

Neurosurgery Elective for Preclinical Medical Students: Early Exposure and Changing Attitudes

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■ **OBJECTIVE:** Exposure to surgical subspecialties is limited during the preclinical years of medical school. To offset this limitation, the authors created a neurosurgery elective for first- and second-year medical students. The objective was to provide each student with early exposure to neurosurgery by combining clinical experience with faculty discussions about the academic and personal realities of a career in neurosurgery.

■ **METHODS:** From 2012 to 2013, the authors offered a neurosurgery elective course to first- and second-year medical students. Each class consisted of the following: 1) peer-reviewed article analysis; 2) student presentation; 3) faculty academic lecture; 4) faculty personal lecture with question and answer period.

■ **RESULTS:** Thirty-five students were enrolled over a 2-year period. After completing the elective, students were more likely to: consider neurosurgery as a future career ($P < 0.0001$), perceive the personalities of attending physicians to be more collegial and friendly ($P = 0.0002$), perceive attending quality of life to be higher ($P < 0.0001$), and believe it was achievable to be a neurosurgeon and have a family ($P < 0.0001$). The elective did not alter students' perceived difficulty of training ($P = 0.7105$).

■ **CONCLUSIONS:** The neurosurgery elective course significantly increased student knowledge across several areas and changed perceptions about collegiality, quality of life, and family–work balance, while not altering the students' views about the difficulty of training. Adopting a neurosurgery elective geared towards preclinical medical

students can significantly change attitudes about the field of neurosurgery and has potential to increase interest in pursuing a career in neurosurgery.

INTRODUCTION

Neurosurgery is a demanding subspecialty with lengthy training. Perhaps as a result, the number of neurosurgery residency applicants declined from 1996 to 2002.^{1,2} Although the numbers have since increased, possible explanations for this downward trend include the duration of training, litigation risk, minimal exposure in medical school, and concerns about work–life balance.^{3,4} Medical students have to decide the type of residency training they will pursue by the end of their third year, if not sooner, to prepare for the match. Exposure to neurosurgery is often limited because of required rotations, scheduling difficulties, and the increasing emphasis on out-of-class academic activities.^{5,6}

Efforts have been made within the field of neurosurgery to promote participation in certain subspecialties among residents.^{7,8} Despite literature discussing medical student recruitment strategies in other surgical subspecialties,⁹ and few studies discussing general recruitment into neurosurgery,^{1,3} no studies have described a formal neurosurgery didactic course targeted specifically to the preclinical years of medical school, before hospital rotations.

To provide early exposure to neurosurgery and offset the limitations imposed by third-year clinical rotations, we created a neurosurgery elective for preclinical first- and second-year medical students. The course objective was to provide each student with an

Key words

- Education
- Medical student education
- Mentorship
- Recruitment
- Residency

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Citation: *World Neurosurg.* (2015).

<http://dx.doi.org/10.1016/j.wneu.2015.08.081>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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early, robust exposure to the field of neurosurgery by combining a strong clinical experience with small group discussions led by faculty regarding the academic and personal side of neurosurgery, while simultaneously portraying a realistic view of the field. Pre-elective and postelective surveys were completed to assess changes in attitude and perception.

METHODS

In the Spring semesters of 2012 and 2013, a comprehensive neurosurgery preclinical elective was offered to first- and second-year medical students at Vanderbilt University School of Medicine (Figure 1). The course was organized by fourth-year medical students (A.M.M., R.H.) and a neurosurgery resident (S.L.Z.) and led by the department chairman (R.C.T.). Classes were held on Wednesdays from 5:00 to 6:30 PM every 2–3 weeks to avoid academic conflicts with preclinical classes and exams. Institutional review board approval was obtained for this prospective, quality-based research endeavor.

Course Objectives and Requirements

The course mission was to provide each student with a strong exposure to the field of neurosurgery. Specific course objectives (Table 1) were designed with the primary intention of introducing students to neurosurgery at an early stage in their medical education, emphasizing professional, academic, and personal lives of neurosurgeons, from residency to career. Only a cursory introduction to neurosurgical principles, pathology, and management was provided, as this was not the primary aim of our course. Rather, the overarching theme was to emphasize what a life in neurosurgery means, through open, honest discussions with faculty members, to educate students for their impending career decision.

