Educating the Next Generation of Global Neurosurgeons: Education for Medical Students Interested in Global Pediatric Neurosurgery

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Abstract:

Objective: Education is a critical component of global pediatric neurosurgery with increasing attention being placed on the role of medical students in global neurosurgery. We provide a background of education for medical students interested in global pediatric neurosurgery, present existing pediatric neurosurgery resources with a focus on virtual modalities, and describe the need to create accessible resources for medical students.

Methods: A narrative and anecdotal review was performed.

Results: Education of medical students regarding pediatric neurosurgery is particularly important due to multidisciplinary collaboration and advocacy. Benefits of virtual education include accessibility across the world, convenience, easily updatable nature, incorporation of multimedia, minimal cost, and personalization. Existing online resources include courses focused on medical webinars, general courses, on-demand content, journals, online simulation, and social media. Few resources focused exclusively on medical students exist in pediatric neurosurgery, and none address the intersection of pediatric neurosurgery and global neurosurgery. Additional educational resources that incorporate neurosurgical knowledge with special applicability to the medical student population will capture the interest of medical students, while those incorporating global health elements will develop a commitment to global neurosurgery.

Conclusion: Education of medical students is important for the sustainability of global pediatric neurosurgery. The development of educational resources for medical students interested in global pediatric neurosurgery should be encouraged.

KEYWORDS: e-learning; global neurosurgery; neurological surgery; online learning; virtual learning

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Introduction

Approximately 22.6 million patients, including 13.8 million who ultimately require surgery, experience neurological disorders or injuries that benefit from neurosurgical consultation annually.[1] Over 5 million surgical cases are unmet per year, all in low- and middle-income countries (LMICs), necessitating an additional 23,300 neurosurgeons.[1] Although the proportion of cases that are within the domain pediatric neurosurgery is unclear, there are an estimated 2,297 pediatric neurosurgeons in practice worldwide, of whom 85.6% operate in high-income and upper-middle income countries.[2] In total, 330 pediatric neurosurgeons care for 1.2 children in lower-middle and low-income countries.[2] Despite an increase in the neurosurgical workforce over time, most LMICs will have insufficient neurosurgical workforce density.[3]

Global neurosurgery is an emerging subfield at the intersection of neurosurgical care and public health that seeks to address the global deficit in neurosurgical care and associated disparities.[1, 4, 5] Domains of global neurosurgery include practice, research, health systems strengthening, advocacy, and education.[6] Education has been recognized as a particularly important element to ensure sustainability in global neurosurgical care through the expansion of local neurosurgical capacity.[7, 8] In addition to in-person education, virtual education has emerged as an effective format for delivering content.[9, 10] Existing educational initiatives in global neurosurgery have appropriately focused largely on trainees and attending neurosurgeons, who have the potential to immediately reduce the global burden of neurosurgical disease.[11-13]

However, attention to the role of medical students in global neurosurgery has increased.[14, 15] In this manuscript, we provide a background of education for medical students interested in global pediatric neurosurgery, present existing pediatric neurosurgery resources with a focus on virtual modalities, and describe the need to create accessible resources for medical students. This manuscript will guide the development of educational initiatives seeking to engage medical students to sustainably reduce the global burden of neurosurgical disease.

Medical Student Education in Pediatric Neurosurgery

Importance

Medical students have been increasingly recognized as the future of global neurosurgery.[14, 15] Medical students add value to global neurosurgery through motivation, diligence, time management and organizational skills, and novel perspectives.[14-16] These factors allow for evolution of existing perspectives, generation of new ideas, utilization of novel models of thinking, streamlining of workflows, and effective and efficient collaboration.[14] Educating medical students in global neurosurgery will develop a generation of global neurosurgeons committed to addressing the burden of neurosurgical disease on the levels of individual patients and health systems, with the requisite knowledge and skills.[14, 17] This is particularly important in global pediatric neurosurgery, where issues of multidisciplinary collaboration and advocacy are fundamental.[18-20]

