

ORIGINAL RESEARCH

A mixed-methods assessment of surgical capacity in Tanzania's Lake Zone

Amanda DiMeo^{1a}, Tenzing N. Lama^{1a}, Meaghan Sydlowski¹, David Barash², Erastus Maina³, Gopal Menon¹, Magdalena A. Gruendl^{1,4}, Monica Cainer⁵, Ntuli Kapologwe⁶, Sarah Maongezi⁷, Augustino Hellar^{8b}, Shehnaz Alidina^{1b}

^aJoint first authors

^bJoint senior authors

¹Program in Global Surgery and Social Change, Department of Global Health and Social Medicine, Harvard Medical School, Boston, MA, USA

²GE Foundation, Boston, MA, USA

³D-Implement, Dalberg Advisors, Nairobi, Kenya

⁴Department of Epidemiology, Technical University Munich, Munich, Germany

⁵Assist International, Ripon, CA, USA

⁶Department of Health, Social Welfare and Nutrition Services, President's Office, Regional Administration and Local Government, Dodoma, Tanzania

⁷Department of Curative Services, Non-Communicable Diseases Section, Ministry of Health, Community Development, Gender, Elderly and Children, Dodoma, Tanzania

⁸Safe Surgery 2020 Project, Jhpiego, Dar es Salaam, Tanzania

Correspondence: Ms Amanda DiMeo (amanda.florian.dimeo@gmail.com)

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Abstract

Background

Five billion people across the world do not have access to safe and affordable surgical, obstetric, and anaesthesia care when they need it. In 2018, Safe Surgery 2020 was launched in Tanzania's Lake Zone region to improve the quality of surgical services. A baseline assessment of surgical capacity was undertaken to provide the context for the implementation of Safe Surgery 2020.

Methods

The surgical capacity assessment focused on 5 domains of the surgical system: workforce, service delivery, infrastructure, information management, and financing. We used a mixed-methods study design, including (1) a cross-sectional survey of 20 health facilities and (2) semistructured interviews (n=34) with surgical team members at 10 health facilities in the Lake Zone of Tanzania between April and July 2018. We used descriptive analysis to quantify surgical capacity and thematic analysis of interview data to gain a deeper understanding of underlying capacity issues and implications.

Results

Surgical, obstetric and anaesthesia workforce density was low at 0.08 surgical, obstetric and anaesthesia providers per 100 000 population. Surgery was performed primarily by general physicians or nonphysician providers and anaesthesia by nurse-anaesthetists. Among 4993 operations captured across the 3 months of baseline data collection in the 5 regions, only 2 of the 3 bellwether procedures—caesarean delivery (n=2640, 54%) and laparotomies (n=388, 8%) were performed. Oxygen, blood, water and electricity were not consistently available in all 20 facilities. The majority of facilities lacked postoperative recovery and intensive care units. The majority of facilities (n=18, 90% of facilities) reported that 1% to 25% of their patients had health insurance. The majority of facilities (n=12, 60%) had specific funds allocated to surgery in their hospital operating budgets.

Conclusions

The surgical capacity assessment revealed critical gaps in each of the 5 domains of the surgical system. Results served as a baseline for the Safe Surgery 2020 intervention and can guide interventions to strengthen the surgical system in Tanzania's Lake Zone and other low-resource settings with similar contexts.

Keywords: health systems, surgical capacity, surgical systems strengthening, Tanzania

Introduction

In 2015, the *Lancet* Commission on Global Surgery (LCoGS) reported that approximately 5 billion people globally do not have access to safe, affordable, and timely surgical, anaesthesia, and obstetric care.[1] The burden of untreated surgical conditions disproportionately affects low- and middle-income countries (LMICs) due to low provider density, inadequate infrastructure, and insufficient service delivery.[2],[3] Previous research suggests that adequate surgical system capacity is essential for providing safe, high-quality surgical care.[4],[5] To that end, the LCoGS proposed a framework identifying 5 domains of a functional surgical system: workforce, service delivery, infrastructure, information management, and financing; and called for high-quality research on surgical systems in LMICs utilizing this framework.[1]

The United Republic of Tanzania faces significant challenges in providing access to high-quality surgical services. Two-thirds of Tanzania's estimated population of 57 million people live in rural areas, where the lack of access to surgical services is highest.[6] The maternal mortality rate, an indicator of surgical quality, is 556 per 100 000 live births, with eclampsia, haemorrhage, and sepsis identified as the leading causes of maternal deaths.[7],[8] The World Health Organization (WHO) has targeted a maternal mortality rate of below 70 per 100 000 live births by 2030.[9] In 2018, the Government of Tanzania launched a National Surgical Obstetric and Anaesthesia Plan (NSOAP)—a 7-year national health plan developed by policymakers and practitioners—to guide surgical system development through coordinated strengthening of the essential domains of surgical, obstetric, and anaesthesia care.[10]

