Global neurosurgery

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CHAPTER 4

Task-shifting and task-sharing in neurosurgery: an international survey of current practices in low-and middle-income countries

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ABSTRACT

Background: As nearly 23,000 more neurosurgeons are needed globally to address 5 million essential neurosurgical cases that go untreated each year, there is a growing interest in task-shifting and task-sharing (TS/S), delegating neurosurgical tasks to non-specialists, particularly in low- and middle-income countries (LMICs). This global survey aimed to provide a cross-sectional understanding of the prevalence and structure of current neurosurgical TS/S practices in LMICs.

Methods: The survey was distributed to a convenience sample of individuals providing neurosurgical care in LMICs with a web-based survey link via electronic mailing lists of continental societies and various neurosurgical groups, conference announcements, emailing lists, and social media platforms. Country-level data were analyzed by descriptive statistics.

Results: The survey yielded 127 responses from 46 LMICs; 21 countries (45.7%) reported ongoing TS/S. The majority of TS/S procedures involved emergency interventions; the top three being burr holes, craniotomy for hematoma evacuation, and external ventricular drain. A majority (65.0%) believed that their Ministry of Health does not endorse TS/S (24.0% unsure), and only 11% believed that TS/S training was structured. There were few opportunities for TS/S providers to continue medical education (11.6%), maintenance of certification (9.4%), or receive remuneration (4.2%).

Conclusion: TS/S is ongoing in many LMICs without substantial structure or oversight, which is concerning for patient safety. These data invite future clinical outcomes studies to assess effectiveness, and discussions on policy recommendations such as standardized curricula, certification protocols, specialist oversight, and referral networks to elevate the level of TS/S care while continuing to increase the specialist workforce.

INTRODUCTION

Neurosurgical task-shifting and task-sharing (TS/S) is the process of delegating clinical tasks to non-neurosurgical specialists, such as general surgeons, general practitioners, or non-physician clinicians.[1,2] Task-shifting is the redistribution of these duties and clinical autonomy from highly qualified healthcare workers to those with shorter training and fewer qualifications.[3] In contrast, task-sharing employs collaborative teams that transfer tasks to less qualified cadres, though both a specialist and less qualified provider share clinical responsibility and there is iterative communication and training to preserve high quality outcomes.[4]

TS/S models most often arise out of necessity to meet the medical demands of a patient population with a limited workforce, and many countries are currently employing TS/S for obstetrics, anesthesia and general surgery.[5-7] In neurosurgery, as approximately 5 million essential neurosurgical cases go untreated each year, and over 23,000 more neurosurgeons are needed in low- and middle-income countries (LMICs) to address this treatment gap, we believe that TS/S may already be quite prevalent in neurosurgery.[8] Furthermore, the most recent Disease Control Priorities section on *Essential Surgery* indicated that first level district hospitals should be able to perform burr holes for hematomas and elevated intracranial pressure and shunts for hydrocephalus, while tertiary care centers should have the capacity to perform craniotomies and craniectomies, predominantly for neurotrauma.[9] Though, current neurosurgical workforce deficits continue to be significant barriers to such care provision.[10] At present, few neurosurgical TS/S studies have been reported and details of the respective training structures were not clearly defined. For instance, in a 2014 study of operations performed in a Malawi hospital, 10% of the total 1186 operative cases were neurosurgical (craniotomies of ventriculoperitoneal shunts), and 80% of the neurosurgery cases were done by clinical officers in a task-shifting model.[11] In 2015, an assessment of 1036 surgeries in a Liberian hospital revealed that all 31 (3.0%) neurosurgical cases were performed by general surgeons; neither training protocols nor clinical outcomes were discernable from the published data.[12] Two models of neurosurgical task-sharing have been recently described in the Philippines and Australia, both of which provided much more detail on the training curriculum, competency evaluation, oversight, referral networks, remuneration and clinical outcomes.[13,14] Nonetheless, a more global understanding of the prevalence and diversity of TS/S is lacking.

