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The effect of the Dar es Salaam neurosurgery training course on self-reported neurosurgical knowledge and confidence

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ABSTRACT

Introduction: The Muhimbili Orthopaedic Institute in collaboration with Weill Cornell Medicine organises an annual neurosurgery training course in Dar es Salaam, Tanzania. The course teaches theory and practical skills in neurotrauma, neurosurgery, and neurointensive care to attendees from across Tanzania and East Africa. This is the only neurosurgical course in Tanzania, where there are few neurosurgeons and limited access to neurosurgical care and equipment.

Research question: To investigate the change in self-reported knowledge and confidence in neurosurgical topics amongst the 2022 course attendees.

Material and methods: Course participants completed pre and post course questionnaires about their background and self-rated their knowledge and confidence in neurosurgical topics on a five point scale from one (poor) to five (excellent). Responses after the course were compared with those before the course.

Results: Four hundred and seventy participants registered for the course, of whom 395(84%) practiced in Tanzania. Experience ranged from students and newly qualified professionals to nurses with more than 10 years of experience and specialist doctors. Both doctors and nurses reported improved knowledge and confidence across all neurosurgical topics following the course. Topics with lower self-ratings prior to the course showed greater improvement. These included neurovascular, neuro-oncology, and minimally invasive spine surgery topics. Suggestions for improvement were mostly related to logistics and course delivery rather than content.

Discussion and conclusion: The course reached a wide range of health care professionals in the region and improved neurosurgical knowledge, which should benefit patient care in this underserved region.

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1. Introduction

Tanzania, in East Africa, has an estimated population of 67 million with a median age of 17 years and a life expectancy of 67 years. (United Nations, 2022) It is classified as a lower middle income country, (World Bank, 2023) and economic and infrastructure challenges contribute to a high rate of trauma (estimated incidence of 30 per 100,00 population fatal road traffic accidents per year). (World Health Organization Organization, 2018) Delayed presentation due to difficulties accessing care and knowledge gaps amongst patients and caregivers, and difficulties sourcing and maintaining essential equipment mean provision of neurosurgical care is challenging. (Santos et al., 2018) Since 2011, Tanzania has seen an increase from three specialist neurosurgeons (Kahamba et al., 2013) to approximately 20 currently. (Kahamba et al., 2013) Muhimbili Orthopaedic Institute (MOI) in Dar es Salaam, the largest city, has the only neurosurgical intensive care and high dependency facilities, which were established in 2019. (Budohoski et al., 2018) Despite this progress in neurosurgical provision, services and resources in Tanzania remain insufficient to provide safe and accessible neurosurgical care for the whole population. (Ellegala et al., 2014)

Despite the challenges, neurosurgery in Tanzania has developed from focusing mainly on trauma and paediatric hydrocephalus to a broad range of services including oncology, skull-base, spine, and neurovascular services. (Mangat et al., 2018) Specialist services, such as neurosurgery, need to develop in combination with allied specialties and services such as anaesthetics, critical care, radiology, pathology, oncology, rehabilitation, neurology, physiotherapy, speech and language, and occupational therapy. In addition, where a national hospital functions as a referral centre, services such as emergency medicine, medicine, paediatrics, and general surgery need to be aware of how to institute first management, and when and how to safely transfer to neurosurgery. (Meara et al., 2015)

Since 2011, Tanzanian neurosurgeons have organised a hands-on practical neurosurgical training course in collaboration with Weill Cornell Medicine for a general audience of doctors and nurses from Tanzania and East, Central and Southern Africa. (Kahamba et al., 2013) Dar es Salaam hosted the second East, Central, and Southern Africa neurosurgical training course in 2011, (Kahamba et al., 2013) then a training course was held at Bugando Medical Center in Mwanza in 2012 and 2013. Since 2014, the course has been held annually at MOI in Dar es Salaam. At the time of the first course in 2011, there were approximately 80 participants, whereas the course now attracts several hundred participants. (Kahamba et al., 2013) These include surgical trainees from the College of Surgery for East, Central and Southern Africa (COSECSA), along with nursing and allied health professionals.

Initially, the course focused on training in trauma management, but due to the expansion of neurosurgical care and involvement of allied specialties the course now covers all general and specialist neurosurgical topics. (Santos et al., 2018) The course aims to improve neurosurgical patient care and outcomes in Tanzania and East Africa by training the healthcare professionals delivering care and empowering them to disseminate their knowledge and skills in their local working environments and train others. Nurses and doctors of all specialties have joint training sessions on clinical care, and there are also practical bedside teaching sessions in the intensive care unit, and surgical skills teaching in the operating theatre with surgical cases.

With the increase in course attendance and the expanded curriculum, we sought to measure the value and impact of the course in improving knowledge and skills in the management of neurosurgical patients. We aimed to identify who is attending the course, what their learning needs are, and whether the course is meeting those needs. We also aimed to analyse participant feedback in order to plan future directions for the course.

2. Material and Methods

2.1. Course details

The 8th Annual Neurosurgery, Neurotrauma and Neurocritical Care Hands-on Practical Course was held between the 21st and 25th March 2022 in Dar es Salaam, Tanzania, at the Department of Neurosurgery at MOI, in collaboration with Weill Cornell Medicine. The course was supported by the Foundation for International Education in Neurological Surgery (FIENS), The College of Surgeons of East, Central, and Southern Africa (COSECSA), The North American Spine Society (NASS), and the Medical Council of Tanganyika (MCT). The course also benefited from sponsorship from Medtronic®, Integra®, and DePuy Synthes ®.

