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ORIGINAL ARTICLE

The Role of Neurocritical Care: A Brief Report on the Survey Results of Neurosciences and Critical Care Specialists

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Abstract
Background Neurocritical care is a new subspecialty field in medicine that intersects with many of the neuroscience and critical care specialties, and continues to evolve in its scope of practice and practitioners. The objective of this study was to assess the perceived need for and roles of neurocritical care intensivists and neurointensive care units among physicians involved with intensive care and the neurosciences.
Methods An online survey of physicians practicing critical care medicine, and neurology was performed during the 2008 Leapfrog initiative to formally recognize neurocritical care training.
Results The survey closed in July 2009 and achieved a 13% response rate (980/7524 physicians surveyed). Survey respondents (mostly from North America) included 362

Dr. Wendy Ziai (Senior Co-author) performed the statistical analysis for this article.

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(41.4%) neurologists, 164 (18.8%) internists, 104 (11.9%) pediatric intensivists, 82 (9.4%) anesthesiologists, and 162 (18.5%) from other specialties. Over 70% of respondents reported that the availability of neurocritical care units staffed with neurointensivists would improve the quality of care of critically ill neurological/neurosurgical patients. Neurologists were reported as the most appropriate specialty for training in neurointensive care by 53.3%, and 57% of respondents responded positively that neurology residency programs should offer a separate training track for those interested in neurocritical care.

Conclusion Broad level of support exists among the survey respondents (mostly neurologists and intensivists) for the establishment of neurological critical care units. Since neurology remains the predominant career path from which to draw neurointensivists, there may be a role for more comprehensive neurointensive care training within neurology residencies or an alternative training track for interested residents.

Keywords Education · Neurocritical care · Survey · Neurointensivists · Critical care

Introduction

The arborization of modern medical practice is extensive with major branch-points subserving a multitude of specialties and subspecialties. This division of labor allows practitioners to provide specialized care to specific groups of patients with concomitant improvements in outcomes [1–10]. The creation of new specialties has not always met with initial enthusiasm. Frequently, there has been substantial debate concerning the need for, yet another division in medical practice. Neurocritical care falls into this category.

Proponents of the field profess that Neurocritical care units (NCCU) bring higher quality care as they focus on the special needs of the population served and specialists are trained with emphasis on the unique aspects of neurologic disease. [1]. In support of this statement, a significant literature has grown extolling the positive virtues of NCCU and neurointensivists [1–8]. Studies comparing patients with strokes and intracranial hemorrhage treated in general or medical Intensive care units (ICU) versus specialized stroke units or NCCUs have demonstrated improved outcomes and decreased mortality rates in the latter [1–4]. Other studies evaluating patient outcomes before and after institution of a neurointensivist led team in an NCCU have shown fewer complications, decreased length of stay, higher percent discharged home or to rehab and improved documentation after the institution of a neurointensivist led team [5–8].

Despite the evidence and expansion of neurocritical care programs internationally, NCCUs still exist in relatively few hospitals/centers around the world and neurointensivists are often placed in the position of defending their subspecialty. [11–13]. Establishing a new unit is particularly challenging due in part to resistance from hospital governing committees and existing critical care specialists who question this need. The strongest literature to date on this topic exists for cardiac care units, historically [14], and more recently, NCCUs and trauma ICUs [9, 10]. Alongside supportive literature are studies which suggest there may not be a mortality benefit to subspecialty ICUs [15] and question the intensivist led team model in the care of critically ill patients, with data supporting both improved [16] and worse [17] outcomes.

The efforts to promote neurocritical care have been aided recently by the United Council of Neurological Subspecialties (UCNS), a nonprofit organization committed to the establishment of training standards for neurological subspecialty fellowship programs. In 2005, UCNS granted neurocritical care formal recognition and acceptance as a medical subspecialty paving the way for accreditation of neurocritical care programs and creating subspecialty certification exams [12]. Also, the Leapfrog Group in their 2008 update recognized the training process and need for neurointensivists and NCCUs [18]. This is a landmark achievement, as this is the first non-neuroscience professional organization that has officially recognized neurointensivists. Considering the significant shortage of intensive care physicians in the United States currently [19], a means of infusing more intensivists into the healthcare system would appear to have support.

The objective of this study was to assess the perceived need for and roles of neurocritical care intensivists and neurointensive care units among physicians involved with intensive care and the neurosciences.