In-Person Events

Traditionally, in-person educational events represent the gold standard for medical student neurosurgery education. Attendance at grand rounds or other faculty presentations provides medical students with the opportunity to learn general neurosurgical content, while guest speakers during neurosurgery interest group meetings allow medical students to learn appropriately tailored content.[21, 22] In-person conferences, such as the American Association of Neurological Surgeons / Congress of Neurological Surgeons Section on Pediatric Neurological Surgery or the International Society for Pediatric Neurosurgery (ISPN) Annual Meeting, also represent a forum to gain neurosurgical knowledge. Interestingly, the proportion of major international neurosurgical conferences containing global neurosurgery sessions has increased since 2015.[23] Lastly, hands-on sessions, such as those focused on neuroanatomy labs, drilling burr holes and craniotomies, sewing and knot typing, and positioning patients, expose medical students to the operating room environment and teach technical surgical skills.[24-26]

Virtual Modalities

The COVID-19 pandemic catalyzed a shift toward virtual education as medical students grew concerned regarding learning, mentorship, and clinical exposure.[9, 27, 28] Online lectures have arisen exponentially[29], such as sessions posted on the Virtual Global Spine Conference YouTube channel or the Lennox Hill BRAINterns program, an 8-week open access webinar series focusing on neurosurgery. Specifically, BRAINterns was evaluated as a good use of time and helped replace lost educational opportunities.[30] The attitudes of medical students regarding all webinars have not been elucidated, trainees and attending neurosurgeons have endorsed a higher degree of satisfaction.[31] Additionally, residents are more comfortable with online webinars and found online lectures more useful than traditional lectures compared to attending neurosurgeons.[31] The perspectives of medical students may be similar to those of residents, as current medical students are quite comfortable with online education. Additionally, a virtual neurosurgery interest group has arisen primarily for students who do not have a home neurosurgery residency program and/or identified with an underrepresented group in subspecialty medicine.[32] Incorporating a multitude of components including a journal club, this virtual interest group has increased knowledge regarding neurosurgery.[32] Benefits of virtual education include accessibility across the world, convenience, easily updatable nature, incorporation of multimedia, minimal cost, and personalization.[9, 33] However, there is controversy where virtual education can substitute for the hands-on technical training provided through in-person sessions.

Existing Online Resources in Pediatric Neurosurgery for Medical Students

Courses Focused on Medical Students

Courses focused on medical students provide medical students with an understanding of neurosurgical pathologies and approaches appropriate for their level. As an example, the Medical Student Neurosurgery Training Center (MSNTC) of the Brain and Spine Group (https://www.neurosurgerytraining.org/)

provides medical students with an interactive forum to learn neurosurgical content. The MSNTC has organized weekend webinars, seminar series, and virtual neurosurgery training camps through virtual platforms. Weekend webinars are usually one to four hours long and provide clinical instruction on overview of a topic of interest. For instance, the Overview of Topics in Craniofacial Surgery weekend webinar was held on April 17th, 2021. The webinar included an overview of the subspecialty of craniofacial surgery, description of conditions treated and relevant surgical techniques and indications, and a survey of current research and future applications of craniofacial surgery within neurosurgery. Seminar series are topical: four-week long summaries of a given neurosurgical condition, with each session hosted by a different neurosurgical faculty mentor. The first session includes an overview of the condition, relevant anatomy, and translational / clinical science advances. The second session describes management, with example cases. The third session is a journal club in which medical students present and discuss new manuscripts on the topic. The fourth session is a grand rounds session in which the faculty member chooses a dimension of the condition to discuss. To date, the MSNTC has hosted three seminar series related to pediatric neurosurgery, including hydrocephalus, Chiari malformation, and temporal lobe epilepsy. Another format is the Virtual neurosurgery training camp: these camps are full-day intensive courses consisting of program director and resident panels, didactic sessions, laboratory presentations, and mentoring sessions.[34] The training camps have included topics related to pediatric neurosurgery and improved neurosurgical knowledge and increased enthusiasm about neurosurgery.[34] All courses are free to attend. Full sessions and clips are available on the MSNTC YouTube channel for those who are unable to attend during the session or wish to review content afterwards.