The course was advertised by word of mouth, social media, email, and through the COSECSA website. Attendance was free for all participants due to financial support for the course, but participants had to organise their own travel and accommodation. The course programme consisted of joint medical and nursing morning lectures and case presentations. In the afternoons the surgeons observed and participated in live surgeries in the operating room at MOI and had teaching using simulation. For nurses, the afternoon sessions included hands-on simulations, practical bedside teaching and case discussions. The course programme is available at: https://tanzanianeurosurgery.org. Topics covered included traumatic brain injury, traumatic spinal cord injury, neuro-oncology, hydrocephalus, paediatrics, neurovascular, neurocritical care, and research methodology. Surgical cases included fixation of cervical and thoracic spine trauma, minimally invasive lumbar decompression and fixation, cerebellopontine angle tumour resection, cranial arterio-venous malformation resection, endoscopic third ventriculostomy and treatment for paediatric hydrocephalus.

2.2. Data collection

To register for the course, participants were asked to fill in an online questionnaire in Google Forms about how they heard about the course, their current country and hospital, qualifications and experience. After the course, another link was sent to participants to give feedback about the course. On both pre- and post-course questionnaires participants were asked to rate their knowledge and confidence for each skill in each topic on a scale of 1 (poor) to 5 (excellent). Different questions were presented to nurses and doctors due to the different course content. Questionnaires are available in the supplementary material. Although registration was by completing the pre-course questionnaire, it was not mandatory to register online prior to attending the course, and everyone who arrived at the course was able to attend.

2.3. Data analysis

The pre- and post-course questionnaire responses were extracted into Excel, duplicate entries with the same name were removed, and pre- and post-course responses were matched for each participant. For comparison of pre- and post-course self-assessment in knowledge and confidence, only those completing both questionnaires were included. All participants included completed all questions. Results are presented visually on the five-point scale. To assess whether self-rating had improved in all skills on a topic, all questions about the topic were assessed for whether the post-course score was higher than the pre-course score for each participant. Only participants where every post-course score for all questions in that topic had increased were counted. All results are given as frequencies and proportions of those completing the questionnaires. The median score and interquartile range (IQR) for each topic before and after the course was also calculated. In each neurosurgical topic some skills were not assessed. For example, surgical techniques for aneurysm

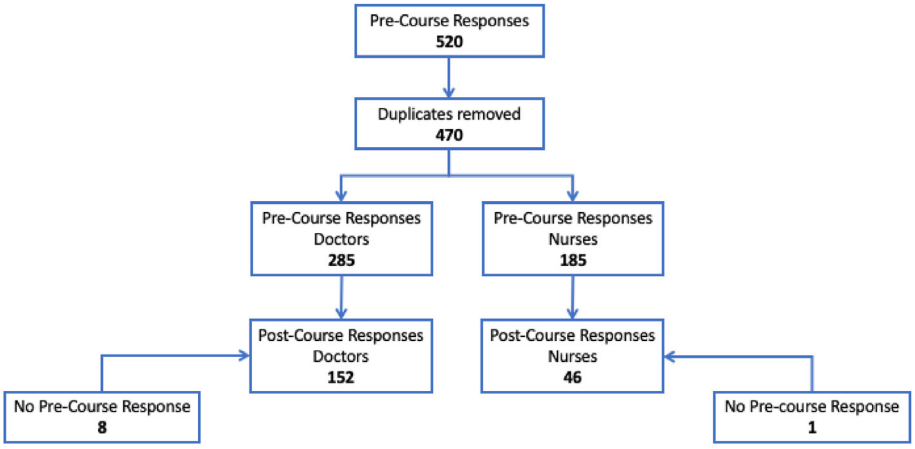

Fig. 1. Flow Diagram of Respondents
Number of participants completing the questionnaires and reasons for exclusions. Duplicate entries for the same person were removed. For the pre and post course comparison only those completing both pre and post course questionnaires were included. There was one nurse and 8 doctors who completed the post-course questionnaire without completing the pre-course questionnaire.