Materials and Methods

The authors developed a survey of 44 questions of categorical data entry in spring 2008, focusing on the following areas: (1) demographics, (2) practice characteristics, and (3) perceptions of goals, strengths, and weaknesses of neurocritical care and neurointensivists (Table 1). At the time of the survey, the UCNS was laying the groundwork for subspecialty certification exams in neurocritical care and the Leapfrog Group had just recognized neurointensivists [12, 18]. After approval by the local (University at Buffalo, The State University of New York) Institutional Review Board, physicians practicing or involved with critical care and the neurosciences were contacted via email. The Neurocritical Care Society (NCS) and Society

Table 1 Core questions of the survey

What is your perception of the goals of neurocritical care?
Would the availability of a neurocritical care *unit* improve the quality of care of critically ill neurological/neurosurgical patients?
Would the availability of a fellowship trained neurocritical care *specialist* improve the quality of care of critically ill neurological/neurosurgical patients?
What field/prior training would, in your opinion, be most desirable for someone who wishes to train in/practice neurocritical care?
A neurologist with fellowship training in neurocritical care can adequately care for critically ill patients with neurological or neurosurgical illnesses in the ICU
A neurosurgeon with or without fellowship training in neurocritical care can adequately care for critically ill patients with neurological or neurosurgical illnesses in the ICU
What primary specialty do the neurointensivists in your facility come from?
To what primary specialty do you belong?
What is your current professional status?
Does your facility train residents or fellows?
What is the predominant setting of your practice/training?
Should neurology residency programs make available a separate training track within the residency for residents interested in neurocritical care? (i.e., more time spent in neurosurgery, internal medicine, cardiology, anesthesia, intensive care units during neurology residency prior to fellowship training)

of Critical Care Medicine (SCCM) agreed to participate. After formal review of the survey, these societies sent their members an email which contained a short introductory letter and directions to access a website that contained the survey (Supplement Material 1). In addition, neurologists were contacted via email addresses obtained from the American Academy of Neurology (AAN) membership directory. At most, two attempts, 1 week apart were made, to contact study participants. The second email message to potential survey participants contained a statement asking them to ignore the invitation if they already responded the first time, to prevent duplication of responses. Participation was voluntary and entirely anonymous. The survey was open for a period of 1 year from July 2008 to 2009.

Statistical Analysis

Survey responses were analyzed using descriptive statistics. We categorized the respondent population as intensivists (both neurointensivists and non-neuro intensivists) and non-intensivists (mostly composed of neurologists, who were not neurointensivists). Neurointensivists were composed of mostly neurologists and internists; non-neuro intensivists were composed mainly of internists and anesthesiologists (Fig. 1).

Differences in responses by category of the respondent populations (such as non-intensivist vs. intensivist, neuro intensivist vs. non-neurointensivist) were analyzed using the Mantel–Haenszel χ^2 test. Odds ratios with 95%

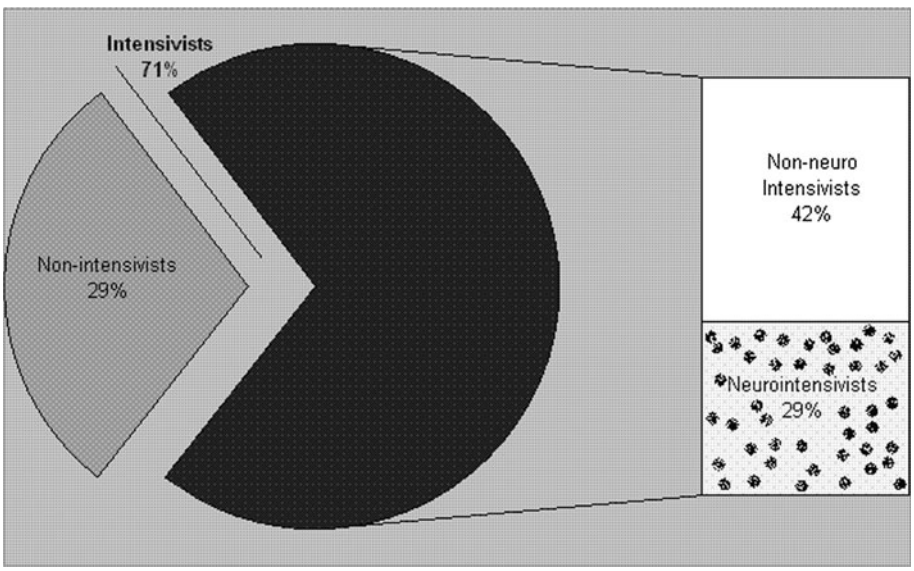

Fig. 1 *Pie chart* showing the subcategories of survey respondents that were created for analysis. Non-intensivists (composed mostly of neurologists) numbered 254 and intensivists numbered 620. Among the intensivists, 364 were non-neuro intensivists and 257 were neurointensivists

confidence intervals were calculated where appropriate. Two-sided tests of significance were used with $P < 0.05$ indicating statistical significance.