The goal of this study was to obtain a cross-sectional examination of the prevalence and distribution of neurosurgical TS/S within LMICs, and to better understand the models of training, scopes of practice, and systemic support TS/S providers have. The results are intended to inform future discussions on policy and training programs to facilitate timely access to safe and affordable surgical care

MATERIAL AND METHODS

Survey Design

The survey was designed using a modified Delphi method,[15] piloting and refining the questionnaire with input from neurosurgical experts from 20 countries, a majority with experience living or working in a country striving to expand the neurosurgical workforce. Questions were written to ascertain current practices, particularly as they related to a theoretical task-sharing model outlined by the Lancet Commission on Global Surgery,[4] and depicted by Robertson et al.[13] (**Figure 1**) and were available in English, French, and Spanish (**Appendix 1**). The final survey was reviewed by the Institutional Review Board at Harvard University and granted exemption (IRB18-0158). The target audience included neurosurgery providers, defined as any health worker providing interventional neurosurgical treatments whether supervised or working independently, from LMICs, as defined by the July 1, 2018 World Bank Income classifications.[16] We divided neurosurgery providers into four types: [NS] Specialist Neurosurgeons: dedicated neurosurgery consultants/attendings; [GS] General Surgeons: general surgery consultants/attendings who have not completed a formal residency/registrar/fellowship training in neurosurgery; [GP] General Practitioners: those with a medical license but without dedicated surgical training; [NPP] Non-physician providers: those who are from a nursing background or from some other, non-physician background.

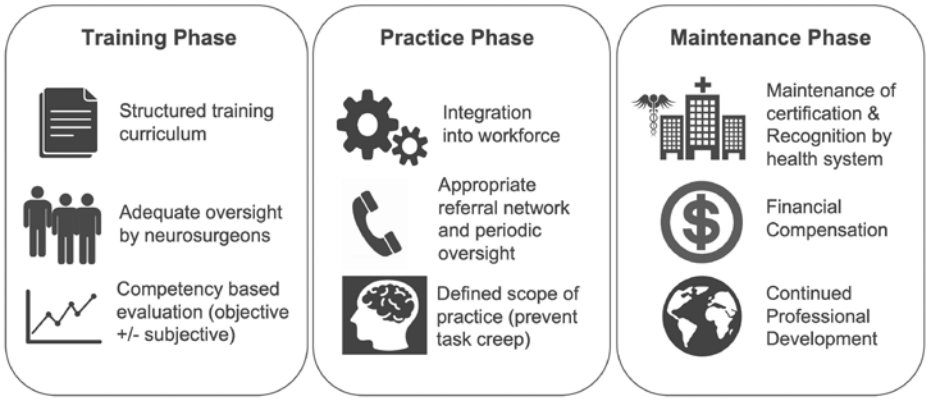


Figure 1. An ideal Task-sharing Model divided into three phases of training, practice, and maintenance of providers. Figure from Robertson et al. 13

Survey Dispersal

The surveys were available online via Qualtrics (Provo, Utah), and accessible via an anonymous weblink, online QR code, and printable PDF that could be collected at various neurosurgical meetings or scanned and emailed to the research team. Participation in the survey was voluntary and without remuneration. The surveys

were distributed by the electronic mailing lists of continental societies and various other neurosurgical groups, email to personal contacts and social media platforms (Facebook, Twitter, WhatsApp). At the end of the survey, individuals were invited to list their name in a separate form to receive collaborator status; this was optional. The wide dissemination of the questionnaire through social media platforms precluded a response rate calculation. The survey remained open from July 2018 to February 2019 and data were exported after survey closure.

Data Analysis

All survey data were exported for analysis on February 28, 2019 from Qualtrics into an excel file and analyzed using Stata 14.0 (College Station Texas). Workforce data were portrayed with descriptive statistics and tables. Data were grouped according to WHO regions: African Region (AFR), Region of the Americas-US and Canada (AMR-USC), Region of the Americas-Latin America (AMR-LA) South-East Asia Region (SEAR), European Region (EUR), Eastern Mediterranean Region (EMR), and Western Pacific Region (WPR), and then reported at the level of individual countries. Respondent free text comments were used to represent general themes.