Later in 2018, Safe Surgery 2020, a surgical quality intervention, was introduced in Tanzania's Lake Zone with the aim of improving safety practices, teamwork and communication, and completeness of patient records in the short-term, and reducing postsurgical infections in the medium term.[11] This study aimed to conduct a baseline assessment of surgical capacity to provide policymakers and the implementers of Safe Surgery 2020 with information on context and priority areas for strengthening the surgical system.

Methods

Study design

Our convergent, parallel, mixed-methods study[12],[13] included a cross-sectional survey and semistructured interviews. The National Institute of Medical Research in Tanzania and the Institutional Review Board at Harvard Medical School approved this study.

Study setting and population

Our setting included 5 regions surrounding Lake Victoria: Geita, Kagera, Mara, Shinyanga, and Simiyu. Collectively, they form one-fifth of Tanzania's population, with the latest census reporting 10 273 116 inhabitants.[14] Our sample included 20 health facilities, including health centres, district

hospitals, and regional hospitals. Safe Surgery 2020 partners selected facilities based on a priori selection criteria, including: a surgical volume of at least 50 major operations per year, the presence of a perceived quality-improvement culture, site accessibility, and willingness to participate.[11] Our sample for the qualitative interviews was a subset of 10 facilities in Mara and Kagera. Our interview participants included the hospital administrator (or a Safe Surgery 2020 medical data collector at the facility when the hospital administrator was not available), and 2 to 3 surgical team members, including surgical providers, anaesthesia providers and nurses.

Data collection tools

Following LCoGS recommendations in 2015, the WHO and Harvard Medical School's Program in Global Surgery and Social Change developed the Surgical Assessment Tool (SAT) to collect data on the capacity of surgical systems. The SAT includes both quantitative and qualitative components to assess surgical capacity.[15] Delphi consensus, with a group of surgical, anaesthesia, and obstetric providers who had experience working in LMICs, was used to validate the quantitative SAT tool.[16]

We shortened the quantitative tool to fit the rural Tanzanian context and created an administration guide to ensure consistent interpretation of survey questions. Our final quantitative component of the SAT included a 131-item survey of availability and functionality of inputs in the 5 domains categorized as: always (100%), almost always (76%-99%), most of the time (51%-75%), sometimes (26%-50%), rarely (1%-25%), and never (0%). We modified the qualitative tool by adding questions related to patient safety and quality, coordination of care, and referrals in the service delivery domain. There were 4 semistructured interview protocols tailored for each type of provider. The quantitative and qualitative SAT tools can be found in [Supplementary File 1](#).

Data collection

Quantitative data were collected during a 5- to 7-hour walk-through of each of the 20 health facilities by members of the study team in April 2018. Surgical procedures performed were captured from operating theatre logbooks using data from February through April 2018. If operating theatre logbooks were unavailable, data were captured from mortality logs and government reporting books. Data were collected electronically using Research Electronic Data Capture (REDCap; Vanderbilt University, Nashville, TN, USA).[17],[18]

Qualitative interviews (n=34) were conducted with surgical, anaesthesia, and nursing providers and a hospital administrator. Interviews were conducted by 2 members of the research team (experienced qualitative researchers holding 2 MPH degrees and 1 SD degree between them), between June and July 2018 in a private space. All participants were informed about the purpose of the study, their rights to opt out at any time or refuse to answer any question, and verbal informed consent was obtained before each interview. Safe Surgery 2020 physician data collectors provided translation support using translated Swahili tools when needed. Con-

Table 1. Facility and respondent characteristics

Level of facility	N=20, n (%)
Health centre	4 (20)
District hospital	11 (55)
Regional referral hospital	5 (25)
Facility ownership	
Government	15 (75)
Faith based ^a	5 (25)
Number of inpatient beds	
0-100	5 (25)
101-300	13 (65)
300+	2 (10)
Distribution of qualitative interview respondents by respondent role	N=34, n (%)
Surgical provider	9 (26)
Anaesthesia provider	7 (21)
Nursing provider	6 (18)
Administrative staff	7 (21)
SS2020 medical data collector	5 (14)

^aFour of the faith-based facilities also received government funding due to their status as Designated District Hospitals.

