided by standard deviation) mean individual responses in considering EPAs as general neurosurgery-specific, not too broad, appropriate for E as entrustment level along with recommended number of assessors and forms. The bars represent 95% confidence interval for the class centroids (dot/triangle). Profile 1 (smooth line/circle) represents 7 respondents. Profile 2 (dotted line/triangle) represents 31 respondents. Profiles differ in considering EPAs for general neurosurgery training, breadth, number of assessors and forms but not in terms of preference for entrustment level.

The variability of responses seen for EPAs deemed appropriate for general neurosurgery training, may represent variations in supervisors' comfort levels, teaching experience or professional experience.[36,37] For example, "Leading discussions with patients and/or their families in emotionally charged situations" was deemed by 97% of respondents to be appropriate for general neurosurgery training yet only 63% would target an entrustment level of "E" for demonstrating competence attainment. As such, over a third of respondents believed in targeting competency levels where residents may still need assistance or instruction when responding to contextual demands of the activity to ensure patient safety was appropriate.

With regards to broadness, respondents believed that the majority of EPAs had well-defined titles and key feature descriptions. Only three were considered too broad (EPA04, EPA11 and EPA13), where two of which, were associated with less consensus for both their appropriateness for general training and targeted resident entrustment level and such, likely need further revisions to accurately reflect expectations of practice. Though EPA13 ("Providing definitive management for patients with complications of neurosurgical conditions"), was deemed appropriate for general neurosurgery training, it was also deemed too broad which possibly resulted in respondents assigning it a lower targeted level of entrustment for resident training. As such, adding additional key feature descriptions could likely improve this EPA's acceptance by Faculty.

Finally, this study demonstrated that Faculty believe a higher number of forms (exception for EPA04) and assessors (exception EPA05) are required to demonstrate competence attainment for each of the proposed EPAs. Overall, it appears that recommended numbers for individual EPAs didn't differ significantly from the overall median number of 5 forms ($p = 0.82$) or 2.5 assessors ($p = 0.85$). Since these results are independent from EPA context, training programs could consider requiring 5 forms demonstrating competence attainment for every EPA and requiring three different supervisors for completing these assessments.

Limitations

Only publicly available email addresses from university or hospital Faculty websites were used to send out the survey to potential participants and as such, could have favored the studies selection of Faculty with teaching, administration and research interests. It is possible that some of the respondents may have been members of the RCPSC's Neurosurgery Specialty Committee which consists of up to nine members and thus, some respondents may have been involved in the development of the EPAs. However, even if all nine committee members participated in this study, this would still mean that the majority of participants (29/38) were not a part of the development of the EPAs and thereby, were able to provide valuable new insight and perspectives on them. Furthermore, the distribution of neurosurgeons represented in this survey closely reflects the proportions of neurosurgeons across the geography of Canada and across the years of practice. This study investigated only a sample of 15 of the possible 61 EPAs to avoid increasing the time to complete it and worsening potential response rates. The 15 EPAs were selected to represent a variety of technical and non-technical skills and covered activities related to all possible subspecialties within neurosurgery. Future studies could involve designing surveys dedicated to only reviewing certain proposed EPAs or to send the survey out in different phases so that all EPAs would eventually be assessed by respondents.

Conclusion

Neurosurgical Faculty across Canada expect the highest standard of competence of graduating residents for the majority of EPAs. For some neurosurgeons, a subset of EPAs, were felt to reflect more subspecialized care to be mastered during fellowships and as such, a lower standard of performance was expected of graduating residents. This reflects the ongoing shift towards subspecialization in neurosurgery and other fields and has implications for curriculum design, delivery and certification.

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Disclosures

No authors of this study were members of the RCPSC's Neurosurgery Specialty Committee and therefore, did not participate in the development of the RCPSC's "EPA Guide: Neurosurgery".

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.amjsurg.2020.12.014.

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