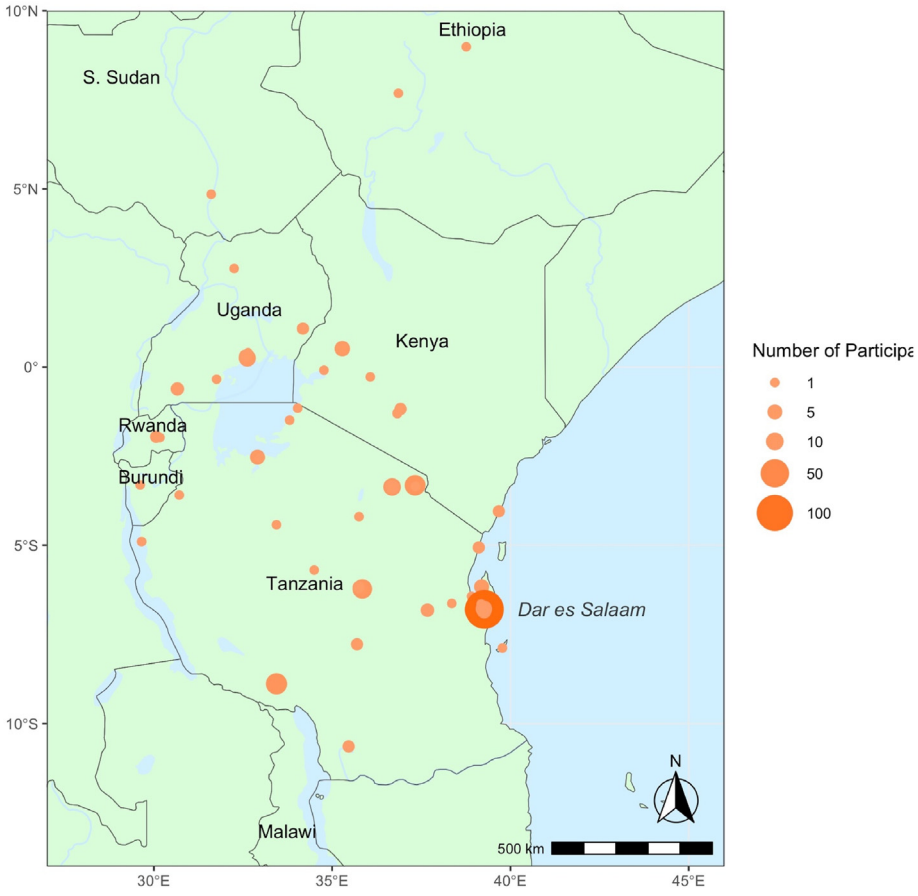

Fig. 2. Map of Attendees
The current hospital of work for participants from the East Africa region is plotted. Number of participants from each location is represented by the size of the point (see key). Participants attending from outside this region are not shown.

clipping were not taught or assessed, so this topic is blank in the graph for aneurysm management. All analyses were performed in R version 4.2.1.

3. Results

There were 470 unique responses to the pre course registration questionnaire, and 198 unique responses to the post course questionnaire (see Fig. 1). However, nine of those completing the post course questionnaire had not completed the pre course questionnaire, so there were 189 with both pre and post course questionnaire responses (see Fig. 1). At the course, 337 participants were counted (261 doctors, and 76 nurses). It was not possible to match those counted at the course (n = 337) with those completing the registration form (n = 470) due to incomplete record availability.

Of those completing the pre-course registration, 395/470 (84%) were from Tanzania. Other countries represented included Uganda (n = 21, 4%), Kenya (n = 15, 3%), and smaller numbers (n = 1–3) from 13 other African countries. Participants attended from a wide geographical area within Tanzania and East Africa. The hospitals of attendees from East Africa are shown on the map in Fig. 2. Two-thirds (n = 309) had not

Table 1
Specialties and Grade of Doctors
Specialty options presented in the questionnaire were as in the table. Registrar and Residents were combined into the trainee category. Specialists and Consultants were combined as Specialists. All students were placed in the Other category.

Grade	Specialty					Total
	Neurosurgery	Orthopaedics	General Surgery	Anaesthetics/Critical care	Other	
Specialist	24	36	12	6	13	**91**
Trainee	32	21	31	5	97	**186**
Student	–	–	–	–	8	**8**
Total	**56**	**57**	**43**	**11**	**118**	**285**

Table 2
Experience of Nurses
Nurses were asked in a free text box how long they had been practicing. Results are tabulated by years of practice.

Years of Practice	Number
Student	6 (3%)
0–2	24 (13%)
3–5	63 (34%)
6–9	34 (18%)
>10	58 (31%)
Total	**185**

attended this course in previous years. Participants heard about the course via: WhatsApp invitation (n = 196, 42%), word of mouth (n = 190, 40%), email invitation (n = 25, 5%), the COSECSA website (n = 28, 6%), phone call (n = 14, 3%), and other methods (n = 17, 4%)

Of the 198 participants completing the post course evaluation, 176 (89%) reported attending all five days. Participants ranged from students to experienced nurses and specialist doctors (see Tables 1 and 2). 197/198 (99%) felt participation in the course would improve their professional effectiveness.

The pre- and post-course self-ratings of doctors for skills in the main neurosurgery topics are shown in Fig. 3. These are for the 144 doctors who completed both pre and post course questionnaires. Doctors also had sessions on research methodology, and self-ratings on these topics before and after the course are shown in Fig. 4. Pre- and post-course self-ratings for the 45 nurses who completed both pre and post course questionnaires are shown in Fig. 5. Self ratings for all topics improved following the course compared to before the course for both nurses and doctors (Figs. 2-4). Median scores across all skills for each topic are shown in Table 3. The proportion of participants whose rating improved at least one point on the 1–5 point scale in each question for each topic is shown in Table 3. The largest number and proportion of doctors improved across all skills in the topics of minimally invasive spinal surgery, intracranial aneurysms, and cerebellopontine angle tumours. For nurses, the largest number improved across all skills in the topics of hydrocephalus and pituitary adenomas. These topics were those with lower self-ratings before the course (see Table 3 and Figs. 3-5).

Fig. 6 shows the opinion of the participants on the level of the course. Doctors felt the level was satisfactory in 118/152 (78%) cases, whereas only 21/46 (46%) nurses felt the level was satisfactory. Fig. 6 shows that nurses felt the course was too advanced and too basic more frequently than doctors. Feedback from both nurses and doctors about the course is shown in Table 4. All 198 participants filled in the free text suggestions for improvement in the post course questionnaire. The most frequent suggestions related to improving the venue and facilities of the course. Participants also frequently requested an increase in the practical teaching component. Comments requested more operative teaching, bedside teaching, and simulation.

4. Discussion

The majority (84%) of participants registered for the 8th annual Dar es Salaam neurosurgery course were from Tanzania, but the course attracted participants from 13 other African countries. Self-assessment of knowledge and confidence in the topics of traumatic brain injury, traumatic spinal cord injury, hydrocephalus, brain tumours, intracranial aneurysms, and research methodology improved following the course. Although most (78%) doctors felt the level of the course was satisfactory, only 46% of nurses did. Most suggestions for course improvement were related to the venue and facilities rather than content, with the exception of increasing the amount of practical teaching.