Course requirements included mandatory class attendance and participation, attending 4 neurosurgical operations and 1 neurosurgery clinic of the student's choice, and a 10-minute group presentation on a neurosurgical topic of their interest. Each student was graded on a pass–fail system.

Class Structure

The elective began with an introductory class followed by 6 class sessions. The department chair and the student/resident coordinators were present for all class sessions. Each class consisted of: 1) peer-reviewed article analysis; 2) a student presentation on a neurosurgical disease; 3) a faculty “academic” lecture; and 4) a faculty “personal” lecture followed by a question and answer session. A course syllabus with the detailed topics for each class is shown (Figure 2).

Peer-Reviewed Article Analysis (10 minutes). For each meeting, 1–2 relevant neurosurgical articles were provided to each student. These articles were specific to the faculty member leading the class and were meant to foster curiosity about neurosurgical subspecialties. A brief review of each article, with relevant figures and tables, was led by the fourth-year medical student or resident (R.H., A.M.M., S.L.Z.).

Student Presentation on a Neurosurgical Disease (10 minutes). A group presentation by 4 students was given on a topic of their choosing, relevant to the subspecialty of the faculty speaker. Examples of topics chosen were: subarachnoid hemorrhage, lumbar spine fusion, primary brain tumors, and deep brain stimulation. These presentations provided peer-to-peer teaching in a low-stress environment. Presentations were assigned with the students' primary medical school curriculum responsibilities in mind. Videos and pictures were highly encouraged.

Faculty Academic Lecture (20 minutes). Each faculty member provided a 20-minute academic lecture, focused on their surgical or research expertise. These lectures were designed with the audience in mind and were appropriately focused to their level. Each academic lecture served as a brief, but not comprehensive, introduction to the subspecialty. For example, the lecture on brain tumors included mention of interesting cases and operations, with videos and pictures, rather than an exhaustive list of all supratentorial brain tumors. Lectures were not designed to teach to a final examination.

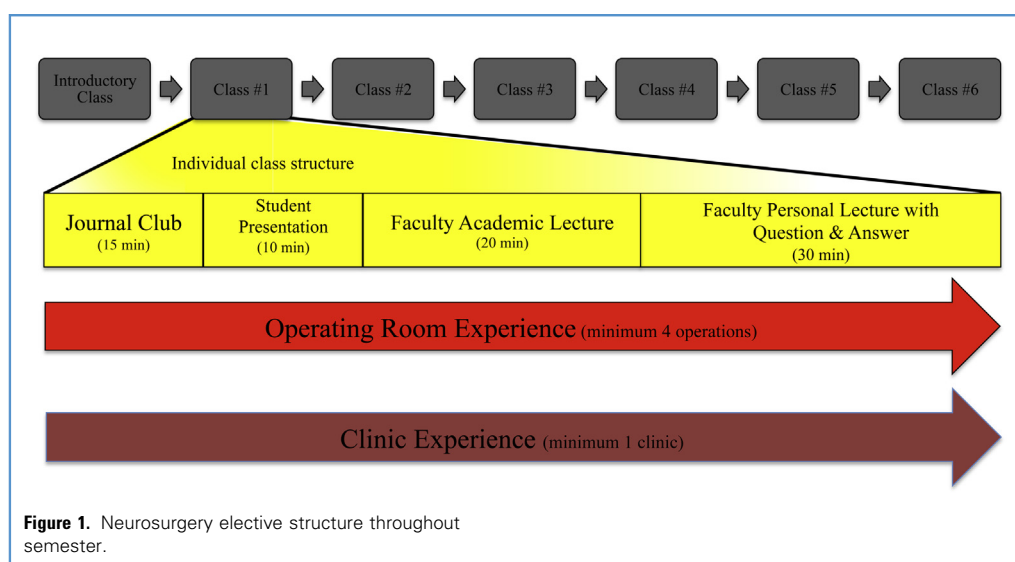


Figure 1. Neurosurgery elective structure throughout semester.