Other Online Courses

Additional courses do not exclusively target medical students but may be useful. The ISPN hosts monthly webinars in the Clash of Titans series (https://www.ispneurosurgery.org/clash-titans-webinars/). Each webinar discusses a controversial topic in pediatric neurosurgery with two important figures, one in support and one against. Past topics include the utility of intracranial pressure monitoring in pediatric head injuries, open versus endoscopic surgery for craniosynostosis, and whether fetal ventriculomegaly should be treated in utero. This series would provide medical students with a nuanced understanding of points of contention in the field. Sessions are posted on the ISPN website. Additionally, the World Federation of Neurosurgical Societies (WFNS) and its committees have organized webinars (https://www.wfns.org/menu/78/webinars). Topics relevant to pediatric neurosurgery include myelomeningocele and posterior fossa tumors. The International Federation of Neuroendoscopy also has a series of webinars, including management of hydrocephalus and approaches to brain tumors. Additionally, Neurosurgical TV is a YouTube channel that provides individuals with access to webinars and grand rounds presentations. All webinars mentioned in this section are free.

The AANS/CNS Joint Section on Pediatric Neurosurgery's Education Committee has started a bimonthly webinar series (https://pedsneurosurgery.org/fellowship-

lecture-series/) to bring the field together for pediatric neurosurgery: while it is geared toward fellows and faculty, residents and medical students have participated from the high-quality discussion and benefit from increased access to this subspecialty field. Discussions across programs facilitate exchange of ideas as well as connectedness in this time of relative social isolation in pandemic times. Individual neurosurgery programs also offer online webinars and journal club offerings that are open to all on the virtual forum, such as Grand Rounds and pediatric neurosurgery focused forums: a few examples include Miami Children's/University of Miami as well as Lurie Children's/Northwestern University. The latter includes not only pediatric neurosurgery content but also interactive case discussions based on global pediatric neurosurgery with guest faculty with extensive experience in the developing world, including Dr. Leland Albright.

On-Demand Content

On-demand content is an alternative virtual educational modality for medical students. The Neurosurgical Atlas (https://www.neurosurgicalatlas.com/) is an online resource containing text chapters, illustrations, educational videos, grand round webinars, and 3D virtual reality models for anatomy training.[35, 36] All content is available for free. Medical students may utilize the Neurosurgical Atlas to expand their knowledge of anatomy, surgical approaches, and other clinical content. Additionally, the Rhoton Collection (http://rhoton.ineurodb.org/mobile) is a website of the late Dr. Albert L. Rhoton containing video lectures, anatomy slides, and an interactive neurosurgical anatomy atlas that is available free of charge. Brainbook (https://brainbookcharity.org/about/) is a charitable organization that provides access to easily understandable articles on neurosurgical conditions and descriptive videos regarding neurosurgical procedures.

Journals

Journals serve as an important source of knowledge for medical students. However, paywalls are a common barrier to accessing journal articles. Pediatric neurosurgical journals, such as the Journal of Neurosurgery: Pediatrics, Child's Nervous System, and Pediatric Neurosurgery, offer authors the option to make their articles open access. Other journals in which pediatric neurosurgical articles may be published do not. Open access journals, such as Neurosurgery Open and World Neurosurgery X, have also arisen but are relatively new developments. Also, the Essential Neurosurgery for Medical Students Supplement (https://academic.oup.com/ons/pages/med_students_suppl) provides an overview of important knowledge for medical students interested in neurosurgery to master.