Main Survey Results

A 13% (980 responses from 7,524 potential respondents) rate was achieved. The primary specialties and demographic data of the survey respondents are shown in Fig. 2 and Table 2. Of these respondents, 620 identified themselves as intensivists and 254 were non-intensivists (the remainder did not provide an answer to this question) (Fig. 1). Among intensivists, 364 identified themselves as primarily non-neuro intensivists and 257 identified themselves as primarily neurointensivists (Fig. 3). Only 73 (7.5%) of participants had not heard of neurocritical care as a distinct specialty. This group was predominantly composed of internists and pediatricians (40/73), who were also intensivists.

The results of the most pertinent survey questions are presented below. Full results to the survey can be obtained by contacting the corresponding author.

Question 1: *What are the goals of neurocritical care?* A majority of all respondents (56.7%) agreed with all four stated goals (Table 3). Another 35% agreed with three of the four goals. The role of a neurocritical care unit in post-operative neurosurgical care and stroke patient care had the highest support while care of neurologically ill patients with other significant medical or surgical issues had the lowest support.

Question 2: *Would the availability of a neurocritical care unit improve the quality of care of critically ill neurological/neurosurgical patients?* A large majority (76.2%, $N = 726$) responded in the affirmative (Table 4). The most common reason for a "yes" response was specialized training of nursing staff. Respondents disagreeing with the statement felt general intensivists could handle the patients with neurologic/neurosurgical consultation (Table 5).

Question 3: *Would the availability of a fellowship trained neurocritical care specialist improve the quality of care of critically ill neurological/neurosurgical patients?* Response numbers were similar to question 2. Of 930 respondents, 74.2% responded "yes" ($N = 690$) (Table 6). The most common reason for a "yes" response was knowledge about the unique needs of the patient population. Respondents who disagreed with the statement again thought that a general intensivist could adequately care for these patients with appropriate consultation (Table 7).

Question 4: *What field/prior training would be most desirable for someone who wishes to train in/practice neurocritical care?* The rank order of which background specialty would be the most appropriate for neurointensivists was as follows: neurology (53.3% of all respondents), neurosurgery, anesthesiology, internal medicine, emergency medicine, surgery (general and trauma), and pediatrics (Table 8).

Question 5: *A neurologist with neurocritical care fellowship training can adequately care for critically ill patients with neurological or neurosurgical illnesses in the ICU?* A large majority (78.5%, $N = 695$) of all