Table 1. Neurosurgery Elective Course Objectives

■ To familiarize students with the breadth of neurosurgical operations
■ To provide first-hand experience in the neurosurgery operating room
■ To offer patient care experiences in various neurosurgery clinics
■ To learn about the cutting-edge scientific discoveries relevant to neurosurgery
■ To acquaint students with the history of Vanderbilt University neurosurgery and current faculty members leading the field
■ To engage in Q&A sessions with faculty about a life in neurosurgery, memorable patients, stories from residency, and personal anecdotes.

Faculty Personal Lecture with Question and Answer Session (30 minutes). At the conclusion of the academic component, each faculty member provided a more personal discussion related to the field of neurosurgery, outside of the operating room and clinic. This was an informal setting where students were encouraged to ask open-ended questions. Each faculty member sat down at the round table with the students. PowerPoint presentations were not used. Examples of topics included: a trip to Africa to provide neurosurgical care to an indigent African population (M.J.M.); specific stories about communicating devastating news to a families (R.C.T.); memorable stories from residency training (J.M.); and what it means to be a private practice versus an academic neurosurgeon (A.K.S.). Invariably, each personal lecture evolved into an interactive question and answer period. Discussions often exceeded the 30-minute allotted class time.

Surveys

Surveys were offered at the outset and completion of the elective (Figure 3). Each question was graded on a Likert scale of 1–10.

A Shapiro–Wilk test was used to assess the normality of the difference between surveys completed before and after the course. Paired *t* tests were performed for normally distributed data, and Wilcoxon signed rank test was used for nonparametric data. Alpha level was set to 0.05. All statistics were calculated using STATA version 14 (StataCorp LP, College Station, Texas, USA).

RESULTS

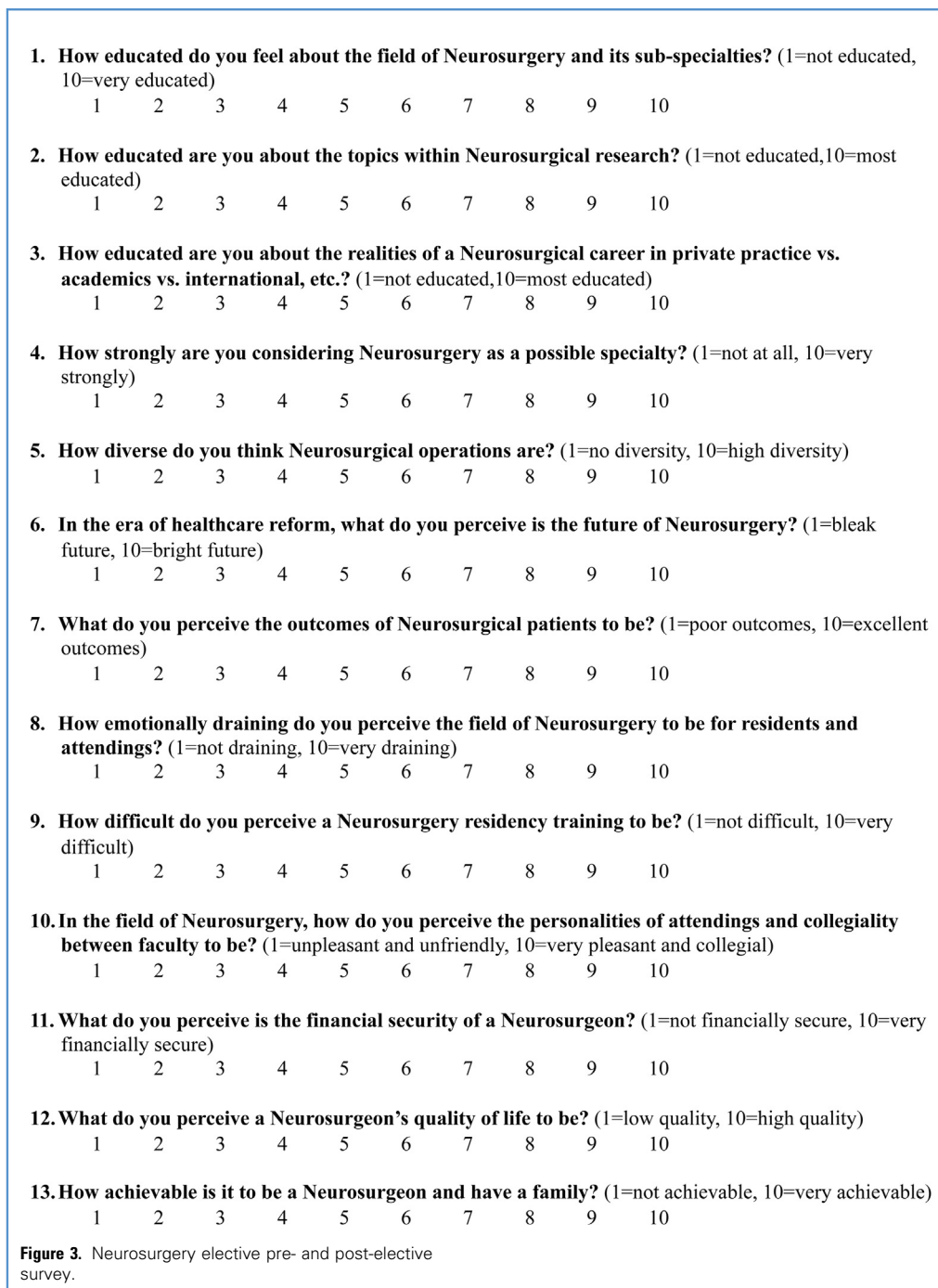
Thirty-five students were enrolled over the 2-year period: 17 in the first year (4 females) and 18 in the second year (3 females). There were 24 first-year students and 11 second-year students. Thirty-five students (100%) completed all course requirements and surveys. The breadth of the operative exposure seen collectively by the 35 students included a total of 135 operations: 34 spine operations, including minimally invasive and peripheral nerve; 49 intracranial adult and pediatric tumor resections, including endoscopic approaches; 13 open vascular and 25 endovascular operations; and 14 functional operations. Students primarily decided to attend the brain tumor clinic (45%) and functional neurosurgery clinic (25%).