Online Simulation

Simulation technologies allow students to learn in quasi-real world clinical settings. While most simulation-based learning for medical students interested in neurosurgery has occurred during in-person courses, online simulation learning may be particularly useful. In addition to the Neurosurgical Atlas, TouchSurgery (https://www.touchsurgery.com/) is a mobile application that allows individuals to simulate common neurosurgical procedures, including shunt revision and intracranial

pressure monitoring. Virtual and augmented reality platforms are also being developed.[37] These technologies represent the strongest virtual option for engaging in hands-on skills training.[38]

Social Media

Social media provides a useful forum for connecting medical students interested in neurosurgery with content, mentors, and peers. Social media has been utilized to publicize upcoming courses, share recordings of previous courses, and increase awareness recently published articles in neurosurgery.[30, 39] The accessibility of social media allows medical students to augment their knowledge base in real time.[40] InterSurgeon (https://www.InterSurgeon.org) is an internet-based social network platform that aims to promote collaboration among surgeons, trainees, and organizations worldwide.[41] InterSurgeon was launched with a module on pediatric neurosurgery and has expanded to adult neurosurgery and other surgical specialties.[41] Users create profiles of their institutions, needs, academic interests, and languages spoken and are matched with mentors for international collaborations within the domains of clinical assistance, education, equipment, research, or training program development via an algorithm.[41] Medical students may utilize InterSurgeon to connect with peers or gain knowledge from mentors. In addition, there are multiple organizations with social media presence for Global Surgery as well as Global Neurosurgery, which engender an open forum for engagement by students, physicians, and other stakeholders. Examples include Global Surgery Students Association, Harvard Program for XXX and Social Change.

Need for Accessible Resources for Medical Students Interested in Global Pediatric Neurosurgery

There are myriad online educational resources available for medical students interested in pediatric neurosurgery. However, few are focused exclusively on medical students, and none focus on pediatric neurosurgery as it relates to global neurosurgery. Additional educational resources that incorporate pediatric neurosurgical knowledge with special applicability to the medical student population will capture the interest of medical students, while those incorporating global health elements will develop a commitment to global pediatric neurosurgery.

Considerations

Development of online educational resources for medical requires certain considerations. First, online education is dependent on access to Internet and Internet speed.[33] Individuals in LMICs may have poor internet connection. Low-resolution options for live lectures or on-demand videos should be made available to circumvent bandwidth issues, while text and picture content should be made downloadable, if possible, to maximize access. Second, language is an important consideration. Qualitatively, most educational resources are available in English. However, individuals may not speak English or have inadequate English proficiency. Translation services should be offered if feasible logistically and in terms of cost to promote inclusivity in neurosurgical education. Third, the structure of educational content merits scrutiny. Text-based content should contain visual

information to increase the memorability and relevance of information.[42] Similarly, interactive online educational sessions are preferable to purely didactic sessions because interactive sessions promote greater engagement and exchange of ideas.[43, 44]

Future Directions

There are numerous future directions to improve medical student education in pediatric neurosurgery with a global emphasis. First, more online courses for medical students focused on pediatric neurosurgical conditions should be developed. Rather than siloed development, stakeholder organizations can consider collaboration for amplification of the field as well as investment in high-quality content. Second, interactive modalities to improve the technical skills of medical students should be developed, including online virtual and augmented reality options. Third, webinars focused on global pediatric neurosurgery should be developed, including description of the burden of pediatric neurosurgical disease; workforce status; access to care and equipment; research, advocacy, and health systems strengthening efforts; and challenges and proposed solutions. These sessions can be general or focused on specific pediatric neurosurgical conditions. Fourth, collaboration across disciplines can create synergies: for instance, the Global Surgery Students' Association has regular webinars and events, and pediatric neurosurgery leadership has been featured. Fifth, a seminar series focused on global neurosurgery, with discussion of global pediatric neurosurgery, is important to increasing knowledge of and interest in global pediatric neurosurgery. Born out of this need, the MSNTC is currently planning such a course. Lastly, a website compiling a comprehensive list of resources for medical students interested in neurosurgery should be created. Although professional organizations have existing lists, none can claim to be comprehensive. The list should be searchable by specialty, such as pediatric, and theme, such as global neurosurgery.

Conclusion

Education of medical students is important for the sustainability of global pediatric neurosurgery. Few resources focused on medical students exist in pediatric neurosurgery, and none address global neurosurgery. The development of educational resources for medical students interested in global pediatric neurosurgery should be encouraged.

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