



Global perspective of neurosurgery practice in lower middle-income countries: challenges, opportunities, and the path forward

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Neurosurgery ranks as one of the most intricate and demanding medical fields, necessitating precision due to the extremely narrow margin for errors, requiring cutting-edge technology, a team of highly proficient professionals, and significant financial resources^[1]. Unfortunately, in low- and middle-income countries (LMICs), the provision of neurosurgical care is significantly hampered by many challenges that affect accessibility and quality^[2]. As neurosurgical conditions such as traumatic brain injuries (TBI), spinal disorders, and congenital anomalies continue to impose a high burden on populations in these regions, it is imperative to address the obstacles and explore viable solutions. Here, we highlight the global perspective on neurosurgery practice in LMICs, emphasizing the challenges, the existing opportunities, and the strategies needed to improve neurosurgical care in these settings.

Neurosurgical conditions disproportionately affect LMICs, mainly due to inadequate access to care. TBI, which can lead to grave consequences if not treated timely, presents a significant public health challenge due to the higher prevalence of road traffic accidents, violence, and occupational hazards in these regions^[2]. According to the World Health Organization, road traffic injuries are responsible for around 1.35 million deaths and disabilities annually, with a significant portion occurring in LMICs. Many of these deaths could be prevented with effective management and prompt neurosurgical intervention^[3].

In addition to TBI, specialized neurosurgical care is essential for conditions like hydrocephalus, brain tumors, spinal cord injuries, and congenital anomalies such as spina bifida. However, the dearth of neurosurgeons and neurosurgical facilities in LMICs means many patients do not receive timely care, leading to adverse outcomes. For example, hydrocephalus, marked by abnormal cerebrospinal fluid accumulation in the brain, typically requires surgical intervention to avert brain damage and death. The absence of skilled personnel and proper surgical equipment in these countries often leaves children with hydrocephalus untreated or subject to inadequate treatment, causing high rates of disability and mortality^[2].

Neurosurgery in LMICs is also plagued by several interrelated challenges spanning the healthcare system. These challenges can be broadly categorized as resource limitations, workforce shortages, financial barriers, and infrastructure inadequacies^[2]. Neurosurgery is a resource-intensive specialty, requiring sophisticated equipment such as MRI and CT scanners, operating microscopes, neuronavigation systems, and specialized surgical instruments. In many LMICs, such equipment is unavailable, outdated, or concentrated in a few tertiary care centers, leaving large population segments without access to essential diagnostic and therapeutic tools^[4]. A World Federation of Neurological Societies (WFNS) review disclosed that 26.8% of LMICs have reported insufficient access to vital neurosurgical equipment^[5]. In some African countries, there are reportedly only one or two MRI scanners available to serve millions of people, leading to long waiting times and delayed diagnoses^[6].

Moreover, the availability of consumables and disposables, such as surgical sutures, implants, and shunt systems, is often limited in LMICs. Relying on donated or second-hand equipment from high-income countries (HICs) is common^[7,8]. Due to the shortages, it has been reported that approximately 5 million neurosurgical operations cannot be performed annually in LMICs. To address these shortages, as well as the lack of microsurgical training facilities, some foundations have begun to be established in HICs. For example, the Madison Microneurosurgery Initiative, among these newly established foundations, was founded in 2020 during the peak of the COVID-19 pandemic. Through its activities, basic microsurgery laboratory training centers have been established within 28 institutions across 18 different LMICs to date. Additionally, 57 microsurgery training kits, 57 stereo microscopes, two surgical microscopes, and several advanced surgical instrument sets have been donated to these newly established laboratories. Furthermore, this initiative organizes online training programs, such as live micro anastomosis training sessions, to support these new centers. Organizations like the Madison

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Microneurosurgery Initiative are crucial in addressing the shortages of institutions in LMICs. Increasing the number of such initiatives, reaching as many LMICs as possible, and eliminating material shortages will be vital to overcoming such challenges in LMICs.^[8-10]