Likert Survey Questions

By the end of the elective, several preconceived notions about the field neurosurgery were altered. After statistical analysis of mean pre- and post-elective Likert scores, the elective increased students' knowledge and changed attitudes across many areas, seen in Table 2 and graphically depicted in Figure 4. However, the elective did not alter students' perception about how demanding the neurosurgical training was (8.7 to 8.6; $P = 0.71$). Lastly, 35 of 35 students (100%) said they would recommend this course to a friend. All questions had parametric data with corresponding paired *t* tests except question 6, for which a

TOPICS	FACULTY	SPOTLIGHT / RESEARCH
Introduction to Neurosurgery <i>Course Nuts and Bolts</i>	Zuckerman/Mistry Feb 6 th	- Rish BL. The Vanderbilt University neurosurgical heritage. <i>J Neurosurg</i> , 1993 - Suk I, Tamargo RJ. Concealed neuroanatomy in Michelangelo's Separation of Light From Darkness in the Sistine Chapel. <i>Neurosurgery</i> , 2010.
Functional and Psychosurgery <i>Balancing Surgery and Research</i>	Dr. Neimat Feb 20 th	- Suthana N, Haneef Z, Stern J, Mukamel R, Behnke E, Knowlton B, Fried I. Memory enhancement and deep-brain stimulation of the entorhinal area. <i>N Engl J Med</i> , 2012 - Lin SC, Deisseroth K, Henderson JM. Optogenetics: background and concepts for neurosurgery. <i>Neurosurgery</i> , 2011. - http://abcnews.go.com/video/player/index?id=5946602 - http://www.thedoctorstv.com/videolib/init/6210
Spine Surgery and Outcomes <i>Humanitarian Aid and Neurosurgery</i>	Dr. McGirt Feb 27 th	- McGirt MJ, Speroff T, Godil SS, Cheng JS, Selden NR, Asher AL. Outcome science in practice: an overview and initial experience at the Vanderbilt Spine Center. <i>Neurosurg Focus</i> . 2013
Brain Tumors <i>Delivering Bad News</i>	Dr. Thompson Mar 13 th	- Myers, J. Who He Is. <i>JAMA</i> . 2012 - Memorable stories from Dr. Thompson's career as brain tumor surgeon
Vascular Neurosurgery <i>Residency Education</i>	Dr. Mocco Mar 20 th	- Hoh BL, et al. "Higher Complications and No Improvement in Mortality in the ACGME Resident Duty-Hour Restriction Era" <i>Neurosurgery</i> . 2012 - Weaver KJ, Neal D, Hoh DJ, Mocco J, Barker FG 2nd, Hoh BL. The "July phenomenon" for neurosurgical mortality and complications in teaching hospitals. <i>Neurosurgery</i> . 2012
Sports Neurosurgery <i>Academic vs. Private Practice</i>	Dr. Sills Apr 10 th	- Schwarz A. "Before Dementia Assistance, Help With N.F.L. Application" <i>The New York Times</i> , Jan 21, 2010 - Dunn IF, Dunn G, Day AL. Neurosurgeons and their contributions to modern-day athletics. <i>Neurosurg Focus</i> . 2006
Pediatric and Peripheral Nerve Neurosurgery <i>Working with Children</i>	Dr. Wellons Apr 17 th	- Wellons JC, Tubbs RS, Pugh JA, Bradley NJ, Law CR, Grabb PA. Medial pectoral nerve to musculocutaneous nerve neurotization for the treatment of persistent birth-related brachial plexus palsy: an 11-year institutional experience. <i>J Neurosurg Pediatr</i> . 2009