RESULTS

A total of 127 respondents from 47 LMICs (34.3% of 137 LMIC countries) responded to the survey (**Figure 2, Table 1**). The African WHO Region had 50 participants (39.4.8% of total respondents), while 32.3% of replies were from the South-East Asia Region, 17.3% from the European Region, 5.5% from the Eastern Mediterranean, and 5.5% from the Latin American Region (**Figure 3**). These countries included:

Algeria(2), Bangladesh (1), Belarus (1), Bosnia and Herzegovina (1), Brazil (6), Bulgaria(1), Cameroon (1), Cape Verde (1),Chad (1), Democratic Republic of the Congo (DRC; 6), Egypt (3), Ethiopia (6),, Georgia (1), Ghana (3), Guinea (1),Guatemala (1), India (13), Indonesia (4), Iran (1), Iraq (2), Jordan (1), Kenya (1), Libya (1), Malawi (1), Malaysia (5), Morocco(1), Namibia (1),, Nepal (2), Nigeria (11), Pakistan (10), Philippines (3), Romania (2), Russia (1), Rwanda(3),, Senegal (1), Serbia (4), South Africa (1), Sri Lanka (1), Sudan (2), Syria (2), Tanzania (1), Thailand (1), Tunisia (1), Turkey (8), Ukraine (3), Vietnam (2), and Zimbabwe (1).

Figure 2. Cartographic depiction of where LMIC survey respondents were located. Created with mapchart.net.

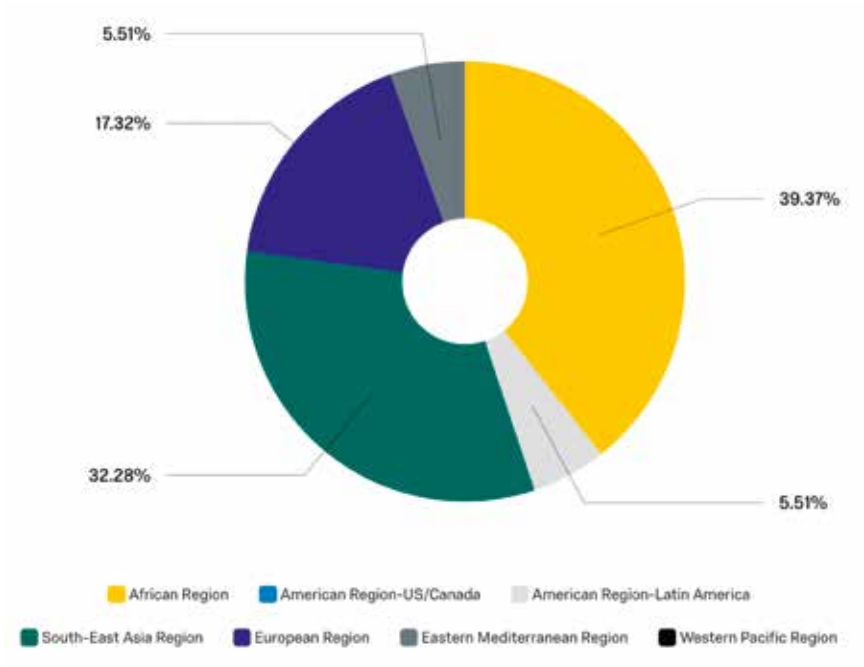


Figure 3. WHO Regions of survey respondents.

Table 1. Survey Respondent Demographics

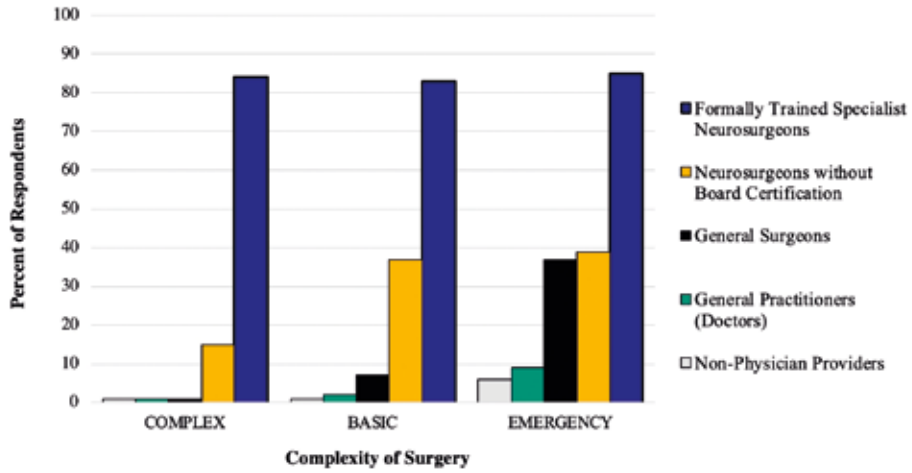
Variable	Number of Responses (%)
Region	*n=126*
African Region	40 (31.8)
South-East Asia Region	40 (31.8)
European Region	25 (19.8)
Eastern Mediterranean Region	13(10.3)
American Region-Latin America	8 (6.35)
Training Level	*n=126*
Consultant Neurosurgeon	84 (66.7)
Neurosurgery Trainee	32 (25.4)
Consultant General Surgeon	1 (0.8)
General Surgery Trainee	1 (0.8)
General Practitioner	4 (3.2)
Other	4 (3.2)
Neurosurgical Society Member	*n=103*
European Association of Neurosurgical Societies	39 (37.9)
American Association of Neurological Surgeons	32 (31.1)
Continental Association of African Neurosurgical Societies	23 (22.3)
Asian Australasian Society of Neurological Surgeons	6 (5.8)
Latin American Federation of Neurosurgical Societies	3 (2.9)
In-Country Neurosurgery Training Availability	*n=101*
Yes	88 (87.1)
Place of Practice *(All responded with percentages, mean, SD)*	*n=126*
Public	67.9 (39.9)
Private	30.1 (38.5)
Faith-based Hospital	2.0 (10.0)
Setting	*n=126*
Urban	116 (92.1)
Rural	10 (7.9)