The shortage of neurosurgeons is a critical issue in LMICs. Although there has been a reported increase in the number of neurosurgeons in some of these countries in the past decade, the availability remains far below sufficient, especially considering the concurrent increase in population. In many LMICs, the ratio of neurosurgeons to population is alarmingly low, with some countries having fewer than one neurosurgeon per million people. This significant shortage of neurosurgeons in these regions leads to an overwhelming workload, resulting in burnout and a decline in the quality of care^[7,11]. Addressing the shortage of neurosurgeons in LMICs requires a concerted effort to enhance training and education. Expanding neurosurgical residency programs within LMICs, coupled with opportunities for fellowships and continuing education, can help increase the number of trained professionals. International partnerships between academic institutions in HICs and those in LMICs can facilitate the exchange of knowledge and expertise, providing trainees from LMICs with exposure to advanced techniques and practices.

Emigration of trained neurosurgeons from LMICs to HICs is further exacerbating the problem. This migration is driven by multiple factors, such as inadequate healthcare policies, social and political instability, and unsafe working conditions, leading many trained specialists to seek opportunities abroad^[12]. Additionally, the lack of safety and violence against doctors in these countries due to political turmoil and weak law enforcement further accelerates this trend. However, neurosurgeons are not the only ones leaving; in recent years, “brain drain” has been observed even among recent medical graduates in LMICs. Poorly structured healthcare policies in these regions fail to regulate working hours and income levels for healthcare professionals, making it increasingly difficult to retain skilled workers. As a result, LMICs are left with a depleted workforce, struggling to meet the growing demand for neurosurgical services. While efforts to retain neurosurgeons in their home countries are essential, inadequate training facilities, limited career development opportunities, and poor working conditions often hinder these efforts. Addressing these challenges through targeted healthcare policies and investment in neurosurgical education could help mitigate the ongoing loss of talent and strengthen the neurosurgical workforce in LMICs^[1].

The cost of neurosurgical care is a significant barrier for patients in LMIC. Neurosurgical procedures are expensive, and in many LMICs, healthcare is predominantly funded out-of-pocket, making it unaffordable for a large portion of the population. For instance, the cost of a craniotomy for tumor resection or the placement of a ventricular shunt can be prohibitive, forcing patients and their families into debt or leading them to forego treatment altogether. Financing healthcare in LMICs frequently faces limitations, with specialized care such as neurosurgery receiving inadequate government funding^[13]. Developing and deploying low-cost, portable diagnostic and surgical tools can significantly enhance neurosurgical capacity in LMICs. Insufficient insurance coverage for neurosurgical procedures also intensifies the financial strain on patients. Implementing innovative financing mechanisms, like social health insurance schemes or public-private partnerships, may

mitigate these economic challenges, although this necessitates robust political commitment and meticulous strategy.^[13-15]

The infrastructure required to support neurosurgical care in LMICs is often inadequate. Many hospitals lack dedicated neurosurgical units, intensive care facilities, and rehabilitation centers, which are essential for the comprehensive management of neurosurgical patients. HICs like the United States have approximately 14 operating rooms (ORs) per 100 000 population, whereas LMICs such as Uganda, Rwanda, Zimbabwe, Tanzania, and Ethiopia have only about 4 ORs per 100 000 population. Similarly, while HICs like the United Kingdom and the United States have between 294 and 382 hospital beds per 100 000 population, LMICs such as Uganda and Tanzania have fewer than 200. In addition to the number of ORs and hospital beds, another major issue in these countries is the maintenance of surgical equipment. Inadequate sterilization practices and a limited number of post-anesthesia care units, unfortunately, contribute to an increased tendency for postoperative complications. Furthermore, the unavailability of adequate electricity, with major shutdowns lasting hours to days, is a challenge faced by many areas in LMICs, especially in far-flung regions. The absence of these facilities means that even when surgeries are performed, the postoperative care required to optimize outcomes is often lacking^[16,17].