Figure 2. Neurosurgery elective syllabus: Spring 2013.



Wilcoxon signed rank test was used because of nonparametric distribution.

Open-Response Questions

At the conclusion of each semester, students were asked 2 qualitative questions about their experience: 1) What was the best part of this course? 2) What was the worst part of this course?

To the first question, 28/35 (80%) of students mentioned the open-ended faculty personal lectures. The remaining 7 students (20%) referenced the operating room experience. Direct quotes from the surveys included:

- "Honest and thoughtful discussions, and question and answer period with faculty."

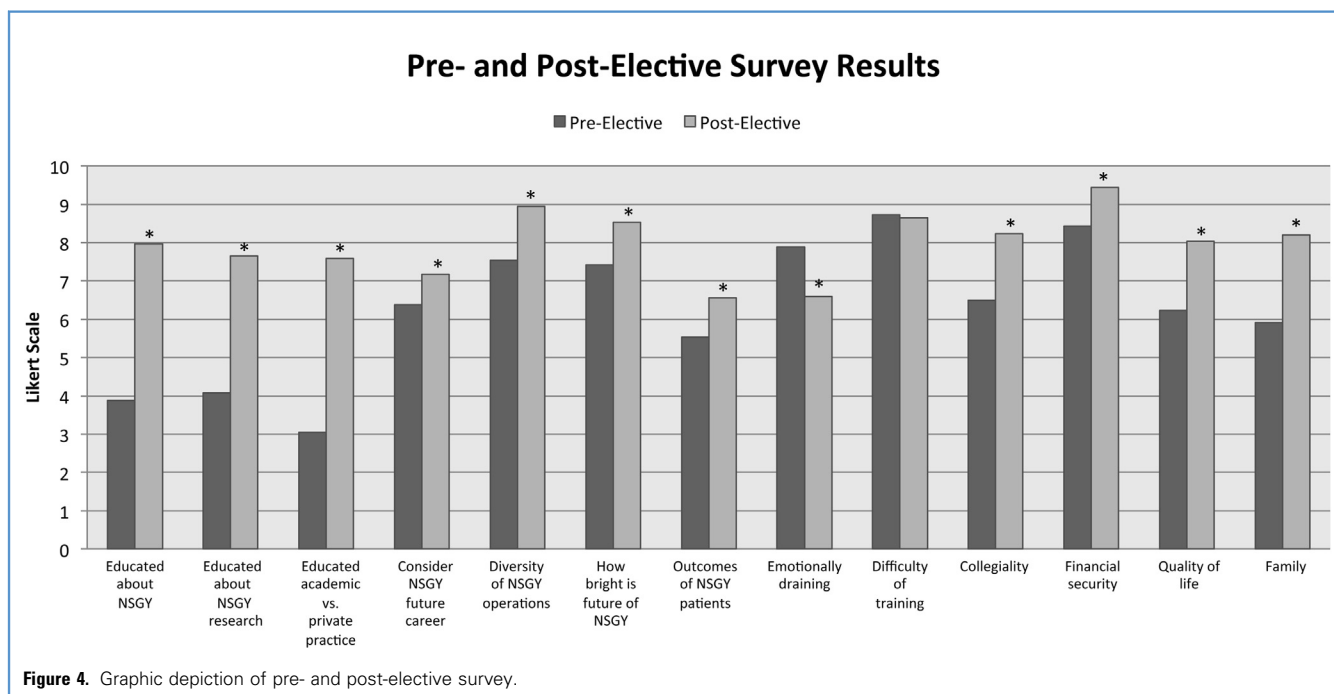
Table 2. Pre- and Post-Elective Survey Averages and Standard Deviations with Paraphrased Questions

