A mentorship model for neurosurgical training: the Mayo Clinic experience

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Neurosurgical education is a continually developing field with an aim of training competent and compassionate surgeons who can care for the needs of their patients. The Mayo Clinic utilizes a unique mentorship model for neurosurgical training. In this paper, the authors detail the historical roots as well as the logistical and experiential characteristics of this teaching model.

This model was first established in the late 1890s by the Mayo brothers and then adopted by the Mayo Clinic Department of Neurological Surgery at its inception in 1919. It has since been implemented enterprise-wide at the Minnesota, Florida, and Arizona residency programs. The mentorship model is focused on honing resident skills through individualized attention and guidance from an attending physician. Each resident is closely mentored by a consultant during a 2- or 3-month rotation, which allows for exposure to more complex cases early in their training.

In this model, residents take ownership of their patients' care, following them longitudinally during their hospital course with guided oversight from their mentors. During the chief year, residents have their own clinic, operating room (OR) schedule, and OR team and service nurse. In this model, chief residents conduct themselves more in the manner of an attending physician than a trainee but continue to have oversight from staff to provide a "safety net." The longitudinal care of patients provided by the residents under the mentorship model is not only beneficial for the trainee and the hospital, but also has a positive impact on patient satisfaction and safety. The Mayo Clinic Mentorship Model is one of many educational models that has demonstrated itself to be an excellent approach for resident education.

https://thejns.org/doi/abs/10.3171/2022.5.FOCUS22170

KEYWORDS education; medical; neurosurgery; residency; mentorship model

Neurosurgical education is a continually developing field with the aim of training competent and compassionate surgeons who can care for the needs of their patients. To keep pace with new innovations and constant hurdles, such as duty-hour restrictions and the COVID-19 pandemic, the curriculum for neurosurgical residents has frequently been monitored and updated.[1,2] Increased attention and standardization to neurosurgical residency programs has brought on a slew of changes within the last several decades. For example, the formalization of a standard 7-year training paradigm in 2014 lengthened the training for residents as well as placed a higher emphasis on research activities and subspecialization. Other initiatives, such as the Milestone Program, led

by the Accreditation Council for Graduate Medical Education (ACGME), restructured programs to be based on achievement rather than just time. Progress through neurosurgical training became more measurable and intentional. The core competencies, highlighted in Table 1, are ranked from 1 to 5 (1 being the most basic and 5 being the most complex), and give educators and trainees a common language to gauge progress and formulate feedback.[3]

Despite this increased standardization, individual programs are still allowed considerable flexibility in terms of how they achieve these milestones and graduation requirements. Through the years, multiple models have been proposed and implemented to train residents. The Mayo Clinic utilizes a unique mentorship model for neurosurgi-

cal training. Herein, we describe the historical roots of this model, as well as provide a logistical and experiential account on how this model is practiced across the enterprise.

History of Neurosurgery and Establishment of the Mentorship Model at Mayo Clinic

The mentorship model at Mayo Clinic was inspired by the example of Drs. Will and Charles Mayo in the late 1800s, and this model has remained the foundation for training. The Mayo brothers established an environment of collective growth and responsibility and invited visiting surgeons to provide trainees with the opportunity to further develop and demonstrate their techniques to a larger audience.[4–6] This training environment was immediately adopted by the Mayo Clinic Department of Neurosurgery at its creation in 1919.

In 1890, surgery of the central nervous system (CNS) was associated with extreme morbiditiy. Dr. Charles Mayo mainly performed these cases at the Mayo Clinic.[7,8] His first assistant, Dr. Emil Beckman, was a bright young surgeon who—after learning Dr. Mayo's technique—became the fourth and youngest surgeon in the hospital. At that time, surgery of the CNS was not held in high esteem, and for that reason, these surgeries were assigned to the younger members of the surgical staff. In 1907, Dr. Charles Mayo appointed Dr. Beckman to take care of neurosurgical cases as part of his practice, and by 1911, all neurosurgical cases were assigned to him.[9] Not long after, Dr. Beckman began noticing that certain brain pathologies were less morbid than initially thought. Dr. Beckman's expertise in neurological procedures increased the number of patients who came to the Mayo Clinic for care.