Of the 127 respondents, 101 identified as being a member of one of the five large neurosurgical societies, with the majority being members of the European (n=36), American (n=29) and African (n=28) Associations. Two-thirds of respondents were of the level of a consultant/attending neurosurgeon (66.1%), 27.6% were neurosurgery trainees, and a small number of general surgeons, general practitioners, or other providers of neurosurgery participated. When asked if neurosurgical training was available in their country, 16.2% indicated that it was not. Regarding place of practice, the majority of the neurosurgical care was provided in the public hospital setting (67.6%), though 30.5% of time was in the private sector, and 2.9% in faith-based hospitals; 92.9% of participants were practicing in urban settings.

The level of reported neurosurgical providers by country is depicted in **Figure 4A and 4B**. **Figure 4A** depicts who performs neurosurgery at the country level, and

Figure 4B demonstrates the reported complexity of surgeries performed according to provider level.

A



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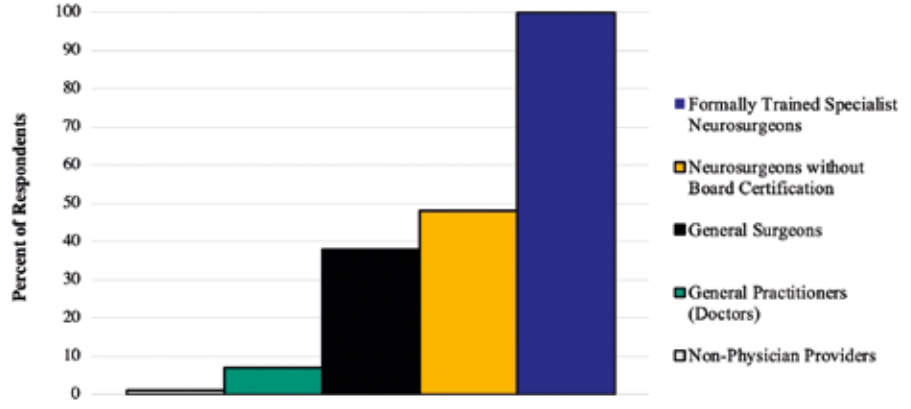

Figure 4A, 4B. Complexity of procedures done by Neurosurgeons and TS/S providers. 4A depicts who performs neurosurgery at the country level. 4B demonstrates the reported complexity of surgeries performed according to provider level. The x-axis reflects the number of responses.