Question	Pre-Elective	Post-Elective	P Value
1. How educated do you feel about neurosurgery?	3.9 ± 2.1	8.0 ± 1.1	< 0.0001
2. How educated are you about areas of neurosurgical research?	4.1 ± 2.4	7.6 ± 1.0	< 0.0001
3. How educated are you about a career in academic vs. private practice?	3.0 ± 1.7	7.6 ± 1.3	< 0.0001
4. How strongly are you considering neurosurgery as a future career?	6.4 ± 1.8	7.2 ± 1.9	0.0296
5. How diverse are neurosurgical operations?	7.5 ± 1.6	8.9 ± 1.0	0.0001
6. How bright do you perceive the future of neurosurgery?*	7.4 ± 1.6	8.5 ± 1.4	0.0033
7. How do you perceive the outcomes of neurosurgical patients to be?	5.5 ± 1.3	6.6 ± 1.3	0.0026
8. How emotionally draining is field of neurosurgery?	7.9 ± 1.5	6.6 ± 1.9	0.0032
9. How difficult do you perceive neurosurgery training to be?	8.7 ± 1.0	8.6 ± 1.2	0.7105
10. How do you perceive personalities and collegiality between faculty to be?	6.5 ± 1.5	8.2 ± 1.6	0.0002
11. What is the financial security of a neurosurgeon?	8.4 ± 1.1	9.4 ± 0.7	0.002
12. How do you perceive the quality of life of a neurosurgeon?	6.2 ± 1.8	8.0 ± 1.5	< 0.0001
13. How achievable is it to be a neurosurgeon and have a family?	5.9 ± 2.1	8.2 ± 1.3	< 0.0001

All questions were answered on a Likert scale ranging from 1 to 10.

*Distribution of data nor normal after Shapiro-wilk test ($P = 0.03$), thus wilcoxin signed rank test was used.

- “Listening to attendings talk about their difficult cases and how they dealt with them.”
 - “The raw, personal stories by the attendings.”
 - “The chance to spend time with faculty sharing their honest opinions about life, family, and their practice.”
 - “Getting to know the neurosurgeons in OR and clinic; it was a very relaxed course which made it very enjoyable and I feel like I was able to have fun while learning a lot.”
- To the second question, 13/35 (37%) students referenced the difficulty of scheduling the operating room (OR) and clinic, and



5/35 (14%) mentioned the late timing of class. For 7/35 (20%) students, they mentioned no negative aspects of the course. Direct quotes from the surveys included:

- “No organization of who is going to which OR and then being told it is too full.”
- “Difficult to figure out surgeries that don’t conflict with class schedule and would be interesting to watch, based on case visibility and length.”
- “Scheduling OR/clinic time around class.”
- “Would be helpful to have more direction for identifying operations to observe.”

DISCUSSION

We successfully designed and implemented a neurosurgery elective for preclinical medical students into our medical school’s curriculum. The elective significantly increased knowledge about neurosurgery in several areas and changed perceptions about collegiality, quality of life, and family–work balance, while not altering the perceived difficulty of training.

Neurosurgery is a small field, comprising less than 1% of all physicians.¹⁰ Fox et al.⁵ surveyed 99 neurosurgery residency programs and found that 62% of neurosurgery medical student clerkships did not have didactic lectures and 90% did not have recommended textbooks. Only 33% of programs offered neurosurgery as a third-year rotation. The authors concluded there was significant room for improvement in the amount of neurosurgical exposure during the preclinical years. Resnick⁶ collected surveys from 65 neurosurgery program directors and 57 medical school deans and found that only one program in North America had a required neurosurgical rotation for all medical students. With rare exception, neurosurgeons were not significantly involved in the education of medical students, even when it involves management of common neurosurgical issues.⁶ This not only has implications for education; it also has the potential to spread spurious information about the field and subsequently affect recruitment. Akhigbe et al.¹¹ evaluated perceptions of 60 medical students toward neurosurgery through an anonymous, 15-question survey. Results confirmed that 80% believed their neurosurgical education was inadequate, 98% and 97% acknowledged the long training period and long operating hours, respectively, 87% believed neurosurgery impeded family life, and 87% thought that future job opportunities for neurosurgeons would be limited.