The strengths of this study are that the same questions were asked of

Table 3
Post Course Improvement in all Skills by Topic
The scores of each participant before and after the course were analysed to see if they improved. The number and percentage of participants whose scores improved by at least one point in all skills in the topics listed are given along with the median pre- and post-course scores for all skills in that topic with the interquartile range. Only those completing both pre and post course questionnaires are included (144 doctors and 45 nurses). (MIS: minimally invasive surgery; ICU: intensive care unit; IQR: interquartile range).

Topic	Profession					
	Doctors			Nurses		
	Improved on all skills	Median score (IQR)		Improved on all skills	Median score (IQR)	
	n (%)	Pre course	Post course	**n (%)**	Pre course	Post course
Lumbar MIS	86 (60%)	2.4 (1.6–3.2)	4.2 (3.8–4.6)	–	–	–
Traumatic Brain Injury	38 (26%)	3.6 (3.0–4.4)	4.4 (4.0–5.0)	19 (45%)	4.0 (3.4–4.3)	5.0 (4.6–5.0)
Traumatic Spinal Cord Injury	62 (43%)	3.2 (2.6–4.0)	4.4 (4.0–4.9)	24 (53%)	3.6 (3.0–4.0)	4.8 (4.4–5.0)
Lumbar MIS	86 (60%)	2.4 (1.6–3.2)	4.2 (3.8–4.6)	–	–	–
Hydrocephalus	62 (43%)	3.0 (2.3–4.0)	4.5 (4.0–5.0)	28 (62%)	3.6 (3.0–4.0)	4.8 (4.6–5.0)
Brain Tumours	–	–	–	25 (56%)	3.2 (3.0–4.0)	4.8 (4.6–4.9)
Pituitary Adenomas	81 (56%)	2.4 (1.8–3.5)	4.0 (3.6–4.6)	30 (67%)	–	–
Cerebellopontine Angle Tumours	91 (63%)	2.2 (1.4–3.0)	4.0 (3.6–4.6)	–	–	–
Intracranial aneurysms	86 (60%)	2.3 (1.5–3.2)	4.0 (3.5–4.7)	–	–	–
ICU Care	–	–	–	25 (56%)	3.3 (2.8–4.0)	4.8 (4.3–5.0)
Research	64 (44%)	3.6 (3.0–4.4)	4.6 (4.0–5.0)	–	–	–