Neurosurgical training in LMICs lags far behind that of HICs. Comprehensive and high-quality training in neurosurgery remains an ongoing challenge; this owes to a lack of funding and cutting-edge modern infrastructure and, thus, the inability of neurosurgeons to perform and teach newer, better techniques^[18,19]. Neurosurgical trainees in LMICs encounter numerous obstacles. A 2023 survey in Pakistan, with a 98% response rate (120 out of 122), showed that 70.8% of the participants were male, averaging 30.4 years old. While 79% had access to teaching courses and 66% to journal clubs, only 14% participated in cadaver workshops and 22% in cranial model-based simulations. Notably, 67% had not published in indexed journals. Furthermore, 69% worked 50–100 hours per week, 62% experienced burnout from the demanding workload and extended hours, and one-third reported poor work-life balance. Trainees dedicated more time to ORs (37%, 10–24 hours/week) and clinics (34%, 24–48 hours/week) than to studying (42%, less than 5 hours/week) and research (64%, less than 5 hours/week). Half of the trainees found gender equality to be lacking. Disparities in subspecialty training were evident, with 67% having no exposure to deep brain stimulation and 75% to epilepsy surgery. Moreover, 52.5% of training institutions did not offer fellowships, and 64.1% of trainees intended to pursue fellowships abroad^[19]. An additional challenge is the uneven distribution of available neurosurgical training opportunities, particularly in urban areas, with a notable absence in rural regions. This disparity exacerbates the educational and professional divide between urban and rural populations. This urban-rural divide also leaves rural populations with limited access to neurosurgical care, forcing patients to travel long distances to receive treatment. International collaboration in this regard can be extremely valuable, as evidenced by the success of such projects as the establishment of the Rabat Training Centre in Morocco through collaborative efforts of the WFNS^[16]. Capacity-building initiatives, such as establishing regional neurosurgical training centers, can have a long-term impact by producing a sustainable workforce of trained neurosurgeons.

Despite the potential for scientific contributions from LMICs, obstacles such as limited resources, funding deficits, insufficient infrastructure, and a scarcity of human resources hinder their significant involvement in neurosurgery research. As a result, the global neurosurgical research landscape is predominantly shaped by HICs, leading to a knowledge gap that fails to fully address the unique needs and challenges of LMICs. Local neurosurgeons, neurosurgery enthusiasts, and medical students in these regions are crucial in identifying research priorities and deepening our understanding of neurosurgical conditions in their distinct settings. We can bridge this gap by fostering enhanced collaboration, securing increased funding, bolstering research infrastructure, and guaranteeing a fair distribution of neurosurgical knowledge worldwide^[20,21]. Research partnerships between institutions in HICs and LMICs can contribute to developing context-specific solutions to neurosurgical challenges and generating data to inform policy and practice.

In LMICs, the logistical challenges associated with transportation, such as the shortage of ambulances, poor road infrastructure, and the lack of emergency medical services, contribute to delays in treatment and poor outcomes^[13,22]. In 2018, it was reported that access to neurosurgical services within 2 hours is available, on average, to 25.26% of the population in Sub-Saharan Africa, 62.3% in Latin America and the Caribbean, 29.64% in East Asia and the Pacific, 52.83% in South Asia, 79.65% in the Middle East and North Africa, and 93.3% in Eastern Europe and Central Asia^[23].

Despite the numerous challenges, there are opportunities to improve neurosurgical care in LMICs. These opportunities lie in leveraging technology, enhancing training and education, fostering international collaborations, and advocating for policy changes. Technology offers significant potential to overcome some barriers to neurosurgical care in LMICs. Telemedicine, for example, can bridge the gap between neurosurgeons in HICs and their counterparts in LMICs, allowing for remote consultations, case discussions, and mentorship as the existing data show promising results in its favor. Through telemedicine, neurosurgeons in LMICs can access expert advice and support, improving their quality of care^[24,25]. Although the use of advanced technological methodologies could help improve neurosurgical practice in LMICs, these countries often face financial constraints when acquiring such technologies. For example, intraoperative MRI is still unavailable in many countries. However, despite this limitation, certain secondary technologies can be utilized to address the issue. One example is intraoperative ultrasound (USG), which can be used in selective cases. Compared to MRI, intraoperative USG is more affordable and easier to access, and with proper neurosurgical training can assist in visualizing lesion boundaries in selective cases. Additionally, some studies have shown that in various LMICs, awake craniotomy could be considered an alternative to neuro-navigation in selective cases. While such procedures may pose higher risks, these risks can be carefully assessed and managed with a well-prepared operative setup^[17].