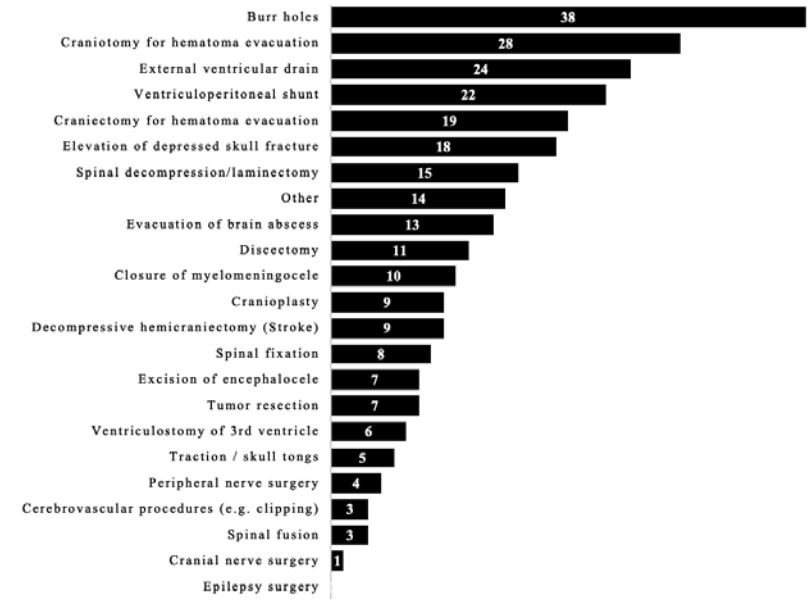

Figure 5. Types of procedures done by TS/S providers.

Overall, 95.1% (n=103) of respondents reported that they had formally trained Specialist Neurosurgeons in their country (one individual from the countries of Bangladesh, DRC, Egypt, Kenya, and Turkey responded "no"; this will be discussed in the limitations section). A total of 21 of the 47 responding countries (44.7%) indicated that TS/S was ongoing in their respective countries. When asked about individuals who completed a neurosurgical training program who are *not* board-certified consultants/attendings but *are* practicing as a neurosurgeon, 44 of 102 respondents from 18 countries affirmed (Brazil, DRC, Egypt, India, Kenya, Malaysia, Morocco, Namibia, Nepal, Nigeria, Pakistan, Philippines, Sudan, Syria, Thailand, Turkey, Ukraine, Vietnam). Thirty-nine of 103 respondents stated that general surgeons were performing neurosurgery in their respective country (Belarus, Cameroon, DRC, Ethiopia, India, Indonesia, Kenya, Malaysia, Morocco, Namibia, Nigeria, Pakistan, Philippines, Sudan, Tanzania, Thailand, and Zimbabwe; 17 countries). Six of 104 respondents stated that general practitioners were performing neurosurgery in their respective country (Malawi, Morocco, Namibia, Nigeria, Sudan, and Tanzania; six countries). Malawi and Morocco reported that non-physician providers also perform neurosurgical procedures. The complexity and types of procedures that TS/S providers perform is depicted in **Figure 5**.

Details from the 21 described TS/S programs are outlines in **Table 2.** When asked if the current Ministry of Health endorses TS/S, 99 individuals responded; 63.6% replied no, 11.1% replied yes (Cameroon, DRC, Egypt, Ethiopia, Indonesia,

Malawi, Malaysia, Nigeria, Sri Lanka, and Turkey), and 25.3% were unsure. Of note, some countries with multiple respondents had both yes and no answers from their respective country, denoting a potential misunderstanding or uncertainty of the MOH's endorsement of TS/S. The actual statement by the respective MOH in each country was not verified during this study. Of these 99 respondents, 8.0% stated there was a standardized training program for TS/S providers in neurosurgery. When asked about the typical duration of training in years for uncertified neurosurgery providers, quantitative answers ranged from no training beyond a general surgery residency, to 1 month (Ethiopia, Indonesia), 3 months (Malaysia, Morocco, Nigeria, Thailand, Philippines), 6 months (Sri Lanka), and 2-3 years (Pakistan).

A subset of respondents elaborated in free text response, which can be viewed in the far-right column in **Table 2**. General themes involved permitting TS/S in neurosurgery in the setting of an emergency, such as an epidural hematoma evacuation, when a fully trained neurosurgeon was not available. One Ethiopian respondent noted: *"They [General Surgeons] do the surgeries where there are no neurosurgeons, and patients are unable to be referred due to financial reasons or because the patient is deteriorating fast."* Another Ethiopian affirmed this: *"They [General Surgeons] practice in district hospitals where virtually no neurosurgeons are available."* In Egypt, India, Indonesia, Israel, Malaysia, Nigeria, the Philippines, and Sudan, respondents echoed that the general surgeons in remote areas will occasionally perform emergency neurosurgery. In Indonesia: *"General surgeons have autonomy to perform emergency neurosurgery such as burr hole evacuation of EDH [epidural hematoma] in remote areas where referral to neurosurgeons is time consuming or impossible."* A Sudanese individual noted that TS/S is *"not allowed, apart [from a] burr hole in [a] remote area for life saving."* In Cape Verde, there was no report on ongoing TS/S, but one respondent noted *"[We have] only one neurosurgeon from Cuba cooperation since 2015. Before that, general surgeons performed emergency neurosurgery and complex cases were sent to Portugal."*