Neurosurgery recruitment efforts have been reported. Agarwal et al.³ showed an increase in the number of students matching in to neurosurgery after implementing a 4-pronged initiative, which included a 2-week third-year clerkship, an interest group, increased research involvement, and a summer program for pre-medical undergraduate students. Eseonu et al.¹ surveyed the 8 U.S. medical schools that matched the highest number of medical students into neurosurgery over a 3-year period and recommended useful recruitment tools, such as neurosurgical mentoring programs, preclinical neurosurgical lectures through collaboration with related fields, involving neurosurgical residents

in preclinical medical education, and creating research opportunities for first year medical students.

The study by Akhigbe and coauthors,¹¹ in addition to commonly held perceptions, acknowledges the “myths” about neurosurgery that can be propagated by those not directly involved in the field. In our 2-year experience, the strength of our elective was the open, honest, and personal lectures between students and faculty, evidenced by the post-elective surveys. Students were afforded a unique opportunity to ask probing, in-depth questions about many different neurosurgical careers. The OR and clinic experience were crucial to building an elective, but giving students the insider’s perspective from those who have lived it is invaluable. This personal perspective is incredibly helpful to students choosing a future specialty, as the opportunity for this unique experience is often limited.

Our post-elective surveys identified areas in which the elective could be improved. The OR experience proved to be difficult for some, specifically scheduling cases to observe. Students can be intimidated by the foreign world of a neurosurgical operating theatre. Once in the room, students often stand for long periods without formal instruction. Creative ways to involve students in the operating room are needed. This extends to the clinic and hospital rounds, and speaks to the need for further engagement of medical students if the opportunities provided by the elective are to be fully realized. The busy nature of a neurosurgical service at a teaching hospital leaves little time for student involvement in patient care and planned education time.⁵ An additional area of improvement within the course addresses gender equity. Our elective enlisted 7 women (20%), and women compose 51% of our medical student body.¹² In the last decade, approximately 16% of neurosurgery residents were female, and 6% of practicing neurosurgeons were women.^{13–15} A recent study concluded that the percentage of women in neurosurgery has remained relatively constant, in part because of higher attrition rates for female surgeons.¹⁵ Because of the ongoing efforts to combat gender barriers in neurosurgery, future medical student recruitment efforts should capitalize on strategies such as mentoring, teaching, and leadership skills to level the gender gap.^{16–18}

Although most medical students will not become neurosurgeons, an important goal in broadening education exposure is to improve recruitment and increase interest. While exposure to the field of neurology provides a window into treatment of central and peripheral nervous system diseases, the lack of exposure to common neurosurgical problems that practicing physicians will undoubtedly encounter in their careers, such as head injury, back pain, hydrocephalus, and chronic subdural hemorrhage, may be a liability. Our elective successfully changed attitudes, but that alone is not the endpoint. In the years that follow our elective, will the students select an elective rotation in neurosurgery and ultimately decide to pursue neurosurgical training? The first class of our elective has recently graduated, and in 2 years, we plan to report the percentage of those who took the elective and subsequently chose to pursue a career in neurosurgery. Furthermore, our medical school curriculum now allows additional elective time during the later years of medical school, and plans for a new third- and fourth-year student elective are in process. This will allow us to determine the true impact of our preclinical elective, and compare early versus late exposure to neurosurgery and the effect on residency selection.

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Conflict of interest statement: The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

This project was accepted for a poster presentation at the American Academy of Neurological Surgeons May 2015 Meeting in Washington, D.C.

Received 24 July 2015; accepted 28 August 2015

Citation: World Neurosurg. (2015).

<http://dx.doi.org/10.1016/j.wneu.2015.08.081>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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