Dr. Beckman's first assistant and future founder of the Department of Neurological Surgery, Dr. Alfred Washington Adson, was a very talented apprentice who initially did not like neurosurgery because he thought the future of the specialty was uncertain. In 1917, Dr. Beckman succumbed to a severe nasal cellulitis which pushed Drs. Will and Charles Mayo to hire Dr. Adson to take over Dr. Beckman's neurosurgical practice. Dr. Adson was reluctant to leave general surgery but as the number of neurosurgical cases at Mayo increased and mortality rates decreased, he agreed to solely pursue neurosurgery.[8,9] From being a young trainee closely mentored by Dr. Beckman to gaining independence during his last year of training, Dr. Adson had a flawless transition from being a novice to being in charge of his own operating room (OR). This achievement was made possible by the close relationship these two extraordinary surgeons had inside the OR; a relationship that not only resulted in strong trust between the two surgeons, but also provided the younger surgeon with the confidence and ability to carry out operations and manage patients independently.

On January 1, 1919, the Section of Neurological Surgery was established at the Mayo Clinic, with Dr. Adson acting as the first chairman. Dr. Adson aimed to change the thinking of general surgeons and convince them that this field had sufficient scope to warrant its own surgical specialty. He was the head of Mayo Neurosurgery for 25 years and later became a senior consultant in 1946. During this time, Dr. Adson formally trained 74 neurosurgeons.[10]

Trainees were treated as individuals and were encouraged to develop their own methods and individual reputations. Since then, residents at Mayo Clinic have been closely supervised and graded on their work. A great deal of effort is continuously spent in teaching, research, and individual surgical instruction. Just like Dr. Adson's training, resident education at the Mayo Clinic is dedicated to providing an integrated clinical practice focused on the needs of the patients and on providing the residents with strong foundations to become authorities in the field.

Overview of the Mayo Clinic Mentorship Model

The current mentorship model at Mayo Clinic is structured to provide 2-month rotation sub-blocks within a larger 6-month block for each type of service (e.g., pediatrics, neuro-oncology, spine, etc.), during which residents are primarily assigned to work with two (or rarely three) consultant neurosurgeons. During the first 2 years, residents have to complete their nonneurosurgical rotations per the ACGME requirement (e.g., neurology, intensive care, etc.) as well as work on the chief resident's team. Afterward, residents are assigned to different consultant neurosurgeons who facilitate residents' exposure to each neurosurgical specialty. At the time of this report, there are currently 9 neurosurgical rotations (Table 2). Residents are typically in the OR every day, alternating between consultants every other day. However, as they are able, residents are encouraged to attend outpatient clinics, examine patients, and participate in preoperative decision making. Residents carry the service pager for their overseeing consultants throughout the day and night, except when scrubbed into an OR case. Residents have postcall days off, as well as time off during the weekend to keep in line with duty-hour restrictions. Residents have ownership over their patients and follow them longitudinally in their medical care, typically prerounding with their patients individually or performing rounds in small units with their attending physician, as opposed to being in a large team with other residents. Overall, residents follow the patient from the OR to discharge and manage every aspect of their care. This strategy allows learners to engage in daily feedback with consultants, given the one-on-one nature of the model. Furthermore, residents are able to learn specific staff preferences and understand the nuances of neurosurgical interventions faster and more efficiently given the consistent immersion. In addition, residents can engage in more complex neurosurgical cases early in their training. The benefits of the constant immersion and early exposure can be objectively quantified, as residents have achieved the minimum case requirements for graduation by the end of postgraduate year 4 (PGY-4).