SS2020, Safe Surgery 2020

sistency in the themes emerging in interviews suggested that we had reached saturation. Interviews were transcribed, and deidentified transcriptions were imported into NVivo 11 (QSR International Pty Ltd, Melbourne, Australia) for analysis.

Data analysis

We analysed quantitative and qualitative data in parallel and then integrated the results. Quantitative data were analysed in Stata/IC 15.1 (StataCorp, College Station, TX, USA) using descriptive statistics. Workforce numbers for the 20 facilities surveyed were collected from the facility administration at each site. The workforce numbers for all of the district hospitals and health centres in the regions were estimated based on the available data and with the assumption that the surveyed facilities did not differ significantly from the facilities not surveyed. Population data were gathered from the Tanzanian National Bureau of Statistics^[14] to calculate the specialist surgical workforce density per 100 000 population. This rate was compared to the general surgical workforce density per 100 000 population when also including general physicians and nonphysician providers who perform surgery and provide anaesthesia.

Interviews were transcribed and imported into NVivo 11 for analysis. Interview transcriptions were analysed using the constant comparison method.^[19] First, we developed a set of deductive codes from the interview guides and field notes. The codes were refined inductively based on the transcripts until no new codes emerged and the coding book was considered final. Coding reliability was established by having 3 independent researchers compare their coding using inter-rater reliability calculations (A.D. and M.S. = 0.87, M.S. and T.L. = 0.81, A.D. and T.L. = 0.87) demonstrating strong agreement between the researchers.^[20] The study team divided the transcripts for coding using the final codebook. We then explored themes related to challenges to achieving surgical capacity across sites.^[21]

Table 2. Surgical workforce and surgical workforce density in the Lake Zone^[14]

Workforce in the surveyed sites (N=20)						
Surgeons	Anaesthesiologists	Obstetrics or gynaecology providers	General physicians performing surgery	General physicians providing anaesthesia	Nonphysicians performing surgery	Nonphysicians providing anaesthesia
5	0	2	96	0	89	67
Surgical workforce density in the Lake Zone ^a						Mean density (range)
Surgical specialists ^b						8.27 (7-14)
Surgical specialists per 100 000 population						0.08 (0.06-0.14)
Nonspecialist surgical, anaesthesia and obstetrician-gynaecologist (SOA) providers						1131 (959-1372)
Nonspecialist surgical, anaesthesia and obstetrician-gynaecologist (SOA) providers per 100 000 population						11.00 (9.33-13.35)

^aIncludes all regional referral hospitals, district hospitals, and health centres in Geita, Mara, Shinyanga, Simiyu, Kagera regions; no data available for dispensaries and other categories. Denominator used is the total population for 5 regions^[14]

^bSurgical specialists include surgeons, obstetrician-gynaecologists, and anaesthesiologists; non-specialist SOA providers include general physicians and nonphysicians who perform surgery and caesarean deliveries as well as provide anaesthesia.

Table 3. Illustrative quotations from interviews on surgical capacity issues

Surgical capacity domain	Domain category	Illustrative quotations
Workforce	Staffing	<i>Sometimes, because of being understaffed, some of the surgical providers are not available, so the surgery will be delayed or postponed.</i>
	Specialists	<i>I think the facility has to get a theatre nurse because there is no theatre nurse for surgical services. We don't have an anaesthesiologist. Also, there [are] some cases where we don't have [a] specialist, so we have to refer that patient.</i>
	Training needs	<i>You don't just want seminars. You want someone to teach you how to do surgeries and things like that. New types of surgeries, best practices, and things like that. You want someone to do a surgery with you and show you.</i>
Service delivery	Referral system	<i>We also lack expertise. It's more based on experience, so not everyone is comfortable attempting those cases, so usually they are referred.</i>
	Coordination of care	<i>There is no specific way of communicating with other colleagues if you want to ask or get some help. Because sometimes you might not even need to just refer the patient; you can call your other colleague, and they give you some tips, and you may just find the solution within your facility.</i>
	Quality and safety	<i>Evaluation chart after surgery—they don't have that. It is important for us. If we start that one, we can improve the quality of surgery. If you do an operation... no records [whatsoever] are left for outcomes. If you leave the patient like that—it's not good.</i>
Infrastructure	Utilities	<i>In our setting, in some situations, there will be limited blood, so we inform the momma of the patient. So, we are waiting [for] the result of checking those blood groups and hepatitis in order to continue with transfusion.</i>
	Supplies	<i>We have a problem with oxygen because sometimes we are going to fill the oxygen cylinder in Mwanza, which is about 250 km from here.</i>
Information management	Postoperative and critical care	<i>It is there just like a building—no equipment, no ventilator, no monitors. So, when we get such patients, we are in trouble. We can do procedures in our theatre because we monitor, we have good anaesthetic machines but not postop care.</i>
	Record-keeping	<i>We have [an] ambulance—it is [a] fine ambulance. It is just the ambulance has no life support equipment.</i>
Financing	Health insurance coverage	<i>The national insurance is only for the government workers; that is a big challenge.</i> <i>Some patients—they can be treated with CHF, community insurance fund.</i>
	Budgeting	<i>Most of the surgeries done here are exemption surgeries; they are maternal surgeries. Not paediatric but maternal surgeries take like 70% of all the surgeries being done here. So, you find that it will take more than half of the income or the budget.</i>