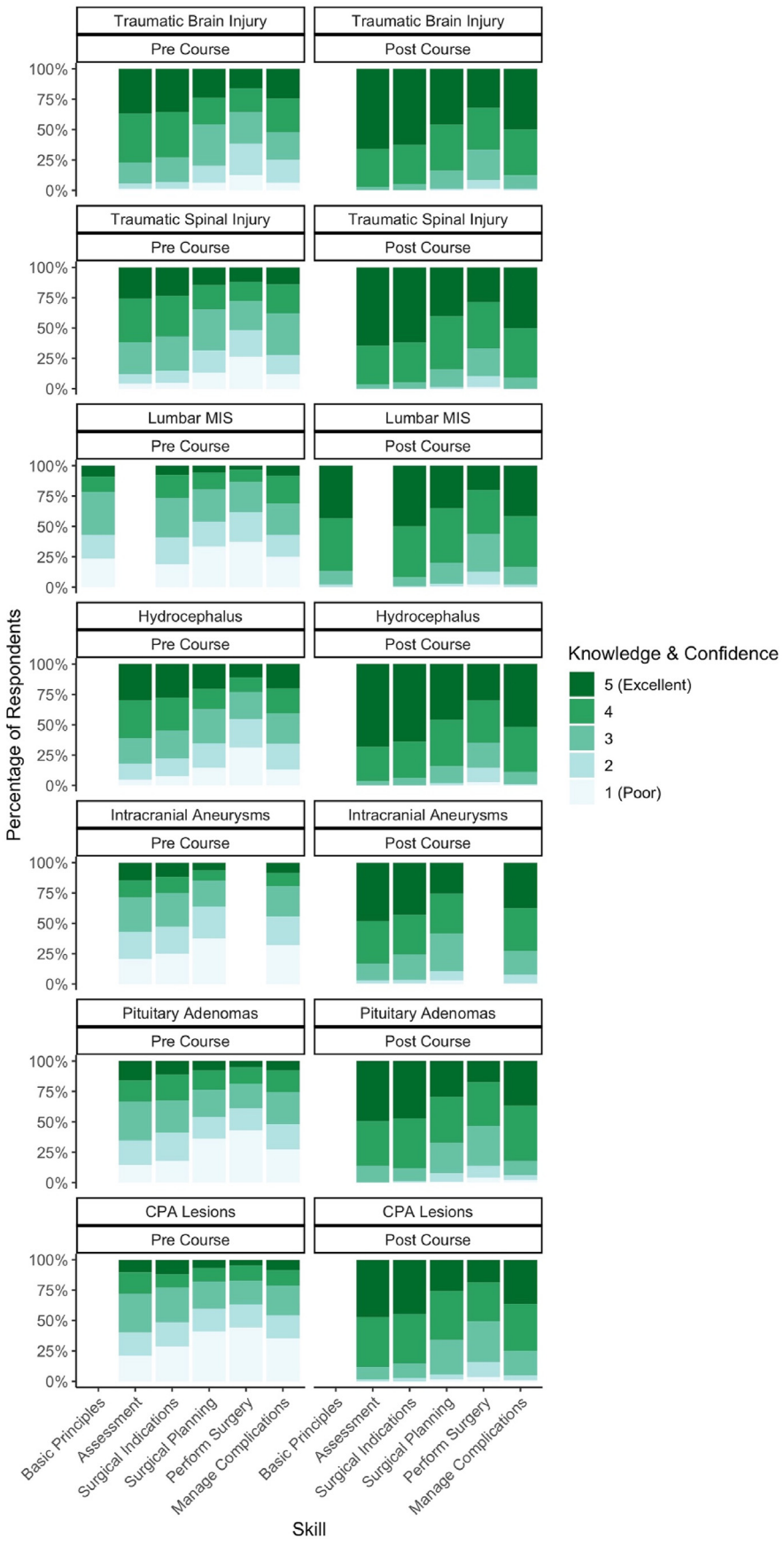

Fig. 3. Self-reported knowledge and confidence on neurosurgical topics of doctors attending the course
Doctors rated themselves on a scale from 1 (poor, shown in light green) to 5 (excellent) shown in dark green, see key). Pre-course results are shown on the left and post-course results on the right. Each row of graphs represents a topic, with the skills in that topic listed on the x axis. There were 144 responses for each question, scaled to 100%. The skills assessed reflect the course topics. The skill of 'Basic Principles' was only assessed for lumbar minimally invasive surgery (MIS), and the skill of 'Perform Surgery' was not assessed for management of intracranial aneurysms. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

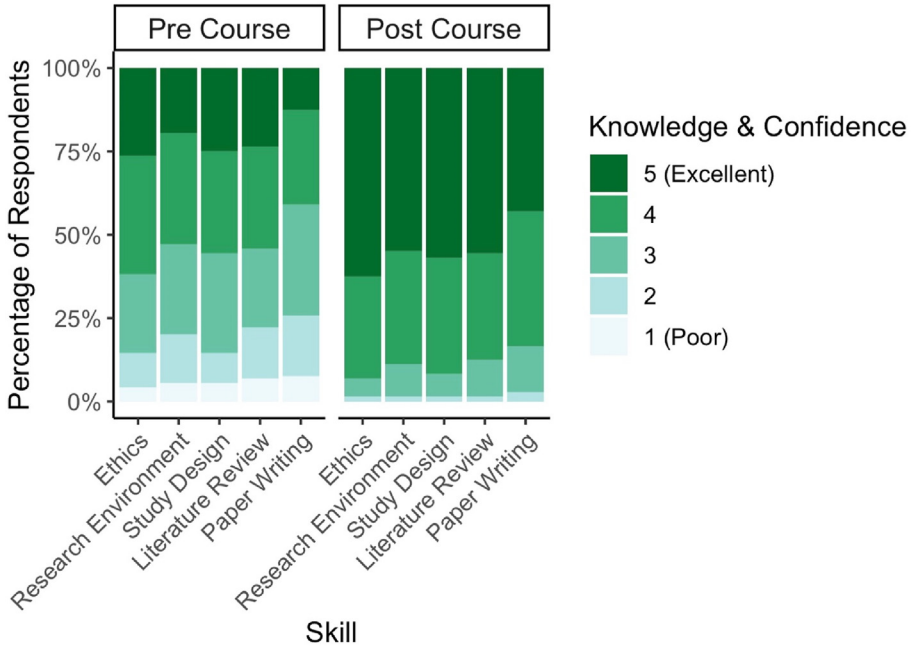

Fig. 4. Self reported knowledge and confidence in research skills

Doctors were asked to rate their research skills before and after the course. The ratings were from 1 (poor, shown in light green) to 5 (excellent, shown in dark green, see key). There were 144 respondents for each question, and the data is scaled so each bar represents 100%. Skills assessed are shown along the x axis. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the same participants before and after the course, and a large number of participants completed both questionnaires (144 doctors and 45 nurses). However, only 51% of doctors and 24% of nurses completing the registration questionnaire also completed the post course questionnaire, so there may be a response bias with those most engaged and learning most responding, and those with less positive feedback not responding. This would overestimate the effect of the course. We used self-report of knowledge and skills rather than using an objective assessment. Due to the variety of levels, specialties, and professionals attending from diverse environments, we felt that self-reporting was a more appropriate method of assessing individual personalised benefit from participating in the course.

The study is limited by the questions asked. We did not assess the different teaching methods used, so we are unable to assess the individual impact of didactic lectures, case discussions, and practical teaching. However, the requests for more practical teaching in the free text feedback suggests that hands-on teaching was valued by the participants. It can also be difficult to extract the benefits of individual taught components of courses separately from the overall experience of collaboration, contact, and experience sharing. The effect of mentoring, role-models and contact are difficult to measure for both course participants and faculty. In addition, non-tangible benefits such as increased confidence, contacts, reputation, and potential funding for departments to develop services cannot be measured by questionnaires, but have surely arisen during the history of the course and the collaborations involved.

The decade long capacity building programme between MOI and Weill Cornell Medicine aims to expand clinical knowledge, operative skills and research methodology in neurosurgery. The annual training course is only one part of this collaboration, Neurosurgeons and trainees from MOI also visit Weill Cornell Medicine in New York for 3–6 months. In return senior neurosurgeons from a variety of countries visit MOI to help build components of the programme. Regular online meetings between MOI and Weill Cornell Medicine to discuss programme expansion, teaching, infrastructure, and surgical care facilitate the collaboration.