The chief resident year, which typically occurs during PGY-6, is a unique experience in this model that focuses not only on developing technical expertise during the most critical year in training, but also on building a strong leadership role. Chief residents are responsible for managing their own clinical service and OR, which is a unique construct among training programs. The chief residency position in this model allows senior trainees to act as junior faculty with "training wheels," with their own autonomous OR and OR staff, including nurses, physician

TABLE 1. Core competencies for neurosurgical trainees as listed by the ACGME

Core Competency	Level 1	Level 2	Level 3	Level 4	Level 5
Patient care	Performs history & physical examination. Provides routine periop care.	Explains risks & benefits of relevant procedures. Assists w/ routine neurosurgical procedures.	Formulates diagnostic & treatment plan for pts. Performs routine neurosurgical procedures.	Adapts standard treatment plans & techniques to special circumstances. Performs complex neurosurgical procedures.	Leads discussion at interdisciplinary conference. Performs advanced neurosurgical procedures. Uses pt outcome data for quality improvement or development of adjunctive therapy protocols.
Medical knowledge	Correlates normal neuroanatomy & physiology w/ function. Gathers, interprets, & reports basic diagnostic test results. Lists differential diagnosis for common clinical presentations. Lists therapeutic options for common clinical presentations.	Correlates pathological neuroanatomy & physiology w/ function. Describes indications for standard diagnostic testing. Provides comprehensive differential diagnosis for wide range of clinical presentations. Explains advantages & drawbacks of standard therapeutic options.	Identifies anatomical & temporal patterns of disease occurrence. Prioritizes, orders, & interprets diagnostic tests appropriate to clinical urgency & complexity. Provides focused differential diagnosis based on individual pt presentation. Justifies optimal therapeutic option based on individual pt presentation.	Interprets unusual variations in patterns of disease occurrence. Prioritizes, orders, & interprets complex diagnostic studies. Interprets anomalous presentations & rare disorders. Adapts therapeutic choice to anomalous or rare pt presentations.	Effectively teaches anatomic-pathological correlation. Utilizes complex diagnostic approaches in novel situations. Studies & reports challenging diagnostic presentations. Creates new or modifies existing therapeutic options.
Systems-based approach	Describes principles of pt safety. Performs safe & effective handoffs & transitions of care in routine clinical situations. Describes basic quality improvement methods & metrics. Describes principles of US health payment systems.	Recognizes & reports pt safety events; performs safe & effective handoffs & transitions of care in complex clinical situations. Participates in local quality improvement initiatives. Analyzes how personal practice affects the healthcare system.	Discloses pt safety events; supervises handoffs & transitions of care. Identifies quality improvement opportunities & assists in development, implementation, & analysis of a quality improvement project. Seeks information about neurosurgical career options & identifies professional mentor(s).	Analyzes pt safety events & offers error prevention strategies; advocates for safe & effective transitions of care w/in & across healthcare systems. Advances multiple quality improvement initiatives through participation in a quality improvement working group or committee. Prepares for transition to practice.	Actively engages teams in process & system modification to prevent pt safety events; improves care transition practices w/in & across healthcare systems. Creates, implements, & assesses quality improvement initiatives. Collaborates w/ nursing & administrative teams to promote high value, quality care w/in healthcare system.
Practice-based learning & improvement	Applies institutional treatment guidelines in basic pt care; identifies & reports complications. Formulates hypotheses & investigative approaches to clinical or basic scientific problems. Demonstrates self-awareness & identifies gaps in knowledge, skills, & experience; incorporates feedback.	Applies published treatment guidelines in standard pt care; tracks personal clinical care outcomes. Participates effectively in clinical or basic scientific research. Teaches medical students, other residents, & pts in informal settings; develops faculty mentorship of self.	Critically adapts guideline recommendations to individual pt specifics & preferences; evaluates & applies available outcomes data to improve pt care. Contributes to peer-reviewed clinical or basic scientific literature. Teaches health professionals in formal settings; mentors medical students.	Participates in creation & implementation of institutional guidelines or evidence-based practice protocols; analyzes & reports outcome data. Leads a clinical or basic scientific research effort, including application for funding. Organizes educational activities at the program level; mentors residents & other healthcare professionals.	Promotes evidence-based practice by publishing clinical guidelines & teaching at local or national conferences; participates in clinical outcomes registry design or administration. Receives grant funding for clinical or basic scientific work & makes novel scientific contribution(s). Designs & implements clinical rotations, curricula, & learning & assessment tools; models & teaches mentoring to others.