When remuneration for TS/S providers was discussed, 40.9% replied that TS/S providers received no financial payment for neurosurgical procedures, 55.2% were unsure (or not applicable), and 3.2 percent replied in the affirmative (n=93; countries recognizing remuneration for TS/S were Indonesia, Kenya, and Turkey). The ability for TS/S providers to continue medical education or maintenance of certification throughout their training was recognized by 9.8% (n=92; 41.3%, no; 48.9% unsure/NA). Continued professional development opportunities for TS/S providers was reported by 8.6% (n=93; 40.9%, no; 50.5% unsure).

Table 2. Details of TS/S training programs where respondents noted that neurosurgical TS/S was occurring in their respective countries.

Country	TS/S Provider Type	MOH Endorsed (Subjective)	Standardized Training	Length of Training Required	Location of Training	Method of Training	Who leads training	Comments
Belarus	GS	Unsure	No	–	–	–	–	–
Cameroon	GS	Yes	No	–	–	–	–	–
DRC	GS	No	No	Not Standardized	Not Standardized	Not Standardized	NS	*They have to seek permission from consultants for every operation*
Egypt	NA	Yes	No	2-3 years	Referral Hospitals	Clinical Experience		*Minimal cases/emergencies can be done by uncertified NS*
Ethiopia	GS	Yes	No	1 month; 3 months	Teaching Hospital	Clinical Experience; Assist Emergency Surgery	NS	*They do the surgeries in district hospitals and/or where NS are unavailable, and when patients are unable to be referred due to financial reasons or rapid deterioration*
India	GS	No/Unsure	No	Unstructured not allowed	–	–	–	*TS/S is variable, practiced in very few institutions or in rural practice. Not regulated. It depends on the senior neurosurgical consultant covering the region*
Indonesia	GS	Yes	Yes	1-2 months	NS Unit, All Centers	Part of General Surgery Training	NS	*General surgeons have autonomy to perform emergency neurosurgery such as burr hole evacuation of EDH in remote areas where referral to neurosurgeons is time consuming or impossible.*
Israel	GS, GP	No	No	3-4 years	Abroad	Clinical Experience	NS	*In emergency cases only*
Kenya	GS	No	No	–	–	–	–	–
Malawi	GP, NPP	Yes	No	–	–	–	–	*A neurosurgeon is not always available to supervise them but they are encouraged to consult if any case they are in doubt or is beyond their scope of training or experience. all complicated cases within their scope must be referred. All cases outside their scope must be referred.*
Malaysia	GS	Yes	Yes	3 months	NS Center	Part of General Surgery Training	NS	*No formal training program available, GS must obtain endorsement by the head of department in each hospital (for hospitals without NS)*
Morocco	GS, GP, NPP	No	No	3 months	France	Observation; Clinical Experience	NS	–

Table 2. Continued

Country	TS/S Provider Type	MOH Endorsed (Subjective)	Standardized Training	Length of Training Required	Location of Training	Method of Training	Who leads training	Comments
Namibia	GS, GP	Unsure	No	–	–	–	–	*Thy perform burr hole and ventriculoperitoneal shunts. Mostly alone (without supervision).*
Nigeria	GS, GP	Yes	Yes	3 months; Trauma surgery training only	NS Unit; Trauma Surgery	Observation/ Hands-on for highly motivated; Part of GS Training	NS; Trauma Surgeons	*No task shifting, but task sharing practiced & encouraged, mostly in rural areas with no NS supervision. Only resuscitate, then refer to NS. Such providers do personally refer patients they are unable to handle or with resultant complications from their procedures to trained NS.*
Pakistan	GS	No	No	2 years	Post graduate medical institute	Local Curriculum Authorities	–	*TS/S is practiced in teaching hospitals with cover and in private practice groups. I know of those who have almost completed their training but unfortunately couldn't clear their exit exams [but still perform NS]*
Philippines	GS	No	No	3 months	Gov. Teaching Hospital	Direct supervision on rotation	NS	*Basic emergency trauma procedures which are life saving for exigency purposes.*
Sri Lanka	GS	Yes	No	6 months	Same hospital as GS training	Clinical Experience	NS	–
Sudan	GS, GP	No	Yes (only for board certified NS)	TS/S training unclear	–	–	–	*Traditionally refer to advance NS trauma center. TS/S not allowed apart of burr hole in remote area for life saving surgery. We have a specialized local board [for clinical approval].*
Tanzania	GS, GP	Unsure	No	Not specified	Local Hospital	Assist in Surgery	–	*Training of uncertified neurosurgeons happens accidentally/not planned. When one meets an interested trainee, it occurs briefly and unsupervised. No one is sure whether the actual neurosurgery practice continues after the training.*
Thailand	GS	Unsure	Yes	3 months	University Hospital	–	NS	–
Zimbabwe	GS	No	No	–	–	–	–	–