International partnerships are vital in enhancing neurosurgical care in low- and middle-income nations. These collaborations may manifest as surgical missions, capacity-building efforts, and research alliances. There have been multiple valuable collaborations between prestigious institutes in the United States and African countries that proved beneficial, including the Weill Cornell Neurosurgery-Tanzania Collaboration, which

significantly increased the number of cervical spine trauma surgeries as well as surgeries on hydrocephalus and brain tumors in Tanzania, and the development of InfraScanner under the Duke Neurosurgery East Africa Project, which can measure the presence, location, and volume of an intracranial hematoma. Another recent collaboration was established between Mass General Brigham and the Edward Francis Small Teaching Hospital in Gambia to develop the capacity for performing complex surgeries for skull-base pathologies. Through this global partnership, along with four other surgeries, the first pituitary operation in Gambia has been performed. On the other hand, increasing the number of alliances between HICs and LMICs aimed at improving the quality of neurosurgical residency training in countries like Tanzania, where the ratio of neurosurgeons to the population is extremely low, will help expand the number of qualified neurosurgeons in LMICs. For instance, recently initiated partnership between Barrow Global and Kilimanjaro Christian Medical Centre in Tanzania is an example of such collaborations. Expanding these initiatives will enable better responses to the existing healthcare needs of these communities. Surgical missions involve neurosurgeons from wealthier nations visiting less affluent countries to deliver immediate medical care and training, addressing critical needs and fostering local expertise.^[26-30]

As future directions to address the inequity in neurosurgical practice between LMICs and HICs, we propose several actionable recommendations. First, the number of international collaborations between these countries should be increased. Through these partnerships, the material and workforce shortages in LMICs can be partially alleviated. Increasing the availability of live-streamed lectures and telemedicine applications is crucial for supporting practicing neurosurgeons in LMICs. Furthermore, not only should the number of international collaborations increase, but their distribution across LMICs should also be broadened to ensure more equitable access to training and resources. Establishing online, free, or low-cost neurosurgical training databases would further enhance the education and skills of neurosurgeons in these regions. From a financial perspective, providing targeted financial support to LMICs can play a vital role in training skilled healthcare professionals. Such support could also encourage these professionals to remain in their home countries, ultimately strengthening the local neurosurgical workforce^[8,31]. Another practical recommendation could be the implementation of augmented reality (AR) and virtual reality (VR) technologies. Establishing AR-VR-assisted surgical simulation training programs in LMICs can be a valuable educational tool for training new neurosurgeons. However, while these methods may be highly effective, they can also be expensive. Therefore, addressing this financial constraint should be among the key focuses of partnerships between LMICs and HICs^[32,33].

Advocacy is essential to drive policy changes that support neurosurgical care in LMICs. Governments in LMIC need to recognize the importance of neurosurgery as a critical component of the healthcare system and allocate appropriate resources to its development. This includes investing in infrastructure, providing financial support for training programs, and ensuring that neurosurgical services are included in national health insurance schemes. A coordinated effort is needed to achieve this, involving governments, international organizations, healthcare providers, and the private sector. By working together,

stakeholders can develop innovative solutions tailored to the specific needs of LMICs, ensuring that neurosurgical care is accessible, affordable, and of high quality^[13,14].

Organizations such as the Federation for International Education in Neurosurgery play a crucial role in promoting global neurosurgical collaboration. By highlighting disparities in neurosurgical care and mobilizing resources, they can further focus on the needs of LMICs and launch more projects to improve neurosurgical services there.^[28,34-37]

Neurosurgery in LMICs faces significant challenges, including a shortage of neurosurgeons, limited access to essential surgical equipment, inadequate training facilities, financial barriers, and infrastructure deficiencies. These constraints result in delayed diagnoses, insufficient surgical capacity, and suboptimal patient outcomes. The migration of neurosurgeons from LMICs to HICs further exacerbates the shortage. Despite these difficulties, several opportunities exist to improve neurosurgical care in LMICs. Expanding international collaborations, increasing financial support, and leveraging technological advancements such as telemedicine, intraoperative ultrasound, and AR/VR-assisted surgical training programs can help bridge existing gaps. Establishing regional neurosurgical training centers, enhancing online educational resources, and promoting capacity-building initiatives between LMICs and HICs are critical steps toward developing a sustainable neurosurgical workforce in LMICs. Addressing these challenges requires a collective global effort. By fostering innovation, collaboration, and strategic policy changes, the international neurosurgical community can work toward ensuring that neurosurgical services are accessible, affordable, and of high quality for all patients, regardless of geographic or economic constraints.