Table 4. Surgical volume and case mix

Indicator	Mean ± standard deviation
Surgical volume	
Monthly surgical volume per facility (all types)	82.2±45.8
Monthly surgical volume per regional referral hospital	127±43.4
Monthly surgical volume per district hospital	79±34.5
Monthly surgical volume per health centre	35±17.9
Monthly bellwether procedures per facility	
Caesarean deliveries per facility	44±29.8
Laparotomies per facility	6.45±5.6
Open fracture repairs per facility	0

Results

Facility and respondent characteristics are summarized in [Table 1](#). The majority of facilities were district hospitals (n=11, 55%) and government-operated (n=15, 75%), with 101 to 300 inpatient beds (n=13, 65%). Interview respondents (N=34) included surgical providers (n=9, 26%), anaesthesia providers (n=7, 21%), administrative staff (n=7, 21%), nursing providers (n=6, 18%) and Safe Surgery 2020 medical data collectors (n=5, 14%). We present our results following the LCoGS framework, weaving quantitative and qualitative findings.

Workforce

Surgical workforce data are presented in [Table 2](#). Across the 20 facilities, there were 5 surgeons, 2 obstetrician–gynaecologists, and 0 anaesthesiologists. One hundred eighty-five nonspecialist providers performed surgery, among whom 96 (52%) were general physicians, and 89 (48%) were nonphysicians. Anaesthesia was provided by nurse–anaesthetists with either 1 year of formal training or informal, on-the-job training. The specialist workforce density in the Lake Zone was 0.08 per 100 000 population when exclusively consid-

ering surgeons, anaesthesiologists, and obstetrician–gynaecologist providers. The nonspecialist workforce density was 11.00 per 100 000 population; nonspecialists included general physicians and nonphysicians performing surgery and providing anaesthesia.

In interviews, the lack of specialist care and inadequate staffing were highlighted as barriers to diagnoses and a common reason for delays in care. Additionally, interviewees highlighted insufficient knowledge of current evidence-based surgical practices as a barrier to providing safe, effective care, and they expressed the need for further clinical training and career development opportunities. Illustrative quotations are presented in [Table 3](#).

Service delivery

Surgical volume and case mix

[Table 4](#) presents the surgical volume and case mix. [Supplementary File 2](#) provides a breakdown of information at the facility level. The mean monthly surgical volume between February and April 2018 across the 20 sites was 82.2 procedures per facility. Among 4993 operations captured across the 3 months of baseline data collection in the 5 regions, caesarean delivery (n=2640, 54%) was the most commonly performed procedure. Nearly three-quarters (n=3459, 70%) of all procedures were emergency cases. None of the surveyed facilities conducted open fracture repairs.

Referral system

Interviewees reported the lack of specialists, nonfunctioning diagnostic equipment, inconsistent availability of drugs and supplies, and open fracture repairs as the most common reasons for referral to higher-level facilities. Reasons for referral to the same level of care included a shortage of specialists and the inconsistent availability of blood, reagents, electricity, and clean water. Some interviewees also mentioned providers' level of comfort with their skillset as a reason for referral ([Table 3](#)).