Abbreviations: GP: General Practitioner; GS: General Surgeon; NPP: Non-physician Provider; NS: Neurosurgeon.

DISCUSSION

This survey is the first cross-sectional examination of the global practice of task-shifting and task-sharing care provision in neurosurgery. Its illumination of the prevalence of neurosurgical TS/S is an important step in describing the global neurosurgical workforce and discussing practical approaches to meet the United Nations Sustainable Development Goals for 2030 to mitigate the global burden of neurosurgical disease.[17]

Overall, 21 LMICs (44.6% of LMICs that responded) indicated that TS/S was ongoing in their country, which underscores the magnitude of the neurosurgeon workforce deficit and that many countries are seeking alternative methods for care provision. While the majority of TS/S models described were employing general surgeons, there were also reports of general practitioners and non-physician providers performing neurosurgery. Perhaps more important was the lack of structure, oversight and regulation for these TS/S models. Only eight of the 21 countries believed that this practice was endorsed by their government's Ministry of Health (this data was not verified with the respective MOH offices), and four countries stated there was a standardized TS/S training program. Most individuals reported that the training was led by a neurosurgeon, but it was unclear who was conducting the teaching in many settings. There was tremendous variability in the length of time TS/S providers would train – from one month to years – and there were no concrete examples of competency-based evaluation. Regarding the scope of TS/S provider practice, it appeared predominantly limited to emergency interventions in a rural or district setting, and the most common procedures were burr holes, craniotomy for hematoma evacuation, external ventricular drain, and shunts for hydrocephalus. However, more complex surgeries such as spinal fusion and tumor resection were also mentioned. By not having a governing body for regulation, or a defined scope of practice, there is a serious risk of task-creep: practicing beyond the scope of one's training.[4] The ability for TS/S providers to continue medical education throughout their training was only recognized by 9.8%, and remuneration, only 3.2%.

Importantly, the survey illustrates the current landscape of neurosurgical TS/S and highlights opportune areas for system improvement. As long as there remains a gap between the demand for emergency neurosurgical care and provider capacity, TS/S is likely to arise. Ethically, TS/S presents many challenges. On one hand, having a necessary operation via TS/S may be superior to no care at all; TS/S may allow acute stabilization of emergency patients to enable safer transfer to tertiary care facilities, thereby improving geographic and temporal access to more affordable, lifesaving therapies.[13,14] Conversely, TS/S raises concerns for lower quality care, ambiguous informed consent since unprecedented surgical intervention models may include unknown risk, and disrupting professional roles if less-skilled workers displace higher skilled staff, as has been discussed in the setting of nurse anesthetists

and anesthesiologists.[18] The core ethical principles of beneficence, respect for persons, and justice should remain central to the goal of care delivery, as it is our responsibility to maintain moral standards as we strive to meet workforce goals.[19] However, these data call us to recognize that this process is ongoing, and we can take steps to improve safety.