In this letter, we aimed to compile the challenges faced by neurosurgery in LMICs, like many other medical specialties. Although we have included the most up-to-date information on various challenges and limitations, many potential factors remain unexplored. To better understand these issues, it would be essential to listen to neurosurgeons who are actively working in LMICs.

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References

- [1] Ismail M, Ayad F, Al-Ageely TA, *et al.* Societal challenges facing neurosurgeons in low- and middle-income countries: Iraq as an example. *Surg Neurol Int* 2023;14:253.
- [2] Lartigue JW, Dada OE, Haq M, *et al.* Emphasizing the role of neurosurgery within global health and national health systems: a call to action. *Front Surg* 2021;8:690735.
- [3] Ahmed SK, Mohammed MG, Abdulqadir SO, *et al.* Road traffic accidental injuries and deaths: a neglected global health issue. *Health Sci Rep* 2023;6:e1240.
- [4] Frija G, Blažić I, Frush DP, *et al.* How to improve access to medical imaging in low- and middle-income countries? *EClinicalMedicine* 2021;38:101034.
- [5] Menna G, Kolas A, Esene IN, *et al.* Reducing the gap in neurosurgical education in LMICs: a report of a non-profit educational program. *World Neurosurg* 2024;182:e792–e797.
- [6] Hasford F, Mumuni AN, Trauernicht C, *et al.* A review of MRI studies in Africa with special focus on quantitative MRI: historical development, current status and the role of medical physicists. *Phys Med* 2022;103:46–58.
- [7] Fuller A, Tran T, Muhumuza M, *et al.* Building neurosurgical capacity in low and middle income countries. *eNeurologicalSci* 2016;3:1–6.
- [8] Keles A, Cancela AA, Moussalem CK, *et al.* A novel approach for free, affordable, and sustainable microsurgery laboratory training for low- and middle-income countries: University of Wisconsin-Madison micro-neurosurgery laboratory experience. *Neurosurg* 2024;94:1311–1323.
- [9] Nazir A, Vervoort D, Reddy CL. From the first mile to the last: challenges of the global surgical supply chain. *Am J Surg* 2021;222:709–11.
- [10] Oosting R, Wauben LS, Groen RS, *et al.* Equipment for essential surgical care in 9 countries across Africa: availability, barriers and need for novel design. *Health Technol* 2018;9:269–275.
- [11] Kanmounye US, Lartigue JW, Sadler S, *et al.* Emerging trends in the neurosurgical workforce of low- and middle-income countries: a cross-sectional study. *World Neurosurg* 2020;142:e420–e433.
- [12] Farooq M, Tariq S, Zahra SG, *et al.* Neurosurgery abroad? Medical graduate's perspective from LMIC. *Brain Spine* 2023;3:102710.
- [13] Shakir M, Khowaja AH, Shariq SF, *et al.* Financing of neurosurgical care for brain tumors in low- and middle-income countries: a scoping review of barriers and strategies. *World Neurosurg* 2024;189:473–482.e3.
- [14] Okon II, Akilimali A, Furqan M, *et al.* Barriers to accessing neurosurgical care in low- and middle-income countries from Africa: editorial. *Ann Med Surg (Lond)* 2024;86:1247–48.
- [15] Nicholas A, Deji O. Invisible illness: the consequences of limited health insurance in Africa. *Health Sci Rep* 2023;6:e1313.
- [16] Ahmed H, Furqan M, Okon II, *et al.* The availability, access, challenges and advancements in neurosurgical care in Africa: a mini review. *Ann Med Surg* 2024;86:2011–15.
- [17] Shakir M, Khowaja AH, Irshad HA, *et al.* Infrastructural barriers to neurosurgical care of brain tumors in low- and middle-income countries: a systematic review. *World Neurosurg* 2025;194:123375.