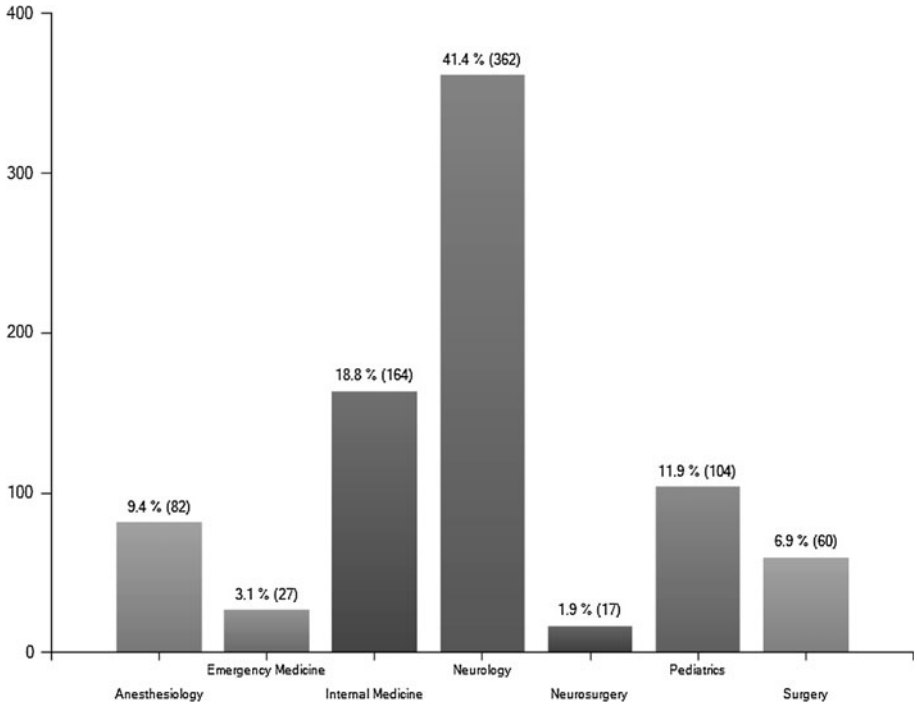

Fig. 2 *Bar graph* showing the primary specialties (numbers and percents) of the survey respondents. Neurologists formed the single largest group. [362 (41.4%) neurologists, 164 (18.8%) internists, 104 (11.9%) pediatric intensivists, 82 (9.4%) anesthesiologists, 60 (6.9%) surgeons, 27 (3.1%) emergency medicine practitioners, and 17 (1.9%) neurosurgeons]

Table 2 Survey results: demographics

Respondent characteristic	Number (%) of respondents
Practice in North America	772 (79.9)
Medical school training in North America	635 (65.4)
University/teaching hospital	597 (68.8)
Healthcare facility in urban area	659 (76.5)
Number of beds >500	422 (49.2)
Facility has neurocritical care unit or employs neurointensivists	489 (55.9)
Primary practice is neurocritical care	257 (29.3)
Current professional status	
Attending >5 years	338 (66.1)
Attending <5 years	97 (19.0)
Trainee	67 (13.1)
Other	9 (1.8)
Facility has resident and/or fellow training program	775 (89.2)

respondents agreed (strongly: 54.5% or somewhat: 24.3%) (Fig. 4). The most common reason for agreement among all groups was that neurologists were experts with nervous system problems, and for disagreement was that neurologists did not receive adequate formal training in general critical care issues.

Question 6: *A neurosurgeon with or without neurocritical care fellowship training can adequately care for critically ill patients with neurological/neurosurgical illnesses in the ICU?* Approximately half (50.5%, $N = 444$) of all respondents agreed (strongly: 18.2% or somewhat: 32.3%, Fig. 5). The most common reason for agreement among all groups was that neurosurgeons could recognize and manage post-operative complications. The reason for disagreement was the same reason given for neurologists: not enough general critical care training.

Question 7: *The demand for critical care specialists exceeds the supply.* The majority of respondents strongly (58.6%) or somewhat (24.3%) agreed, 7.0% ($N = 61$) disagreed, and 10.1% ($N = 88$) were "neutral".

Question 8: *Should neurology residency programs make available a separate training track within the residency for residents interested in neurocritical care?* (i.e., *more time spent in neurosurgery, internal medicine, cardiology, anesthesia, intensive care units during neurology residency prior to fellowship training)?* A small majority, 57% ($N = 494$) responded "yes," 26.3% (228) responded "no," and 16.6% (144) were "not sure" (Fig. 6).

Discussion

Our survey of predominantly neurologists and intensive care practitioners shows a broad consensus agreement that the establishment of NCCU with neurointensivist staffing would improve the quality of care of critically ill neurological and neurosurgical patients. There was slightly more support for the neurocritical care unit itself, compared with the presence of a neurointensivist, mostly driven by the presence of nursing care skilled in the neurologic exam. There was less enthusiasm for the benefits of NCCU among general intensivists, more established practitioners and those who practiced in a hospital without an NCCU. The major perceived shortcoming of the current concept of a neurointensivist was that neurologists, the most common trainees in neurocritical care, do not receive sufficient formal training in medical and surgical aspects of critical care, which affects their ability to provide complete care of the critically ill patient. Currently, all neurocritical care programs accredited by the UCNS are 2 year programs (as opposed to most surgical ICU fellowships and non-pulmonary medical critical care training, which are 1 year