TABLE 1. Core competencies for neurosurgical trainees as listed by the ACGME

Core Competency	Level 1	Level 2	Level 3	Level 4	Level 5
Profession-alism	Behaves ethically & professionally & takes responsibility for personal conduct. Describes importance of personal & professional well-being; manages sleep deprivation & fatigue.	Employs ethical & legal principles & appropriately seeks advice. Evaluates personal & professional well-being; seeks appropriate personal help & fatigue mitigation when needed.	Performs tasks in a thorough, timely, & respectful manner in complex or stressful situations & takes ownership of team outcomes. Monitors & attempts to optimize professional well-being of team; adjusts team assignments to mitigate fatigue & promote wellness.	Recognizes, reports, & helps rectify lapses in ethics or professionalism, including coaching others. Coaches & assists others in meeting professional expectations; recognizes & responds to physical impairment in self & others.	Promotes ethical & professional behavior by creating a teaching resource, addressing system-level problems, or serving on an ethics panel or institutional review board. Develops structured plan or team activity to optimize personal & professional well-being, resilience, & success; participates in a peer-support program.
Interpersonal & communication skills	Uses language & nonverbal behavior to exhibit respect, establish rapport, & demonstrate cultural competency. Accurately records information in pt record & safeguards protected health information; coordinates care w/in neurosurgical service.	Establishes therapeutic relationships in straightforward encounters using active listening & clear language. Communicates orally & in writing in a respectful, organized, clear, concise, & timely manner w/ all members of interprofessional healthcare team; coordinates care w/ consulting services.	Establishes therapeutic relationships, thoughtfully delivers information, & strives for consensus in challenging pt encounters. Effectively manages complex, team-based clinical care; coordinates care w/in a hospital system.	Consistently models & mentors others in optimal pt & family communications. Models & mentors others in effective communication, including bidirectional feedback & conflict resolution; coordinates long-term care, including rehabilitation.	Formally teaches communication skills to healthcare professionals. Develops or implements strategies for improving communication & teamwork w/in healthcare system; creates care pathways at healthcare system level.

Pt = patient.

assistants, scrub technicians, and surgical assistants. Chief resident cases are booked on an elective basis from their own clinical practice. Additionally, chief residents directly supervise, educate, and mentor the PGY-1 and PGY-2 junior residents on their service. Furthermore, chief residents manage all emergency cases, including cranial and spinal trauma, as well as inpatient and outpatient consults. Chief residents alternate all consults, elective surgery, and emergency calls on a daily basis. Therefore, chief residents perform surgery for a mixture of common neurosurgical procedures as well as complex cases. Although in many ways chief residents conduct themselves more in the manner of an attending physician than a trainee, the chief resident still receives oversight from the on-call attending physician to provide a "safety net." A staff member reviews all chief resident cases and is co-listed on the case with the chief. Staff members then participate to varying degrees depending on necessity and are present for critical portions of the case. Given that the year of chief residency occurs during PGY-6, a majority of residents do enfolded fellowships during PGY-7. Their specific fellowship selection is typically determined prior to their chief year and is dictated by their overall clinical interests.

One of the most important objectives of the mentorship model at the Mayo Clinic is to maintain trainees at the "zone of proximal development" (ZPD) during PGY-1 through PGY-6 of residency, so that they gain enough confidence and skill to be capable of doing things unsupported and independently by their chief residency year. The ZPD, a concept that was first proposed by psychologist Lev Vygotsky in the late 1920s, is defined as the area between what a learner can accomplish independently and what they can achieve with the guidance of a more knowledgeable teacher.[11] Residents progress through the ZPD by first observing and learning how to properly assist their mentors during an operation. Then, under direct observation, residents are instructed on how to complete portions of the operation themselves. The support and oversight are gradually withdrawn as they become unnecessary, and residents gain autonomy. Steadily over the course of each rotation, these skills transition from the ZPD to the "zone of achieved development" (Fig. 1). Therefore, the mentorship model serves as a transition to practice approach with residency training. The chief resident is semiautonomous, with increasing responsibilities, while continuing to have formal mentorship and oversight from staff.