- [18] Farooq M, Khan H. Breaking barriers in neurosurgical training in LMICs: augmented reality as a potential future? *J Clin Neurosci* 2024;126:361–62.
- [19] Deora H, Garg K, Tripathi M, *et al.* Residency perception survey among neurosurgery residents in lower-middle-income countries: grassroots evaluation of neurosurgery education. *Neurosurg Focus* 2020;48:E11.
- [20] Jalloh M, Kankam SB, Okon II, *et al.* Fostering neurosurgery research in low- and middle-income countries: the role of international collaboration. *Neurosurg Rev* 2024;47:128.
- [21] Weiss HK, Garcia RM, Omiye JA, *et al.* A systematic review of neurosurgical care in low-income countries. *World Neurosurg* 2020;5:100068.
- [22] Strasser R, Kam SM, Regalado SM. Rural health care access and policy in developing countries. *Annu Rev Public Health* 2016;37:395–412.
- [23] Punchak M, Mukhopadhyay S, Sachdev S, *et al.* Neurosurgical care: availability and access in low-income and middle-income countries. *World Neurosurg* 2018;112:e240–e254.
- [24] Eichberg DG, Basil GW, Di L, *et al.* Telemedicine in neurosurgery: lessons learned from a systematic review of the literature for the COVID-19 era and beyond. *Neurosurgery* 2021;88:E1–e12.
- [25] Tandon V, Raheja A, Mishra S, *et al.* Trends in neurosurgical teleconsultation services across the globe during COVID-19 pandemic. *World Neurosurg* 2021;150:e645–e656.
- [26] Deora H, Garg K, Umana GE, *et al.* Social media neurosurgery and global neurosurgery. *Front Surg* 2024;11:1480013.
- [27] Onyia C, Morgan E, Oyemolade TA, *et al.* The role of international collaborations in sustainable neurosurgical development in Nigeria. *World Neurosurg* 2023;185:e264–73.
- [28] Uche EO, Sundblom J, Uko UK, *et al.* Global neurosurgery over a 60-year period: conceptual foundations, time reference, emerging Co-ordinates and prospects for collaborative interventions in low and middle income countries. *Brain Spine* 2022;2:101187.
- [29] Attebery JE, Nuwas E, Mayegga E, *et al.* Global neurosurgery: a retrospective cohort study to compare the effectiveness of two training methods in resource-poor settings. *Neurosurgery* 2024;94:263–70.
- [30] Aristizabal P, Burns LP, Kumar NV, *et al.* Improving pediatric neuro-oncology survival disparities in the United States–Mexico border region: a cross-border initiative between San Diego, California, and Tijuana, Mexico. *JCO Glob Oncol* 2020;6:1791–802.
- [31] Keles A, Greenway GP, Dempsey RJ, *et al.* Establishing microsurgery skills laboratories in low- and middle-income countries with integrated remote teaching: a novel approach. *Neurosurg Clin N Am* 2024;35:449–63.
- [32] Arboleda V, Lajevardi A, Barletti P, *et al.* Augmented reality (AR) in surgery in low- and middle-income countries (LMICs): a scoping review. *Cureus* 2024;16:e64278.
- [33] Olivieri DJ, Baticulon RE, Labuschagne JJ, *et al.* Geospatial mapping of international neurosurgical partnerships and evaluation of extent of training and engagement. *World Neurosurg* 2020;144:e898–e907.
- [34] Okon II, Akpan UU, Lucero-Prisno DE, *et al.* Global neurosurgical challenges: a focus on Central Asia. *World Neurosurg* 2024;187:e1106–e1111.
- [35] Conti A, Magnani M, Zoli M, *et al.* Social media for global neurosurgery. Benefits and limitations of a groundbreaking approach to communication and education. *Brain Spine* 2023;3:101728.
- [36] Okon II, Musharaf I, Adeniran Bankole ND, *et al.* Neurosurgical challenges of open access publishing in LMICs. *Ann Med Surg* 2024;86:3199–200.
- [37] Chaurasia B. Letter to the editor. *Neurosurg Pract J Neurosurg* 2023;139:1202–03.