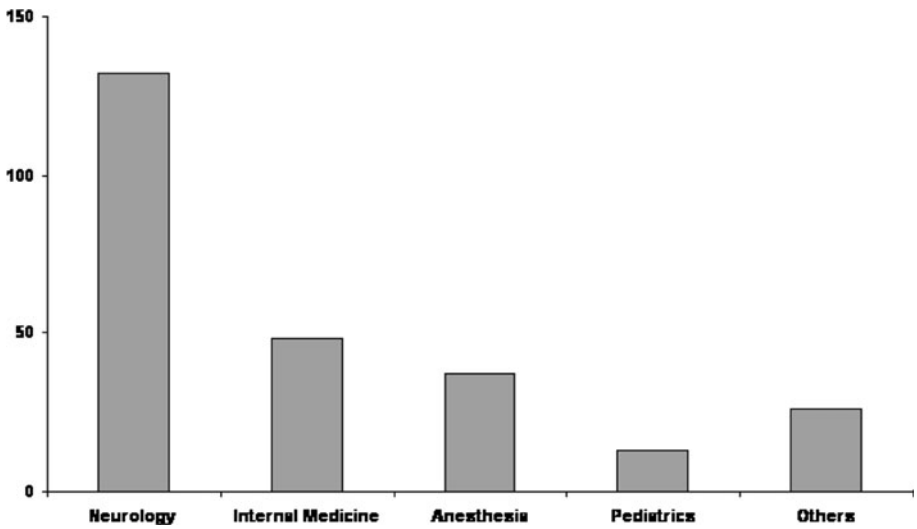

Fig. 3 *Bar graph* showing the primary specialties of the neurointensivists in the survey. Neurologists were the largest group. However, a significant number of other specialties were represented [neurology: 132; internal medicine: 48; anesthesia: 37; pediatrics: 13; others (surgery: 9; emergency medicine: 9; neurosurgery: 8); one respondent did not provide their primary specialty]

Table 3 Response to survey question: What are the goals of neurocritical care? (Total respondents—946)

	Yes [% (number)]	No [% (number)]
Care of pre- and post-operative neurosurgical patients	90.2 (822)	9.8 (89)
Care of patients whose neurologic condition warrants critical care WITHOUT other major medical/surgical issues that independently warrant admission to the ICU	85.6 (780)	14.4 (131)
Care of *any* neurologically ill patient WITH other major medical/surgical issues that independently warrant admission to the ICU	77.2 (716)	22.8 (212)
Care of acute stroke/post thrombolytic therapy or post endovascular intervention therapy	94.2 (862)	5.8 (53)

Table 4 Response to survey question: Does a NCCU improve quality of care of critically ill neurological/neurosurgical patients? (Total respondents—943)

Survey participant category	Responded yes (%)	Survey participant category	Responded yes (%)	*P* value
Neurointensivist	226/257 (87.9)	Non-neuro Intensivist	216/364 (59.3)	<0.001
Intensivist	441/620 (71.1)	Non-intensivist	233/254 (91.7)	<0.001
Attending physician	546/725 (75.3)	Trainee	128/148 (86.5)	0.003
Attending >5 years	396/539 (73.5)	Attending <5 years	148/183 (80.9)	0.006
University affiliated	582/762 (76.4)	Private practice	88/106 (83.0)	0.27
>500 hospital beds	341/423 (80.6)	<500 hospital beds	323/437 (73.9)	0.05
Hospital with NCCU	440/515 (85.4)	Hospital w/o NCCU	237/365 (64.9)	<0.001
Urban hospital	639/829 (77.1)	Non-urban hospital	24/32 (75.0)	0.83

Table 5 Response to survey question: Does a Neurocritical Care Unit improve quality of care of critically ill neurological/neurosurgical patients? Comparison of reasons for positive and negative responses

Reasons for "Yes" response (total—714)	Number (%)	Reasons for "No" response (total—50)	Number (%)
Nursing and allied staff have specialized training	662 (92.7)	Critically ill neurological patients can be cared for in general intensive care units with a neurology/ neurosurgical consult as needed	40 (80)
Cluster patients with similar needs into a single unit	584 (81.8)	Not enough patients to justify creation of a separate neuro-specific ICU	28 (56)
Shown to improve outcomes (morbidity and mortality)	506 (70.9)	Not enough neuro-specific therapies to justify creation of a separate ICU	28 (56)
Specialized unit decreases length of stay	475 (66.5)	A seperate neuro ICU is not cost effective	25 (50)
Increased physician (Neurosurgeon and Neurologist) satisfaction	472 (66.1)	Decreased healthcare staff satisfaction (due to limited case mix)	17 (34)
Cost efficient utilization of resources	448 (62.7)	Not shown to improve outcomes (morbidity and mortality)	16 (32)
Increased patient and family satisfaction	434 (60.8)	Decreased patient and family satisfaction secondary to fragmentation of care	16 (32)
Increased healthcare staff satisfaction	343 (48.0)	Low numbers of nurses with specialized training in neurocritical care	12 (24)
–	–	Decreased physician (neurosurgeon and neurologist) satisfaction	3 (6)

long) and must follow a core curriculum which strongly emphasizes both medical and surgical aspects of ICU care. These educational mandates were in evolution at the time of this survey and perceptions may have changed since the survey was conducted. A similar approach to 2 year critical care training for interested emergency medicine graduates who want to train in and practice medical critical care is being undertaken by the American Board of Internal Medicine (ABIM) in collaboration with the American Board of Emergency Medicine (ABEM) [20]. This will