This structure of the mentorship model contrasts with university models of residency training, in which residents are typically assigned as teams to different groups of neurosurgical patients (e.g., tumor service), and operate with

TABLE 2. Summary of program structure

Training Yr	Program Structure*
PGY-1	5 mos on NSGY Chief Resident Service (2nd assistant surgeon)
	1 mo on NSGY Staff Service (2nd assistant surgeon)
	6 mos on non-NSGY rotation (neurology, neurocritical care, etc.)
PGY-2	5–6 mos on NSGY Chief Service (1st assistant surgeon)
	1 mo on neurocritical care
	5–6 mos on NSGY Staff Service (1st assistant surgeon)
PGY-3 & -4	12 mos on NSGY Staff Service (1st assistant surgeon)
	2-mo rotations w/ consultants in neuro-oncology, cerebrovascular, skull base, degenerative/deformity spine, spinal oncology, peripheral nerve, & pediatrics
PGY-5	Elective time: research, advanced degree (e.g., MPH, MBA, etc.), enfolded or outside clinical rotation
PGY-6	Chief resident year/transition to practice if enfolded fellowship is pursued
	Elective time
PGY-7	Chief year/transition to practice, OR
	Enfolded fellowship (skull base, spine, peripheral nerve, neuro-oncology, etc.)

NSGY = neurosurgery.
* Core structure of the program; however, individual variations may apply during PGY-5 to -7, based on resident goals and subspecialty interest.

FIG. 1. Dr. Lev Vygotsky's theory of learning and development applied to the Mayo Clinic Mentorship Model for neurosurgical training.

consultants on a hierarchical basis (i.e., OR assignment starts from PGY-7 and moves down the chain). Within the mentorship model, junior PGY-3 and PGY-4 residents are allowed to get early exposure to complex cases. By doing so they gain a deeper level of confidence and comfort with more challenging procedures early in their training.

The mentorship model also allows residents to engage in lasting relationships with patients and builds a sense of patient "ownership" and responsibility of postoperative outcomes. In addition, the longitudinal care provided by residents minimizes handoffs between providers, thereby decreasing the risk of adverse patient safety events. Residents are also able to increase allocated time to the patients under their care, which has the effect of improving patient satisfaction. In regard to resident well-being, meaningful mentorship, which is intrinsically built into the Mayo model, has been shown to be protective against burnout in neurosurgical residents.[12] Overall, the mentorship model for the neurosurgical residency program has been preferred since the founding of the Mayo Clinic. Residents rate this model favorably, and it consistently receives positive feedback during the annual program evaluation.

Metrics

Case logs are evaluated by the ACGME as a measure of breadth of resident experience. Additionally, these logs can gauge the efficacy of the mentorship model—to ensure that residents are receiving the hands-on experience that is crucial to their development as independent surgeons. This metric is also helpful in comparing how a program
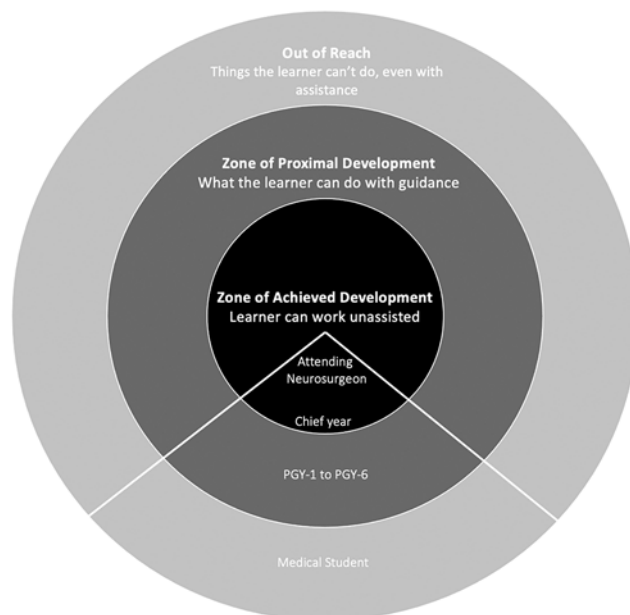
is performing compared to similar programs at other institutions.

ACGME neurosurgical resident national reports were downloaded from the ACGME website.[13] Case log data from these reports were gathered from the year 2020–2021 regarding the national average of procedures performed by residents overall and in the different subspecialties (cranial, spine, pediatrics, etc.). These data were compared to our institution-specific collected data for the same year. In the graduating year 2020–2021, ACGME data reported a national average of 1624.8 total procedures performed as the senior or lead resident. In comparison, Mayo Clinic residents (n = 4) reported an average of 1714 total procedures performed as the senior or lead resident, a rate 5.5% higher than the national average. Mayo Clinic residents reported performing higher average numbers of procedures in the sectors of cranial and peripheral nerves compared with national averages (723.5 vs 628.4 and 55 vs 28.4, respectively). However, average numbers of procedures in spinal and pediatric sectors were lower in Mayo residents than the national averages (443.3 vs 528.8 and 85 vs 97.9, respectively). Table 3 demonstrates the national versus Mayo Clinic average number of cases for different procedure types for the year 2020–2021. The mentorship model at Mayo Clinic does not appear to substantially influence case volume but may influence resident autonomy in the OR. In addition, residents in our program are typically integrated early in their training as lead resident surgeons on cases to offset the time away from the OR during the 2 years of elective time. This integration allows for increased time during training for residents to act as lead surgeons.

In addition, academic productivity of residents is an important factor for many applicants in making residency program selection decisions. The amount of published lit-

TABLE 3. National average number of cases performed by residents overall and in the areas of cranial, spine, pediatric, and peripheral nerve procedures versus the average number of cases performed by Mayo Clinic residents in the year 2020–2021

	Average No. of Cases		
	National	Mayo	Percent Difference*
Total	1624.8	1714	+5.5%
Cranial	628.4	723.5	+15.1%
Spine	528.8	443.3	−16.2%
Pediatric	97.9	85	−13.2%
Peripheral	28.4	55	+93.7%

* Calculated as (Mayo average − national average)/national average × 100.

erature produced during neurosurgical residency has been shown to be significantly associated with holding an academic position and becoming a professor or chair/chief.[14] By searching the PubMed and Mayo authors' databases, we collected data on the total number of intraresidency publications of Mayo neurosurgical residents who graduated from the years 2012 to 2019 (n = 21). The median number of total publications per resident over the entire course of residency was 15 (range 0–40). The median number of first-author publications per resident was 6 (range 0–21). The number of intraresidency publications has been reported in the literature and appears to be around 3 publications per resident during residency as well as around 3 first-author papers.[14–16] However, a study performed by Crowley et al.[14] found that graduates in academic positions published significantly more total intraresidency publications (mean 5.1 vs 1.9) and first-author publications (mean 3.0 vs 1.0) than those not in academic positions. The mentorship model at Mayo Clinic allows for more direct contact time, in 2- to 3-month intervals, with staff who can set the stage for development of clinical research projects, particularly those sparked by certain operative cases seen during this time. The mentorship model appears to extend beyond increasing clinical immersion into benefiting the resident by exposure to scientific advancement and discovery with direct mentorship in this realm.

Discussion

Mentorship is integral to medicine and surgery. While certainly not unique to the Mayo Clinic, the roots of mentorship run deep within the Mayo culture. Doctors Will and Charles Mayo established the mentorship model not through formal paperwork but by practice. Young trainees would learn directly under more senior surgeons, getting direct feedback and instruction on their skills in real time. This model was adopted by Dr. Adson when he established the Department of Neurosurgery at the Mayo Clinic in 1919. Today the mentorship model in neurosurgery operates in much the same way as it did a century ago. Residents are assigned directly to the service of one or two attending physicians for a 2-month rotation. During this period the residents operate solely with these attendings and make rounds on just their patients. This allows the residents to focus on learning the specific skills and pref-