Information on the completeness of information on referral forms, extracted from interview transcripts, is presented in [Table 5](#). Seven of the 10 facilities indicated that they always sent information on the patient's history, results of tests completed, and reason for referral to the receiving facility. However, only 2 of the 10 facilities reported that they received complete information from the referring facility most of the time. None of the facilities indicated that they

Table 5. Number of sites where complete patient information was included with referrals sent and received

Frequency	Referring hospital sends information regarding patient history and reason for referral	Receiving hospital receives information regarding patient history and reason for referral
	n (%)	n (%)
Always	7 (70)	0 (0)
Most of the time	2 (20)	2 (20)
Sometimes	1 (10)	8 (80)
Seldom or never	0 (0)	0 (0)

Table 6. Access to essential utilities and resources (N=20)

Resource	Accessibility, n (%)					
	Always ^a	Almost always ^b	Often ^c	Sometimes ^d	Rarely ^e	Never ^f
Electricity	8 (40)	11 (55)	0 (0)	1 (5)	0 (0)	0 (0)
Water	7 (35)	6 (30)	3 (15)	3 (15)	1 (5)	0 (0)
Oxygen	15 (75)	3 (45)	0 (0)	2 (10)	0 (0)	0 (0)
Blood	3 (15)	10 (50)	3 (15)	3 (15)	1 (5)	0 (0)

Depending on the healthcare facility surveyed, these resources were available and functional either ^a100%, ^b76%-99%, ^c51%-75%, ^d26%-50%, ^e1%-25%, or ^f0% of the time in the previous 12 months.

had systems in place to track referrals, and most indicated that they did not know what happened to patients after they left their facility.

Coordination of care

The majority of interview participants reported good communication among providers within the facility. However, mechanisms for coordination of care with external facilities were not widely reported, and often relied on personal relationships. Interviewees expressed the need for a reliable telephone network, telephone numbers of providers at other hospitals, and a shared electronic health system for better coordination of care with external facilities (Table 3).

Quality and safety

When asked about current quality improvement processes, responses were limited to morbidity and mortality reviews. Participants described formal processes for the review of all maternal deaths through monthly meetings and daily morning reports. Interviewees also referred to written policies and documents, as presented in Table 3. The majority of facilities reported having a quality-improvement team. Regular use of the WHO's Surgical Safety Checklist was not reported at any facility.

Infrastructure

Utilities

Table 6 provides information on the availability of essential utilities. For the purposes of presenting these data, we describe consistent access as "always available" or "almost always available". Notably, 17 of the 20 facilities surveyed (85%) did not have consistent access to blood for transfusion within 2 hours of prescription. Fifteen facilities (75%) reported that functional oxygen cylinders or oxygen concentrators were always available in the operating theatres.

The quantitative data were supported by qualitative insights. Interviewees highlighted the lack of screened blood as an ongoing problem. One respondent explained that when facilities ran out of oxygen cylinders, they had to borrow from neighbouring facilities or travel to Mwanza, the closest centre with an oxygen plant, about 3 to 5 hours away. Interviewees reported electrical outages, resulting in service interruptions, and delays in surgery (Table 3).

Supplies

Figures showing the availability of anaesthesia, essential medications, and diagnostic equipment are presented in Supplementary File 3. X-ray and ultrasound were always available in 3 (15%) and 9 (45%) facilities, respectively. The majority of facilities could not perform a chemistry panel (n=13, 65%) or coagulation studies (n=15, 75%). Five facilities (n=5, 25%) were unable to perform full blood counts, and 6 (30%) were able to perform full blood counts 1%-50% of the time. Qualitative interviews reinforced the quantitative results regarding the lack of supplies and equipment. Interviewees from only 2 of the 10 facilities described having standard, routine maintenance of equipment at their facilities (Table 3).

Postoperative and critical care

Only 4 of the 20 facilities had dedicated intensive care units, and only 1 ventilator was available for use among those 4 facilities. Facilities reported the presence of postoperative care beds (defined as a dedicated space for patients to recover after surgery) at 11 of the 20 facilities (55%).

Multiple interviewees discussed the presence of intensive care units that were not functionally equipped to provide adequate care. Interviewees discussed the lack of emergency, postoperative recovery, and intensive care units as major challenges and explained that, while facilities often had ambulances available, they usually did not have the equipment to support care within the ambulances (Table 3).

Information management

Either paper-based or electronic methods of information management were present in 18 facilities (90%). Despite this, 11 facilities (55%) reported that charts were not accessible across multiple visits for the same patient. All facilities used a series of primary and secondary registers called *Mfumo wa Taarifa za Uendeshaji Huduma za Afya (MTUHA)*, a Kiswahili term for health information system, which were largely used to collect data on maternal and newborn indicators. Staff reported general health data in the primary books, while the secondary books included totals and summaries from the primary books.