Table 6 Response to survey question: Does a Neurointensivist improve quality of care of critically ill neurological/neurosurgical patients? (Total respondents—930)

Survey participant category	Responded yes (%)	Survey participant category	Responded yes (%)	*P*-value
Neurointensivist	214/257 (83.3)	Non-neuro intensivist	214/364 (58.8)	<0.001
Intensivist	428/620 (69)	Non-intensivist	225/254 (91.7)	<0.001
Attending physician	533/725 (73.5)	Trainee	120/148 (81)	0.05
Attending >5 years	381/539 (70.6)	Attending <5 years	150/183 (81.9)	0.005
University affiliated	566/762 (74.2)	Private practice	83/106 (78.3)	0.57
>500 hospital beds	319/423 (75.4)	<500 hospital beds	324/437 (74.1)	0.77
Hospital with NCCU	406/514 (78.9)	Hospital w/o NCCU	249/364 (68.4)	<0.001
Urban hospital	622/829 (75)	Non-urban hospital	21/32 (65.6)	0.41

Table 7 Response to survey question: Does a Neurointensivist improve quality of care of critically ill neurological/neurosurgical patients?

Comparison of reasons for positive and negative responses			
Reasons for "Yes" response (total—679)	Number (%)	Reasons for "No" response (total—46)	Number (%)
Knowledgeable about unique needs of patient population	625 (92)	The general intensivist can provide adequate care to these patients with appropriate consults (Neurology/Neurosurgery)	40 (87)
Ready availability of intensivist (not on other floors/in operating room)	533 (78.5)	Not shown to improve outcomes	18 (39.1)
One attending physician provides care for patients in unit (better co-ordination of care)	501 (73.8)	The primary attending for each patient can provide adequate care in an open unit format	6 (13)
Able to carry out research in order to advance the field	480 (70.7)	Decreased satisfaction among healthcare staff	5 (10.9)
Shown to improve outcomes (morbidity and mortality)	372 (54.8)	Decreased satisfaction among patients and family members (having a new physician who is not the primary in other settings)	3 (6.5)
Increased satisfaction among patients and family members	371 (54.6)	–	
Increased satisfaction among healthcare staff	355 (52.3)	–	

Table 8 Response to survey question: What field/prior training would be most desirable for someone who wishes to train in/practice neurocritical care? (Total respondents—891)

Specialty	Number (%)
Neurology	430 (53.3)
Neurosurgery	139 (16.9)
Internal medicine	87 (11.2)
Anesthesia	75 (9.6)
Surgery (general and trauma)	23 (2.9)
Emergency medicine	18 (2.4)
Pediatrics	16 (2.1)

then make it possible for emergency medicine graduates to be subspecialty certified in critical care. Other than increased duration of fellowship training, improved critical care skills among neurointensivists may be facilitated by altering residency training to offer more rotations in ICU, cardiology, neurosurgery, and anesthesia for those neurology residents interested in pursuing a career in neurocritical care. More than half of all respondents agreed that this would be an appropriate step to undertake. However, this may place unacceptable demands on neurology residency programs without promoting the core requirements for graduation. Mandatory rotations in an NCCU during neurology residency training may be a preferable alternative.

The same criticisms provided to neurologists becoming neurointensivists also extended to neurosurgeons. Most of the respondents felt that neurosurgeons too did not receive adequate formal training in the medical and (non-neuro) surgical aspects of critical care.

Although, neurology was the first choice specialty for neurointensive care training, there was support for entry into the field from multiple background specialties the most preferred being neurosurgery, anesthesiology, internal medicine, and emergency medicine.

