BMJ open accessible medical research

Emergency and surgery services of primary hospitals in the United Republic of Tanzania

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To cite: Penoyar T, Cohen H, Kibatala P, *et al*. Emergency and surgery services of primary hospitals in the United Republic of Tanzania. *BMJ Open* 2012;**2**:e000369. doi:10.1136/bmjopen-2011-000369

► Prepublication history for this paper is available online. To view these files please visit the journal online (http://bmjopen.bmj.com).

Received 6 October 2011
Accepted 14 December 2011

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ABSTRACT

Objective: The primary objective was to evaluate the capacity of first-referral health facilities in Tanzania to perform basic surgical procedures. The intent was to assist in planning strategies for universal access to life-saving and disability-preventing surgical services.

Design: Cross-sectional survey.

Setting: First-referral health facilities in the United Republic of Tanzania.

Participants: 48 health facilities.

Measures: The WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care was employed to capture a health facility's capacity to perform basic surgical (including obstetrics and trauma) and anaesthesia interventions by investigating four categories of data: infrastructure, human resources, interventions available and equipment. The tool queried the availability of eight types of care providers, 35 surgical interventions and 67 items of equipment.

Results: The 48 facilities surveyed served 18.6 million residents (46% of the population). Supplies for basic airway management were inconsistently available. Only 42% had consistent access to oxygen, and only six functioning pulse oximeters were located in all facilities surveyed. 37.5% of facilities reported both consistent running water and electricity. While very basic interventions (suturing, wound debridement, incision and drainage) were provided in nearly all facilities, more advanced life-saving procedures including chest tube thoracostomy (30/48), open fracture management (29/48) and caesarean section delivery (32/48) were not consistently available.

Conclusions: Based on the results in this WHO country survey, significant gaps exist in the capacity for emergency and essential surgical services in Tanzania including deficits in human resources, essential equipment and infrastructure. The information in this survey will provide a foundation for evidence-based decisions in country-level policy regarding the allocation of resources and provision of emergency and essential surgical services.

ARTICLE SUMMARY

Article focus

- On-site visits to primary health centres in a developing nation.
- Evaluate capacity to deliver emergency and surgical care-identify gaps in equipment, skills and personnel.

Key messages

- Basic surgical procedures are being performed in nearly all health centres.
- Significant deficits in human resources, essential equipment and infrastructure.
- