



Exploring the impact of early exposure and mentorship on the neurosurgery career aspirations of medical students in low- and middle-income countries

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Abstract

Early exposure to neurosurgery has been shown to have a positive influence on students' perceptions and attitudes towards the field of neurosurgery. This review delves into the problems faced by the neurosurgery workforce in LMICs, highlighting the necessity for local and international collaborative strategies and plans to enhance the medical education curriculum, training, and retention of neurosurgeons in their home countries. Mentorship also emerges as a crucial factor in neurosurgical career progress, narrowing the gap between theoretical knowledge and real-world practical skills, and providing guidelines in career pathways. Despite numerous benefits of early exposure and mentorship, limitations such as limited resources, inadequate elective opportunities, and negative cultural influences, hinder students' interest in neurosurgery. However, initiatives such as global outreach programs and collaborations between HICs and LMICs aim to address these challenges and improve access to mentorship and training opportunities and programs. This review recommends the integration of mentorship into career development strategies, establishing well-structured mentorship programs, and strengthening neurosurgery exposure in medical education. By implementing these recommendations, the next generation of neurosurgeons can be better equipped to address the complex challenges in LMICs, ultimately, enhancing easy access to neurosurgical care and strengthening healthcare systems.

Keywords: career aspirations, exposure, LMICS, medical students, mentorship, neurosurgery

Introduction

Low- and middle-income countries suffer greatly from the shortage of surgical professionals. Recent studies show ~5 billion

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HIGHLIGHTS

- This review explores the impact of early exposure and mentorship toward career development in neurosurgery for medical students in low- and middle-income countries (LMICs).
- The low prevalence of neurosurgeons in Africa has affected neurosurgical services in the region. Therefore, addressing the shortage of neurosurgeons is significant for consideration.
- Mentorship also emerges as a crucial factor in neurosurgical career progress, narrowing the gap between theoretical knowledge and real-world practical skills, and providing guidelines in career pathways.

people worldwide lack access to basic surgical care, with particularly scarce neurosurgical services in LMICs^[1]. Despite the high patient burden of traumatic brain injury, stroke, epilepsy, hydrocephalus, and other neurosurgical-related conditions^[2], there is an inadequate neurosurgical workforce in LMICs, which is a major contributing factor^[3]. In the Sub-Saharan African regions, only about 25% of the population can access neurosurgical services within a 2-h travel time^[1]. According to The WHO, an appropriate neurosurgical service delivery requires at least one neurosurgeon for every 200 000 people per country to

achieve adequate service delivery. However^[4], a ratio that is yet to be completed in most LMICs. The resulting inequitable neurosurgeon-patient ratio is a barrier to receiving proper neurosurgical care, leading to significant morbidity and mortality. The consequence of such a deficiency in the neurosurgical workforce is made glaringly obvious in the gaps in care seen in neurological and neurosurgical emergencies such as stroke, which have a rising burden in Africa^[5].

To address the deficit in neurosurgical training, we need a comprehensive strategy including stronger international collaboration^[6], and training programs to attract and retain students and doctors in their home countries after completing their studies. Early exposure to the field and mentorship can positively impact students' perceptions. Specific data on mentorship in neurosurgery for students in LMICs is needed to inspire more students to consider neurosurgery as a career and bolster the neurosurgical workforce in these regions. This review delves into the problems faced by the neurosurgery workforce in LMICs, highlighting the necessity for local and international collaborative strategies and plans to enhance the early exposure, mentorship programs, medical education curriculum, training opportunities, and retention of neurosurgeons in their home countries.

Methodology

This current review answers 4 main questions “Challenges facing neurosurgical workforce in LMICs“, “influence of career aspirations on early exposure to neurosurgery“, “impact of mentorship in neurosurgery career development “and “Barriers and facilitators to neurosurgery career development in LMICs “through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines^[7].

In Identifying relevant studies for the literature, we conducted a comprehensive search from 3 March to 10 March 2024 on Google Scholar, Pubmed, and AJOL, using the following keywords “early exposure“, “mentorship“, “Medical students“, “neurosurgery“ and “LMICs“. Boolean operators (AND and OR) were used to broaden the search by including similar keywords to the selected keywords and the “AND” operator was used to narrow down the search by combining the keywords to establish a full and detailed search. A supplementary hand search was performed Using Google Google Inc., Mountain View, California, USA) to identify relevant gray literature.

The three databases altogether generated a total of “articles after the literature search. Out of these,” “articles were screened at the title and abstract level for eligibility after applying the inclusion criteria discussed above. At this stage, “articles were excluded. Furthermore, “articles underwent a full-text article screen. After the manuscript screening using the inclusion criteria above, a total of 32 articles were included in the final review. The final included articles were subjected to a further full-text review to extract relevant qualitative data on challenges facing the neurosurgery workforce in LMICS, the influence of career aspiration, and the impact of mentorship as well as barriers to neurosurgery career development in LMICs. The data from the included studies were synthesized and presented in a narrative format, reviewing major findings in the current evidence. Screening was also done on the reference list of the articles to ensure an accurate selection of articles, with those highly relevant

to the studies being chosen and those that didn't meet the eligibility criteria being excluded.

Neurosurgery workforce challenges in low- and middle-income countries (LMICs)

Neurosurgery workforce challenges in LMICs are multifaceted and require comprehensive strategies to address. The shortage of skilled neurosurgeons and healthcare professionals in LMICs is exacerbated by factors such as deficient infrastructure, brain drain, and disparities in training opportunities^[8,9]. Initiatives focusing on enhancing neurosurgical education and training programs in LMICs have been identified as crucial for improving the retention of the surgical workforce^[10]. However, challenges persist in retaining trained fellows and staff due to lower compensation and inadequate facilities^[11].

Efforts to bridge the gap in neurosurgical care include global outreach programs and collaborations between high-income countries (HICs) and LMICs^[12,13]. These collaborations aim to provide specialized training and knowledge transfer to neurosurgery residents and medical students in LMICs, who often lack access to such opportunities^[14]. In addition, the COVID-19 pandemic has significantly impacted neurosurgery training and admission in LMICs, prompting concerns regarding the continuity of education and skill development in this domain. This underscores the pressing need for the implementation of innovative strategies to ensure the uninterrupted provision of neurosurgery training and admission processes in the face of pandemic-related challenges^[15].

Addressing the challenges in the neurosurgery workforce in LMICs requires a holistic approach (Table 1) that includes enhancing student or junior doctor involvement through the availability of training programs, early exposure to the field, enhanced educational curriculum, and overall, infrastructural and quality technology and equipment availability for example medical imaging modalities. Improving access to medical imaging, enhancing educational programs, and implementing strategies to recruit, develop, and retain healthcare professionals in underserved areas^[16]. Furthermore, promoting research involvement among students and healthcare professionals potentially enhancing publications on neurosurgical-related scientific knowledge including neurosurgical trial research and so on, can contribute to advancing neurosurgical care and addressing the disparities between HICs and LMICs thus creating opportunities for medical students interested in neurosurgery^[17].

Briefly, tackling the neurosurgery workforce challenges in LMICs necessitates collaborative efforts, sustainable training programs, infrastructure development, and research initiatives to ensure the availability of skilled neurosurgeons and quality care for patients in underserved regions.

Early exposure to neurosurgery: influence on career aspirations

Early exposure to neurosurgery can significantly influence medical students navigating the vast landscape of specializations (Table 2). Research suggests a complex interplay between introducing this demanding field and its impact on career aspirations. On the one hand, studies reveal a positive association between early exposure and increased interest. Institutions with shorter

Table 1
This table presents a concise summary of the obstacles encountered and the solutions proposed to tackle them within the scope of neurosurgery workforce dilemmas in LMICs

Challenges in the neurosurgery workforce in LMICs	Strategies to address challenges
Shortage of skilled neurosurgeons and healthcare professionals	Enhancing neurosurgical education and training programs
Deficient infrastructure	Global outreach programs and collaborations with HICs
Brain drain	Providing specialized training and knowledge transfer
Disparities in training opportunities	Innovative approaches for continuous education and skill development
Lower compensation and inadequate facilities	Improving access to medical imaging, Promoting research activities, and increasing published neurosurgical trials

HIC, high-income country; LMIC, low- and middle-income country.

pre-clinical programs and active neurosurgical student chapters often see a higher proportion of students drawn to the field^[18]. Early introduction before students become entrenched in other disciplines can spark curiosity and ignite a passion for the intricate world of the nervous system.

Furthermore, well-designed exposure programs can significantly enhance student understanding. Initiatives like electives that combine clinical observations with interactive faculty discussions have been shown to improve knowledge and dispel misconceptions about neurosurgery^[19]. By witnessing the meticulous precision and problem-solving nature of neurosurgical procedures firsthand, students can gain a more realistic perspective on the field^[20].

Additionally, these programs often address the work-life balance concerns often associated with surgery, potentially making the career path more appealing. However, the picture isn't entirely rosy. Research also indicates that early exposure doesn't always translate to a surge in aspiring neurosurgeons. One study found that students exposed to various surgical specialties, including neurosurgery, were more likely to lose interest compared to those who hadn't^[21]. This suggests that a broader surgical experience might be crucial for students to refine their career goals. By witnessing the diverse range of surgical disciplines, students can gain a clearer understanding of what resonates most with their skills and interests^[22]. Therefore, the optimal approach seems to be a balanced one. Early exposure to neurosurgery can be a valuable tool for informing medical students and fostering interest. Well-structured programs that combine clinical observations with interactive learning can play a significant role in demystifying the field and attracting passionate individuals. However, it should be offered as part of a larger strategy that includes opportunities to explore various medical and surgical specialties. This comprehensive approach allows students to

make informed decisions about their career paths. (Table 3).

Ultimately, a successful neurosurgical career requires more than just early exposure. Factors like a deep fascination with the nervous system, the ability to handle high-pressure situations, meticulous attention to detail, and a strong work ethic are likely to play a crucial role in a student ultimately committing to this demanding yet rewarding field^[23]. Early exposure can serve as the spark that ignites a passion for neurosurgery, but it's the combination of knowledge, experience, and personal qualities that fuels a lifelong dedication to this remarkable specialty.

Mentorship in neurosurgical career development

There persists a stark inequality in access to neurosurgical treatment between HICs and low- and middle-income countries^[24]. To tackle this disparity, the field of global neurosurgery has emerged, aiming to identify and address the underlying issues contributing to the discrepancies in the quality of neurosurgical care^[25]. Among the identified challenges are inadequate funding sources, infrastructure deficits, and limited resources. However, to enhance neurosurgical capability and reduce these inequities, it is crucial to prioritize elements such as mentorship, training, and education^[26].

Reducing inequities in access to neurosurgical treatment requires addressing disparities in educational opportunities for medical students. Compared to their peers in high-income nations, international medical students, especially those from LMICs, often have limited access to educational resources^[27].

Fostering early involvement of senior physicians and faculty in medical student training can be an effective strategy to broaden students' perspectives and enhance their future career prospects. Providing aspiring neurosurgeons with quality mentorship is essential, as evidenced by Akhigbe *et al.*^[28]'s report, which

Table 2
Summary of the impact of early exposure to neurosurgery on career aspirations

Factor	Positive influence	Negative influence	Neutral influence
Early exposure	Increases interest in neurosurgery	May not always translate to a surge in aspiring neurosurgeons	Can provide a broader understanding of the field
Broader surgical experiences	Allows students to refine their career goals	May lead to a loss of interest in neurosurgery	Provides a clearer understanding of various medical and surgical specialties
Mentorship	Provides focused guidance in career pathways	May not be accessible due to limited resources and time	Bridges the knowledge gap between theoretical knowledge and practical skills
Work-life balance	Can alleviate concerns about work-life balance	May not be a significant factor for all students	Is a crucial consideration for some students
Cultural influences	Can be a significant factor in shaping career aspirations	May not be universally applicable	Varies across different cultural contexts

Table 3
Shows some key factors that influence career aspirations in neurosurgery due to early exposure

Factors	Description
Hands-on experience	Early exposure to neurosurgery often involves hands-on experience, which can significantly influence a student's interest and confidence in pursuing this career.
Mentorship	Having a mentor in the field of neurosurgery can provide guidance, support, and inspiration, which can greatly influence career aspirations.
Research opportunities	Early exposure often provides opportunities to participate in neurosurgical research, which can spark interest and provide valuable experience.
Clinical observations	Observing neurosurgeons in a clinical setting allows students to understand the day-to-day responsibilities and challenges of the profession, influencing their career decisions.
Academic exposure	Early academic exposure to neurosurgical topics can stimulate interest and provide a solid foundation for further study.

confirms the benefits of effective mentoring for the personal and professional growth of neurosurgery trainees. Such early mentorship can play a pivotal role in shaping the careers of future neurosurgeons and addressing workforce deficits in resource-limited settings.

The mentor-mentee relationship offers several invaluable benefits. It provides focused guidance in charting early-career pathways, with the mentor serving as a role model. Crucially, it bridges the gap between the foundational neurosurgical knowledge imparted in medical school and the development of technical and non-technical skills required in real-world clinical scenarios^[28]. Moreover, mentees receive insightful critiques and feedback from their mentors, which are critical for continual performance improvement and professional growth^[29]. This dynamic exchange fosters an environment conducive to the comprehensive development of aspiring neurosurgeons, equipping them with the necessary knowledge, skills, and guidance to navigate their careers effectively.

Early neurosurgery mentorship programs can play a pivotal role in guiding medical students toward well-informed career decisions that align with their interests and aptitudes^[30]. In addition to imparting tangible surgical skills, mentors provide invaluable didactic guidance that encompasses patient-centered care and real-world scenario-based learning. This synergistic partnership facilitates growth on both ends, benefiting mentors and mentees alike^[31].

However, from a medical student's perspective, the discipline of neurosurgery often receives inadequate attention, with neu-

rosurgical departments facing significant deficiencies, including a lack of robust teaching components^[40]. Research by Minta and colleagues highlights several barriers, such as limited resources and time constraints among neurosurgery trainees and consultants, insufficient curricular time for extracurricular mentorship programs, lack of awareness about neurosurgery and neuroscience interest groups, inadequate resources to support additional mentorship initiatives, and a scarcity of qualified and experienced neurosurgeons in some regions^[32].

A few organizations provide mentorship programs to medical students who want to pursue a career in neurosurgery (Table 4). They include the Walter Dandy Society UK (WDNS)^[33], the Association of Future African Neurosurgeons (AFAN), the Brain and Spine Group (BSG) (www.brainandspinegroup.org), and the Neurology and Neurosurgery Interest Group (NANSIG)^[34]. To match prospective mentees with mentors in the UK, NANSIG recently introduced a mentorship program for medical students. This program, which offers the chance to improve a medical student's portfolio and offer unofficial career guidance, is exclusively available to medical students from the UK^[35]. In addition, the only mentorship program that WDNS offers is to medical students in the United Kingdom.

UK medical students interested in neurology and neurosurgery form the Walter E. Dandy Neurosurgical Society, a branch of the Walter E. Dandy Global Society dedicated to research in these fields. One of its main programs, The Global NeuroMentorship Program, was introduced in 2023 to teach and mentor medical students from LMIC countries in neurosurgery research.

Table 4
Shows initiatives advancing early exposure and mentorship activities for medical students in LMICs and their positive outcomes

Neurosurgery mentorship program	Impact of mentorship programs
NERVE (Neurosurgery Education and Research Virtual Experience) group by the Brain and Spine Group (BSG)	It has helped supplement traditional medical school curricula by enabling students to hone their clinical and research skills in neurosurgery, especially those with demonstrated interest in neurosurgery
Neurology and Neurosurgery Interest Group (NANSIG)	It has enabled students globally to engage in high-quality neurosurgical research, providing exposure early in their medical careers. Additionally, it has reduced the barrier of access to neurosurgical training by uploading all educational material on open-source platforms.
Association of Future African Neurosurgeons (AFAN)	Creates networking opportunities between medical students and experienced medical doctors, neurosurgical residents, and eminent professors in neurosurgery. Weekly webinars also provide members with virtual training on various aspects of neurosurgery as a discipline. The AFAN Research Incubator Project equips enrollees with foundational research skills that are essential in research careers in neurosurgery
Global Neuromentorship program	Field experts are invited to provide insight on fields such as research design and statistical analysis, generally improving the mentees' knowledge of how to conduct research in neuroscience. Participant satisfaction in various domains such as learning opportunities, research opportunities, and access to resources was relatively high indicating that it improved the participants' knowledge on neurosurgery as a field.

LMIC, low- and middle-income country.

Table 5
Potential impacts of early exposure and mentorship programs

Impact	Description
Increased Interest	Address barriers and foster supportive environments to nurture interest in neurosurgery careers among medical students in LMICs.
Workforce development	Contribute to a robust pipeline of future neurosurgical specialists, improving access to neurological care in resource-constrained regions.
Healthcare strengthening	Ultimately strengthen healthcare systems in LMICs by building a sustainable neurosurgical workforce.
Collaboration and knowledge-sharing	Foster a culture of collaboration and knowledge-sharing within the neurosurgical community, creating a ripple effect through mentee-mentor relationships.