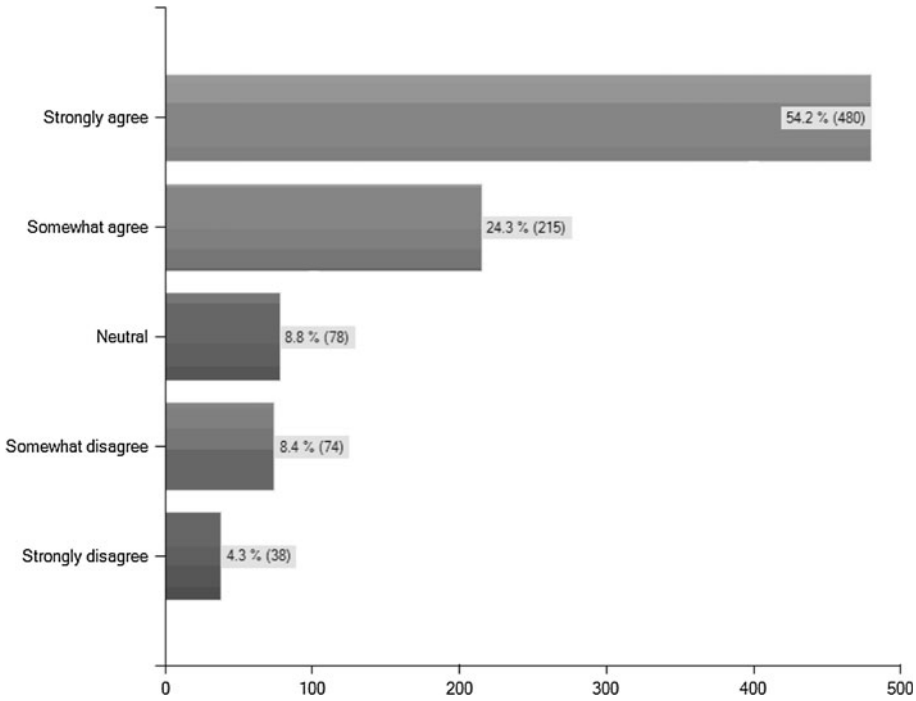

Fig. 4 *Bar graph* showing the Likert scale responses of all survey respondents to the adequacy of neurologists as neurointensivists. The majority agreed with the statement

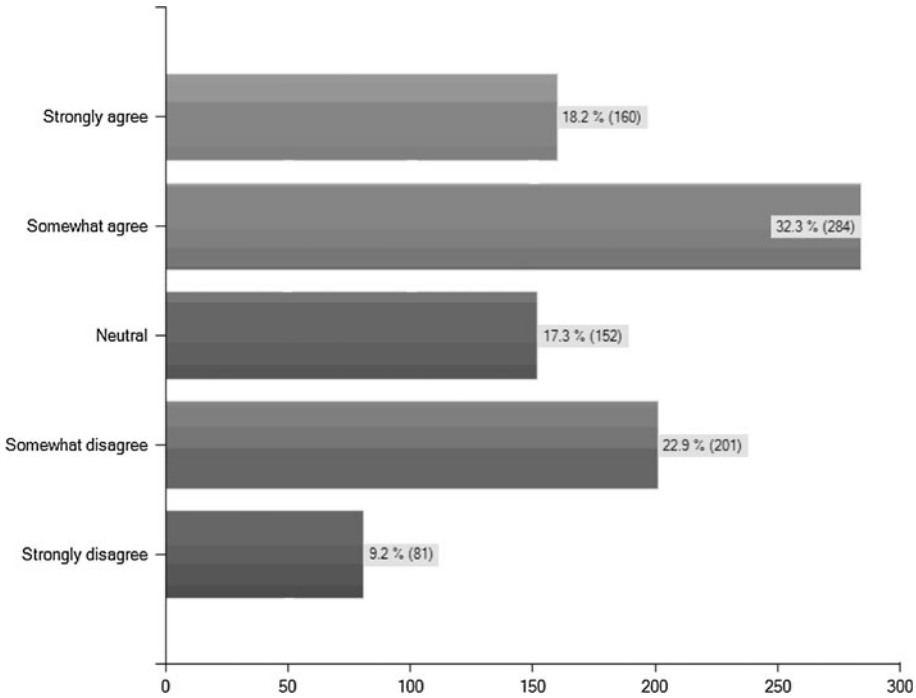

Fig. 5 *Bar graph* showing the Likert scale responses of all survey respondents to the adequacy of neurosurgeon as neurointensivists. Although the majority agreed with the statement, support was less robust