erences of their mentors, which they can later choose to adopt in their own practice. While this model may not substantially increase case volume over other resident training programs, it may benefit early resident autonomy and time spent operating as the lead resident surgeon. More importantly, the longitudinal care they provide allows residents to take greater ownership of their patients, which not only gives trainees the tools to become independent and practice with confidence, but also has a strong impact on patient satisfaction and safety. This model has been used successfully to train neurosurgeons for over a century, and has now expanded to three sites. While the described model has many benefits for resident training, it is not necessarily superior to the standard academic model. We present this model as an alternative option to the standard academic or "university" model.

Mentorship in neurosurgery can take many different forms. An innovative approach integrating Vygotsky's learning theory with real-time feedback through a smartphone app was piloted by Haglund et al. in 2021.[17] Their program, called the Surgical Autonomy Program (SAP), places trainees in their zone of proximal development and has faculty properly advise and monitor them in a step-by-step fashion using the TAGS system (T = Teach and Demonstrate, A = Advise and Scaffold, G = Guide and Monitor, S = Solo and Observe). In this study, the authors demonstrated that the SAP-included residents reported feeling more prepared to independently perform an anterior cervical discectomy and fusion. The SAP system is a modernized approach to mentorship and feedback and could help standardize training based on competency criteria regardless of the number of procedures completed by residents. Similar to the Mayo Mentorship Model, the interactions between faculty and residents in the SAP allow residents to have open discussions regarding technical skills and to have a more active role during preoperative planning and longitudinal patient care.

The benefits of mentorship are numerous and succeed beyond improving technical skills and clinical decision making. Fruitful mentorship relationships can help improve career and life satisfaction and be mutually beneficial to the mentor and mentee.[18] The psychologist Erik Erikson proposed that mentors can find new meaning in life's later stages by taking on an apprentice.[19] Influenced by this idea, psychologist Daniel Levinson went so far as to claim mentorship was a developmental stage of life.[20] In neurosurgery, this process is clear to see as prolific surgeons often take on apprentices to carry on and build upon their legacy. Take for example the "father of neurosurgery," Dr. Harvey Cushing, whose list of mentees included Drs. Walter Dandy, Wilder Penfield, and Louise Eisenhardt, all extraordinary physicians in their own right. The symbiotic relationship forged between mentor and mentee allowed these esteemed neurosurgeons to attain such great heights.[21,22]

Study Limitations

The Mayo Mentorship Model certainly comes with its limitations. The generalizability to smaller programs may be limited by a smaller resident pool, postcall absences, and a suboptimal staff-to-resident ratio constraining fea-

sibility. Furthermore, this model has been developed at a specialized tertiary care center. As such there is a strong emphasis placed on subspecialization, with residents allowed to explore these specialties early in their training. This approach contrasts with that used in community programs, where surgeons may practice more broadly and adjustments may need to be made to adopt this model in community-based residency programs. Early exposure to complex cases may also limit residents in terms of their autonomy in specific cases, whereas these cases would traditionally be taken by more senior residents in the university model.

Conclusions

Mentorship plays an integral role in neurosurgical education. The first iteration of the Mayo Clinic Mentorship Model was first established by Dr. Alfred Adson and the Mayo brothers in 1919. In its current form, residents are paired with two faculty members for 2- to 3-month rotations. By working directly under these faculty members, learners are granted gradually increasing autonomy as clinicians and surgeons, leading to a smooth and efficient transition to practice. This model has positive effects on resident well-being and clinical confidence, as well as patient satisfaction.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions

Conception and design: Daniels, Singh, De La Peña, Suarez-Meade, Kerezoudis. Acquisition of data: Singh. Analysis and interpretation of data: Singh, De La Peña, Kerezoudis. Drafting the article: Singh, Kerezoudis. Critically revising the article: Daniels, Singh. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Daniels. Administrative/technical/material support: Bendok, Meyer, Spinner. Study supervision: Daniels, Kerezoudis, Akinduro, Chaichana, Quiñones-Hinojosa, Bydon.

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