LMIC, low- and middle-income country.

Participant satisfaction was remarkable in several domains. The initiative promoted diversity and succeeded in its goals^[33].

One of the non-profit organizations, BSG, also strives to enhance worldwide neurosurgical care. They achieve this objective through teaching by offering medical students and patients virtual neurosurgery education. The organization also established the Neurosurgery Virtual Education and Research Group, a national virtual interest group that is only open to medical students enrolled in medical schools and offers a multi-institutional venue for shared objective mentorship^[36].

The implementation of a unified platform for neurosurgical mentorship is necessary to break down geographical and economic barriers and assist underprivileged areas and emerging nations by directing youngsters toward a future career track at early stages. For medical students, receiving early-stage mentoring in neurosurgery is crucial to their career and personal growth. It prepares them for a career in neurosurgery and aids with their understanding of one of the intricate subspecialties in medicine. Establishing a mentoring program would help both the mentor and the mentee by providing medical education, influencing the future trajectory of neurosurgeons, opening doors for additional research, and creating a more universal, streamlined curriculum.

Impact assessment and outcomes

The available evidence suggests that early exposure and mentorship can significantly impact the career aspirations of medical students in LMICs towards neurosurgery. Recent studies have provided valuable insights into the outcomes of such interventions.

A multinational cross-sectional audit, the Global Mentorship in Neurosurgery for Medical Students Study (GloMNMS), surveyed over 2900 medical students from 60 countries worldwide. The findings revealed that a lack of neurosurgical mentorship was often attributed to limited time and resources among neurosurgery trainees. Aside from that, insufficient curricular time in medical schools and inadequate awareness of relevant societies and networking opportunities also contributed to the disparity^[37]. These barriers suggest that targeted interventions to improve access to mentorship and early exposure could significantly influence students’ interest and pursuit of neurosurgery as a career. Complementing these insights, a cross-sectional study in Saudi Arabia examined the factors affecting medical students’ choice of neurosurgery as a future career^[37]. The study involved 1141 participants and found that half of the respondents (50.1%) expressed interest in pursuing neurosurgery, driven primarily by the challenging nature of the field. However, stress emerged as the most significant deterrent factor. Interestingly, the study also identified differences in the perceptions and preferences between

male and female students, with a higher proportion of females finding “interest in neuroscience” to be an attractive factor, while more males perceived “risk” as a deterring factor.

These collective findings highlight the potential (Table 5) for early exposure and mentorship programs to positively influence medical students’ interest and pursuit of neurosurgical careers in LMIC settings. Addressing the identified barriers, such as lack of resources and awareness, and fostering a supportive environment could help build a sustainable neurosurgical workforce in resource-constrained regions.

The long-term implications are particularly promising. Nurturing the interest and skills of aspiring neurosurgeons, especially during the crucial stages of career decision-making, could contribute to a robust pipeline of future specialists, improving access to neurological care in resource-constrained regions^[38]. Ultimately this will contribute to the overall strengthening of healthcare systems in LMICs.

Furthermore, the positive effects of these programs extend beyond individual career trajectories, as they can foster a culture of collaboration and knowledge-sharing within the neurosurgical community. Mentees who have benefited from such programs may, in turn, become mentors themselves, creating a ripple effect (Fig. 1) that amplifies the impact and sustainability of these initiatives.

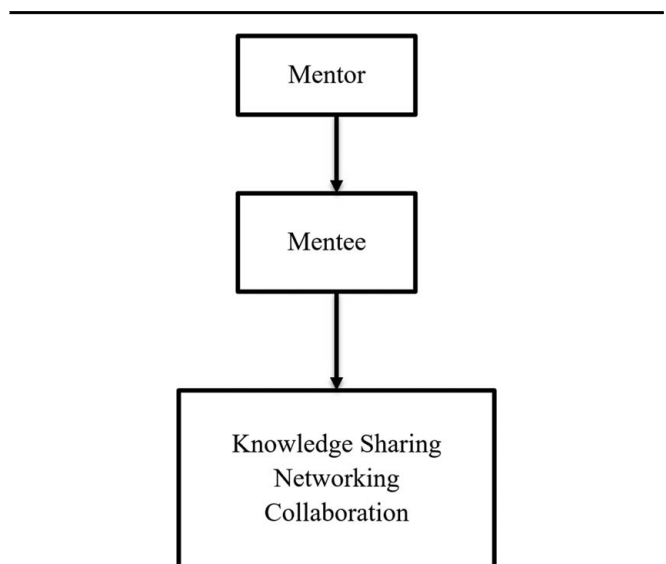


Figure 1. Mentor-Mentee relationship and its ripple effect.