Limitations to this study are as follows. Exclusive use of a web-based survey targeting a large population (in this case all neurologists and intensivists) resulted in a relatively low response rate. Well-known examples of such studies are the Nurses Health Study II [21], with a 24% response rate, and the ACGME work hour compliance survey [22], with an 8% response rate. The 13% response rate of this study is therefore within the expected range although the responses may not be reflective of the target population especially for specialties with the lowest participation rates (such as neurosurgeons). Second, selection bias may have occurred, as some participants may have responded because of vested interests. Third, this survey likely oversampled a population that has a high likelihood

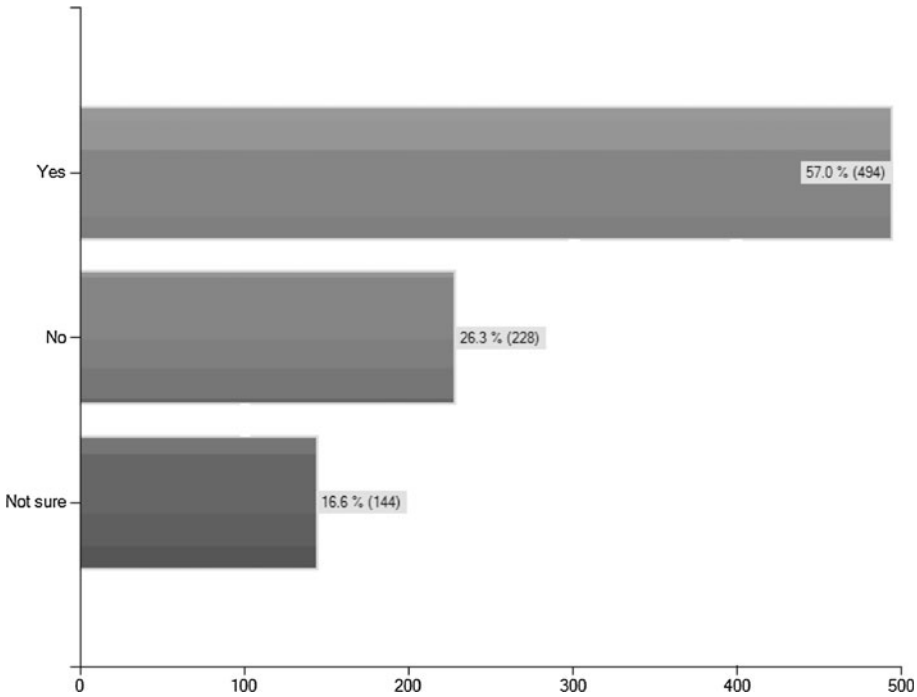

Fig. 6 *Bar graph* showing the responses of all survey respondents to the question of the need for neurology residency programs to create alternative training tracks for neurointensive care bound residents. A small majority agreed with this course of action

of favoring neurocritical care (neurologists and neurointensivists) while undersampling the non-neuro intensivist group and neurosurgeons, the latter being integral to the practice of neurointensive care. Further collaborative efforts to include neurosurgical societies in such surveys are needed. Fourth, this survey was conceived at the time when subspecialty certification was being developed for neurointensivists and the Leapfrog group had just recognized neuro ICUs and neurointensivists. A similar survey done in the near future, with more inclusive participation of neurosurgeons and hospital administrators may produce different results. Finally, this survey did not include questions about other educational options available to expand exposure to neurocritical care for neurology and other residency programs many of which currently have no such training opportunities.

With the advancement of modern medicine, subspecialty fields will cease to be the province of one specialty. Neurocritical care currently draws from multiple specialties: neurosurgery, neurology, anesthesiology, trauma surgery, internal medicine, emergency medicine, and pediatrics (in the appropriate settings). There is vast potential inherent in such inter-disciplinary collaboration. It provides a wider source pool of practitioners from which to draw and would potentially alleviate some manpower shortages faced by the critical care world. It allows for innovation in therapeutics, development of novel inter-disciplinary research ideas that will reach a wider audience if successful and ultimately further advancement of the field. The ultimate winners will be our patients, who at all times deserve the best possible care in their most vulnerable state.

Conclusion

Establishing neurointensive care units, fully staffed with trained neurointensivists is supported by a broad consensus of the survey respondents (mostly neurologists and intensivists). Since neurology remains the predominant specialty from which to draw neurointensivists, neurology residencies should provide exposure to and potentially more comprehensive critical care training for interested residents.

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Conflict of interest None.

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