Practical and theoretical neurosurgical training courses exist in many countries, mainly aimed at neurosurgical residents. For example, courses are run regularly by the European Association of Neurosurgical Societies, and the Society of Neurological Surgeons runs bootcamps in America. (Selden et al., 2013) Similar neurosurgical training courses for residents have also been reported in Bolivia (Ament et al., 2017), and South East Asia, (Rock et al., 2018) and a competency based international traumatic brain injury course has been developed. (Calero-Martinez et al., 2020) However, measurement of the effectiveness of neurosurgical courses is usually based on post course satisfaction and self-report, similar to our course with no objective measures. Long term measurement of the impact of neurosurgical courses is generally lacking in the literature, although an assessment of the Society of Neurological Surgeons Bootcamps reported retained knowledge six months following the course. (Selden et al., 2013) No other neurosurgical courses report multidisciplinary learning between nurses, doctors, and allied health professionals to improve overall service delivery.

The topics with the largest proportions of participants reporting improvement across all questions were those which were more recently introduced in the course, eg. neuro-oncology and neurovascular topics. This may reflect a lack of familiarity with these topics prior to the course, as they are areas of developing neurosurgical provision in Tanzania. This is supported by the finding of lower self-reported knowledge and confidence prior to the course for these topics. Traumatic brain injury and traumatic spinal injury may be more familiar due to the longer and more extensive neurosurgical provision for trauma in East Africa, with traumatic brain and spine injuries research and teaching at MOI for nearly 10 years, (Leidinger et al., 2019; Mangat et al., 2021) and possibly the success of previous courses in disseminating principles of trauma care throughout Tanzania and East Africa. (Santos et al., 2018; Kahamba et al., 2013; Mangat et al., 2018)

Research methodology was included in the course for the first time in 2022, reflecting the need for ongoing neurosurgery service improvement through analysis of locally collected data and critical application of research findings in a manner appropriate to the setting. (Budohoski et al., 2018) This inclusion of research training in surgical training is gaining momentum in the region with the expansion of the COSECSA Fundamentals of Surgical Research Course. (Long et al., 2021) One of the goals of global surgical training recognised by The Lancet Commission on Global Surgery is for self-sufficiency in training with high quality in-country surgical training. (Meara et al., 2015) Whilst this course adds to training opportunities within Tanzania, and was accessible and well attended by participants from across Tanzania and COSECSA countries, no specific training on teaching was included. Training the trainers is a recognised method of dissemination of surgical training to deliver care, and cascade training to train others to do the same. (Meara et al., 2015;