Barriers and facilitators to neurosurgery career development

The burden of neurosurgical care remains a priority in Africa, and the system suffers a severe workforce deficit. Approximately, 1 986 392 neurosurgical cases are seen annually in Africa, with a neurosurgical case capacity and case deficit of 108 824 and 1 877 568, respectively^[39].

Meanwhile, several factors have constantly influenced the progress or downgrading of neurosurgical care in Africa associated with workforce deficit.

The African population has maintained a constant growth streak to an estimate of 1 382 111 434 population^[39]. Africa has about 54 countries, with 22 countries having potential neurosurgical care training programs and only 176 trainees are seen yearly. Major perceived barriers encountered that influence motivation for a career in neurosurgery include, length of the program, high cost, cross-cultural conflicts, fear of the work balance, and personality traits^[40].

It takes ~4–6 years to complete neurosurgery training in Africa, majorly conducted through the College of East, Central, and West African College of Surgeons as the regional administrator of these programs. Meanwhile, an average medical school training in most African countries takes 6–7 years, which includes both pre-clinical and clinical studies. Unlike in the USA where 4 years is spent in training for undergraduate, and the rest of the years for intended specialty training, African students spend much of their years navigating through paths that are not aligned with theirs.

Furthermore, although there are several training programs, most medical students still do not choose neurosurgery due to the high cost of their inclusive fees altogether. Not many assisted funding opportunities for the training are available.

Aside from work balance propagation fear, most students perceive neurosurgery as a very complex and busy career path. Culture still influences and instigates fear especially with also regarding the intensity of the workload, such, while most African cultures surround the idea of having women as part of home caretakers rather than undertaking strenuous career paths^[39].

Nevertheless, we are grateful for the constant efforts to propagate neurosurgical care training in Africa. Most of the credit goes to the efforts of increasing neurosurgical care training programs and the availability of international collaborating societies such as the World Federation of Neurosurgical Societies and the Foundation for International Education in Neurosurgery^[39].

Strengths and limitations

The manuscript has many strengths such as the availability of adequate studies for a standard review of the literature. This has allowed for an accurate synthesis and extraction of data relevant to the study. Also, the manuscripts explore an important topic that is relevant to the development of neurosurgery in Africa. As the manuscript has many strengths, it has various limitations. The important one is the issue of financial constraints in accessing various databases as well as articles with a paywall. This stems from the lack of funding of these databases by the institution of the authors of the manuscript which is a continental issue for researchers in Africa. Therefore, we encourage African institutions to subscribe to important databases relevant to research as this will ease research writing for researchers in the region.

Another limitation is the exclusion of non-English articles in the study presenting language bias. Therefore, we encourage researchers to use non-English articles in their studies to prevent this bias in the future.

Conclusion and recommendations

Early exposure and mentorship are crucial in shaping a neurosurgical career, impacting professional development, networking, and job satisfaction. This study reveals that early neurosurgery exposure, through formal education or informal mentorship, has a lasting career impact. Mentors provide invaluable guidance, support, and encouragement, which eases early-career stress and uncertainty.

Effective mentorship programs in neurosurgery are needed, as existing ones often lack structure and resources. We therefore recommend developing comprehensive programs with regular check-ins, training sessions, and networking opportunities to support young surgeons and aspiring medical students better.

Incorporating mentorship into career development plans for trainees and early-career professionals is also essential, ensuring that mentorship is recognized in promotions and incentivizing experienced neurosurgeons to mentor.

Establishing formal mentorship programs that pair experienced neurosurgeons with early-career surgeons or medical students, providing mentor training, and implementing regular check-ins, feedback sessions, and networking events are also crucial.

Additionally, increasing hands-on experiences and clinical rotations in neurosurgery during medical school and residency, developing comprehensive electives and research opportunities, and encouraging collaboration with local neurosurgery departments will significantly enhance neurosurgery exposure in medical education.

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