To begin, task-sharing should be emphasized over task-shifting since shared clinical responsibility with expert involvement is presumed to be a safer option.[4] Building from the theoretical model discussed in the Lancet Commission on Global Surgery and depicted in **Figure 1**, it would first be recommended that the TS/S trainee would have obtained a degree in medicine and currently be in or have completed a surgical training program prior to beginning neurosurgical TS/S training. This is to ensure adequate understanding of both medical and operative management and experience in clinical decision making. From the data, it appears that the majority of country models were already adhering to this practice, as 19 of the 21 countries identified general surgeons as TS/S providers; the seven countries that reported general practitioner or non-physician TS/S providers could adapt alternative training programs to ensure that only general surgeons were certified to do such work. Regarding the training protocol, there would not have to be a one-size-fits-all model, but local and tertiary care hospitals could work with their national neurosurgical society and Ministry of Health to agree upon defining the details of their training programs. We saw that countries who recognized specific lengths of neurosurgical TS/S training included ranges from 1 month, 3 months, 6 months, to multiple years, and there was variation between observation and operative exposure. In order for individuals to be competent and confident in technical and non-technical skills, observation is unlikely to be sufficient, and the length of training should correlate with a set number of supervised operative experiences. Furthermore, the programs should involve competency-based evaluation prior to allowing TS/S providers to practice. This concept of progression in surgical competence along the learning curve being directly associated with caseload experience, graduated autonomy, and time has been shown extensively in surgical education literature.[20-23] Local supervision should follow the completion of formal training to ensure maintenance of skills and competencies. Subsequently, local supervision should happen periodically to ensure maintenance of skills and competencies, and proper referral networks should be established for complex cases and complications to allow for tele-consultation and physical transfer of patients when necessary.[24]

Finally, the governance and financing of TS/S regulation and maintenance is critical. Again, only seven of the 21 countries believed that this practice was endorsed by their government's Ministry of Health. The importance of governmental support can be illustrated with the Mozambique model of *Tecnicos de cirurgia*. In 1984, the Mozambican health system introduced *Tecnicos de cirurgia* as a new professional cadre to deliver basic comprehensive services, mainly in rural areas.[25] Initially, this effort was met with resistance from medical doctors and nurses. However, by having a

governance structure, the health system was able to regulate training, define a scope of practice, collect data for ongoing evaluation and safety improvement, and provide financial compensation that facilitated workforce retention.[26] If neurosurgical TS/S providers were officially recognized and supported by their MOH and institutions with a clear definition of their scope of practice adequate financial remuneration, and clear opportunities for career progression, it could prevent task-creep to protect both the patients and the providers; clear role definition empowers the TS/S provider to defer operations that he or she may be pressured to do electively and protect patients from being taken advantage of by individuals seeking to expand their skillset unsafely for financial or professional gains.[4] It also mitigates worry from other professional roles about job security and encroachment upon their specialty. These data show that clear role definition is needed, since it would be more advisable that complex procedures such as spinal fusion and tumor resection remain under the practice of fully trained neurosurgeons.

Limitations

The limitations of this study warrant further discussion. The absolute prevalence of TS/S practice should be interpreted with caution, as we used neurosurgical member societies as our primary source of survey dispersal, and the individuals who received the survey though neurosurgical society email lists were a majority of practicing neurosurgeons in urban settings. These individuals may have limited information about non-neurosurgeon providers and ongoing practices in rural or remote parts of the country, or there may be political reasons or bias that lead to underreporting. Though, that would likely underestimate the true prevalence of TS/S, making this a conservative estimate. Regarding survey structure, questions may have been misinterpreted or the individual who completed the survey may not have had accurate information. An example of this was potential misinterpretation of the number of "formally trained" Specialist Neurosurgeons in one's country, as four individuals from Bangladesh, DRC, Egypt, Kenya and Turkey reported zero, however, we know from the 2016 WFNS survey that these countries have approximately 138, 4, 400, 22, and 981 neurosurgeons, respectively.[27] Nonetheless, this study represents one of the first attempts to elucidate global perspectives on task shifting and sharing in neurosurgery and will facilitate further discussion on workforce solutions.

CONCLUSION

In summary, the combination of neurosurgical workforce deficits and a high and growing burden of neurological trauma and disease amplifies the demand for scaling up neurosurgical care in low resource settings. This survey illustrated that TS/S is ongoing in many LMICs without substantial structure or oversight, which is concerning for patient safety. Overall, this represents a call to action for

future discussions on policy and training programs. Additional recommendations and regulations could elevate the level of care, such as additional governance, requiring standardized training, competency-based evaluation, clear role definition, maintenance of certification, adequate oversight, and proper referral networks for complex cases. Moreover, continued collaboration between HICs and LMICs will be needed to optimize residency and task-sharing training programs, ensure proper governance and financing of task-sharing models, and encourage an iterative reflection and improvement process as we strive to mitigate the global burden of neurosurgical disease by 2030.

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