Interviewees from 7 of the 10 sites explained the lack of adequately trained workforce for maintaining records as an impediment to long-term maintenance of patient data (Table 3). Interviewees explained that, while they kept patient records at the facilities, patients were responsible for maintaining their file numbers after being discharged from the facility. Lost file numbers were reported to cause delays and difficulties locating files, hindering continuity in care.

Financing

Data provided by the quantitative SAT survey found that most facilities (n=18, 90%) reported that 1%-25% of their patients were covered by health insurance. Caesarean deliveries were provided free of charge at all public facilities. Eight facilities (40%) did not have specific funds allocated to surgery and anaesthesia in their hospital operating budgets.

Interviews supported the quantitative data regarding the lack of insured patients, noting that most of those insured under the national insurance scheme were government employees. Additionally, interviewees described the availability of community health funds as another source of coverage for eligible patients. However, such community-based health insurance was not consistently available. Regarding budgeting, interviewees reported a lack of patient revenue as a significant challenge due to the high number of exempt patients, given that caesarean deliveries represented the majority of operations performed in these facilities. Illustrative quotations are presented in Table 3.

Discussion

Our assessment identified cross-cutting challenges associated with shortages of providers and a lack of training opportunities, as well as inadequately developed referral, coordination, and quality systems; insufficient equipment and infrastructure; weakly developed information systems; and inadequate financing for surgical care. Our results also provide important subregional data for the monitoring of the NSOAP. In interpreting our results, we focus on 2 key areas to strengthen surgical capacity.

Workforce numbers are consistent with previous reports showing that the low numbers of surgical providers are not distributed equally between rural and urban Tanzania.[22]-[24] The reliance on nonspecialist providers highlights the need to build the capacity of general physicians and nonphysician providers to safely perform essential surgical procedures. Tanzania has demonstrated success in training nonphysician clinicians to provide essential surgery.[25],[26] Furthermore, evidence shows that training, mentorship, and opportunities to safely perform the operations can increase the confidence and self-efficacy of providers.[27],[28] A mentorship team from the zonal hospital could serve as a model and strengthen existing referral linkages. Congruency in culture and discipline of mentors can promote more positive experiences among mentees.[27],[28] Additionally, strategies suggested in the Tanzanian NSOAP for incentives and local training hubs can facilitate retention in rural areas.[10]

There is a significant opportunity to strengthen information management at the facility level to improve the quality of surgical care, monitor the impact of interventions, and support advocacy and funding to strengthen surgical services. We found that providers faced challenges with maintaining the physical (MTUHA) register, which is consistent with the findings of other studies in the same region.[29],[30] These data are important as they are used to report on health indicators through the District Health Information Software (DHIS).[31] Furthermore, the MTUHA registers lacked surgical indicators, including postsurgical infection incidence data, which can increase the difficulty of surgical quality monitoring. Finally, patient files were not available over time, which could impede continuity of care. Therefore, there is a need to invest in information technology, incorporating a core set of surgical indicators, at the facility level. In introducing these surgical indicators, it will be important to train surgical teams on the importance of monitoring and evaluation, the indicators themselves, how to collect high-quality data, and how to leverage data for quality improvement. Research suggests that data quality training holds promise,[32] in combination with mentorship interventions.[33]

This baseline assessment of surgical capacity can facilitate the monitoring of the Safe Surgery 2020 intervention. Safe Surgery 2020 is a multicomponent intervention that focuses on strengthening surgical capacity in 4 cross-cutting areas, including leadership, teamwork, and communication; evidence-based surgical, anaesthesia, and sterilization practices, supported by onsite and virtual mentorship; data documentation practices; and infrastructure strengthening through grants, a perioperative equipment package, and training of biomedical engineers for each facility.[27]

Limitations

Our study had a number of limitations. First, we focused on a small number of facilities whose experiences may reflect their unique environments. Second, responses to the SAT tool were subject to recall bias and information available at the time of the visits. Third, we did not test our qualitative interview tool in the field because of time constraints. Fourth, social desirability bias can be a concern, as interviewees were aware that the researchers were involved with Safe Surgery 2020. Finally, this study did not obtain patient perspectives, which is notable because staff provided second-hand reports about the experiences of patients. Patient surveys should support future investigations.

Conclusions

Our results emphasize the need for a comprehensive approach to improving surgical capacity that leverages innovation to strengthen the surgical system in the Lake Zone and addresses gaps in all 5 domains of the surgical system. Findings from this study aligned with the NSOAP in terms of several recommendations for improving the surgical system in Tanzania,[10] emphasizing the importance of international and domestic funding to support the implementation of the NSOAP, towards improving surgical systems and capacity.

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