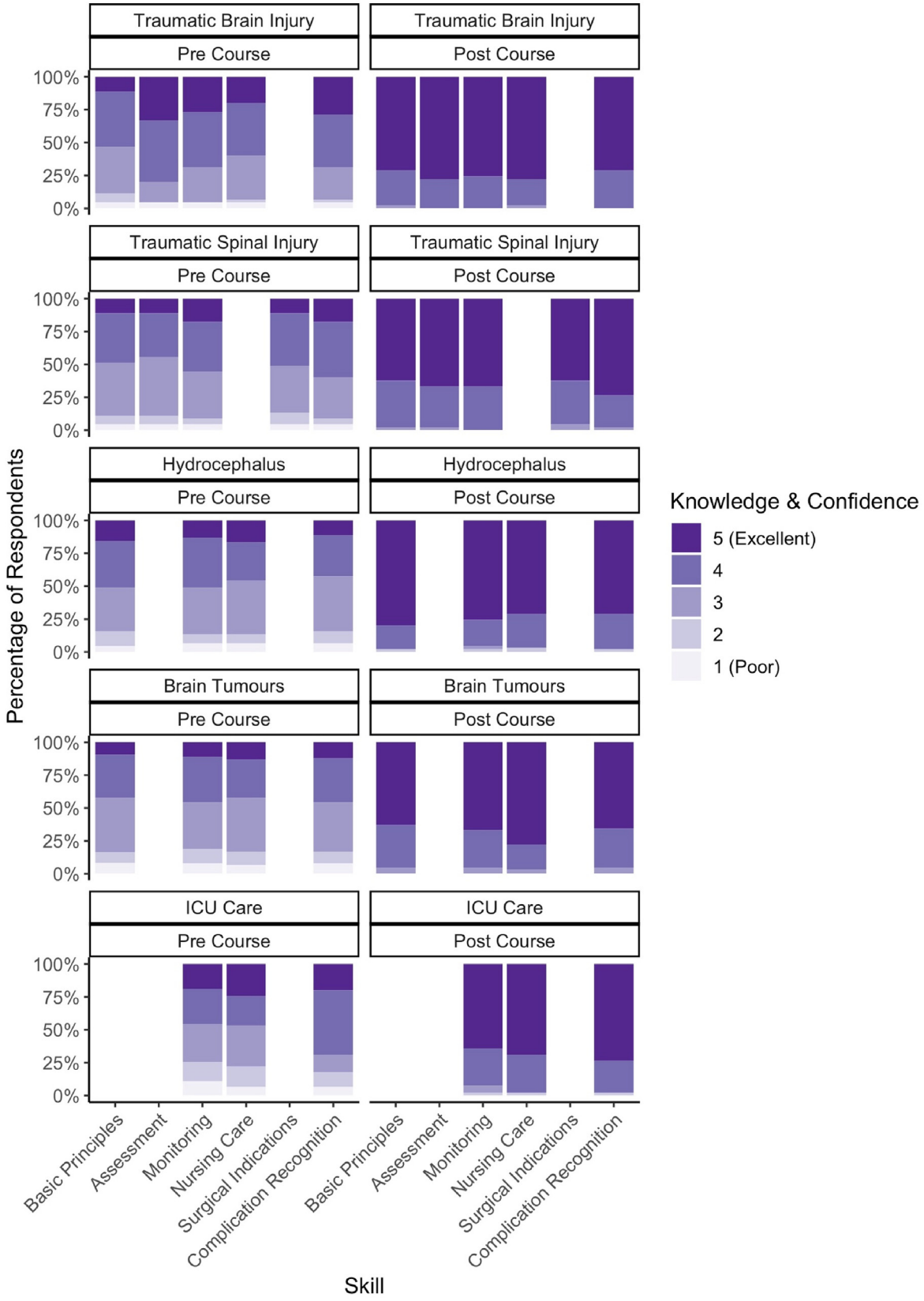

Fig. 5. Self-reported knowledge and confidence on neurosurgical topics of nurses attending the course
Nurses rated themselves on a scale from 1 (poor, shown in light purple) to 5 (excellent) shown in dark purple, see key). Pre-course results are shown on the left and post-course results on the right. Each row of graphs represents a topic, with the skills in that topic listed on the x axis. There were 45 responses for each question. The skills assessed reflect the course topics. Some topics had more than one question per skill, and some skills were not asked about in some topics. Responses are scaled to represent 100% of answers for each topic in each skill. Pituitary adenomas, posterior fossa tumours, and other generic brain tumour questions were all assigned to the brain tumour topic. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

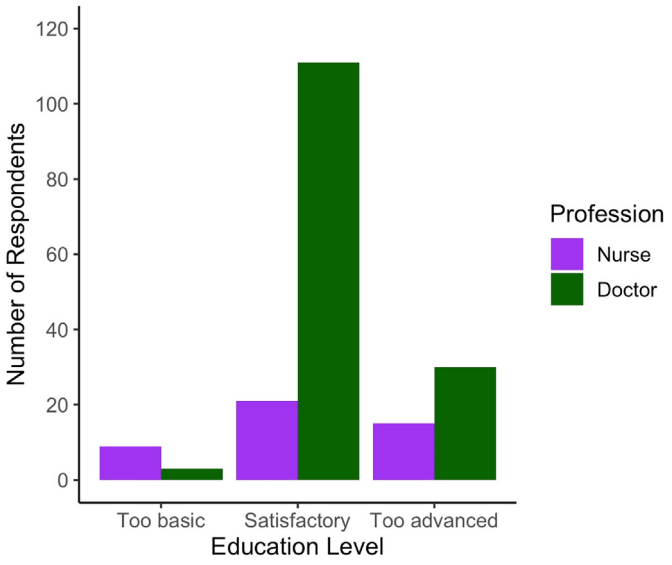

Fig. 6. Assessment of Course Education Level by Profession
All participants were asked to assess whether the level of the course was too basic, satisfactory, or too advanced. Responses split by profession are shown in the bar chart. All participants completing the post course questionnaires were included regardless of whether the pre course questionnaire was completed (n = 198).

Table 4
Improvement Suggestions
Suggestions for improvement for the course. There were 198 participants who completed the post-course questionnaire. Free text responses were tabulated into topics. The most common suggestions for improvement are shown in this table. Participants could suggest as many improvements as they wanted. Percentages are the proportion of participants making that suggestion out of all the participants completing the questionnaire.

	No of participants
Total completing post-course questionnaire	n = 198
Venue & Organisation	
Bigger venue to accommodate all participants	83 (42%)
Improved IT/media/streaming	33 (17%)
Improved time management/organisation/communication	32 (16%)
Longer course/more frequent	31 (16%)
Content	
More practical sessions	71 (36%)
Wider range of topics/Additional topics	29 (15%)

Dempsey and Buckley, 2020) Previous initiatives in Tanzania, (Ellegala et al., 2014) and neighbouring countries such as Uganda, (Haglund et al., 2017) have been successful in training surgical trainers to deliver neurosurgical training and care, particularly for hydrocephalus.

The next Dar es Salaam course on the theme of Global Neurosurgery will be held in March 2023. Sessions on training and teaching will be added, and the joint learning model expanded by advertising attendance to other allied healthcare professionals such as physiotherapists and rehabilitation services. We will also analyse responses by specialties and professional group to ensure the course meets the difficult aims of specialist neurosurgical training for residents and neurosurgical nurses, and general neurosurgery training for those involved with the specialty but not working in the specialty.

In summary, the practical and theoretical neurosurgical training course in Dar es Salaam improved self-reported knowledge and confidence in neurosurgical topics. The course has a large reach across Tanzania and East Africa, and future developments should aim to empower those returning to their local regions to disseminate knowledge and skills gained, including in the areas of teaching and research to facilitate continued improvements in practice. Results from the questionnaires and feedback about the course suggest continued course development is required to meet the needs of the growing neurosurgical services in the region.

Role of the funding source

There was no direct funding for this study. The course was supported financially by: Muhimibili Orthopaedic Institute, Weill Cornell Medicine, Medtronic, Integra, and DePuy Synthes. The sponsor and funder had no role in study design, collection, analysis and interpretation of data, writing of the report, or the decision to submit for publication.

Contributions of authors statement

Study design: FW, SLM, JMM, ZAS, CAB, FS, HM, DGM, DK, MYN, AAK, AJK, SA, JM, FM, MM, BM, IH, WOK, NBR, HSM, LLM, RH, HKS. Data collection: FW, SLM, JMM, ZAS, CAB, FS, HM, DM, DK, FM, MM, IH. Data analysis: FW, JW. Manuscript drafting: FW, JW. Review and approval of manuscript: FW, JW, SLM, JMM, ZAS, CAB, FS, HM, DM, DK, MYN, AAK, AJK, SA, JM, FM, MM, BM, IH, ACI, WOK, NBR, HSM, LLM, RH, HKS. All authors have reviewed and approved the final article and agree to submission.

Data availability statement

Anonymised data are available on request from the corresponding author.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ibrahim Hussain reports a relationship with 3DBio that includes: consulting or advisory. Ibrahim Hussain reports a relationship with AO Spine that includes: consulting or advisory. Ibrahim Hussain reports a relationship with AO Spine that includes: funding grants. Fabian Sommer reports a relationship with Baxter that includes: speaking and lecture fees. Roger Hartl reports a relationship with DePuy Synthes that includes: consulting or advisory. Roger Hartl reports a relationship with Brainlab AG that includes: consulting or advisory. Roger Hartl reports a relationship with Ulrich that includes: consulting or advisory. Roger Hartl reports a relationship with Zimmer Biomet that includes: equity or stocks. Roger Hartl reports a relationship with RealSpine that includes: equity or stocks.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bas.2023.101727.

References

Ament, J.D., Kim, T., Gold-Markel, J., et al., 2017. Planning and executing the neurosurgery boot camp: the Bolivia experience. World Neurosurg 104, 407–410. https://doi.org/10.1016/j.wneu.2017.05.046 [published Online First: 20170517].

Budohoski, K.P., Ngerageza, J.G., Austard, B., et al., 2018. Neurosurgery in East Africa: innovations. World Neurosurg 113, 436–452. https://doi.org/10.1016/j.wneu.2018.01.085.

Calero-Martinez, S.A., Matula, C., Peraud, A., et al., 2020. Development and assessment of competency-based neurotrauma course curriculum for international neurosurgery residents and neurosurgeons. Neurosurg. Focus 48 (3), E13. https://doi.org/10.3171/2019.12.Focus19850.

Dempsey, R.J., Buckley, N.A., 2020. Education-based solutions to the global burden of neurosurgical disease. World Neurosurg 140, e1–e6. https://doi.org/10.1016/j.wneu.2020.01.057 [published Online First: 20200116].

Ellegala, D.B., Simpson, L., Mayegga, E., et al., 2014. Neurosurgical capacity building in the developing world through focused training. J. Neurosurg. 121 (6), 1526–1532. https://doi.org/10.3171/2014.7.Jns122153 [published Online First: 20140912].

Haglund, M.M., Warf, B., Fuller, A., et al., 2017. Past, present, and future of neurosurgery in Uganda. Neurosurgery 80 (4), 656–661. https://doi.org/10.1093/neuros/nyw159.

Kahamba, J.F., Assey, A.B., Dempsey, R.J., et al., 2013. The second African Federation of neurological surgeons course in the East, central, and Southern Africa region held in Dar es Salaam, Tanzania, January 2011. World Neurosurg 80 (3–4), 255–259. https://doi.org/10.1016/j.wneu.2011.07.021 [published Online First: 20111107].

Leidinger, A., Kim, E.E., Navarro-Ramirez, R., et al., 2019. Spinal trauma in Tanzania: current management and outcomes. J. Neurosurg. Spine 31 (1), 103–111. https://doi.org/10.3171/2018.12.Spine18635.

Long, K.L., Galukande, M., Kyamanywa, P., et al., 2021. Developing research potential and building partnerships: a report of the Fundamentals of surgical research course at the College of surgeons of East, central, and Southern Africa. J. Surg. Res. 259, 34–38. https://doi.org/10.1016/j.jss.2020.11.020 [published Online First: 20201202].

Mangat, H.S., Schöller, K., Budohoski, K.P., et al., 2018. Neurosurgery in East Africa: foundations. World Neurosurg 113, 411–424. https://doi.org/10.1016/j.wneu.2018.01.086.

Mangat, H.S., Wu, X., Gerber, L.M., et al., 2021. Severe traumatic brain injury management in Tanzania: analysis of a prospective cohort. J. Neurosurg. 1–13. https://doi.org/10.3171/2020.8.Jns201243 [published Online First: 20210122].

Meara, J.G., Leather, A.J., Hagander, L., et al., 2015. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Lancet 386 (9993), 569–624. https://doi.org/10.1016/S0140-6736(15)60160-X [published Online First: 20150426].

Rock, J., Glick, R., Germano, I.M., et al., 2018. The first neurosurgery boot camp in Southeast Asia: evaluating impact on knowledge and regional collaboration in Yangon, Myanmar. World Neurosurg 113, e239–e246. https://doi.org/10.1016/j.wneu.2018.02.001 [published Online First: 20180210].

Santos, M.M., Qureshi, M.M., Budohoski, K.P., et al., 2018. The growth of neurosurgery in East Africa: challenges. World Neurosurg 113, 425–435. https://doi.org/10.1016/j.wneu.2018.01.084.

Selden, N.R., Anderson, V.C., McCartney, S., et al., 2013. Society of Neurological Surgeons boot camp courses: knowledge retention and relevance of hands-on learning after 6 months of postgraduate year 1 training. J. Neurosurg. 119 (3), 796–802. https://doi.org/10.3171/2013.3.Jns122114 [published Online First: 20130416].

United Nations, 2022. United Nations Population Division World Population Prospects 2022.

World Bank, 2023. World Bank Country and Lending Groups.

World Health Organization, 2018. In: Organization, W.H. (Ed.), Global Report on Road Safety 2018. World Health Organization, p. 403.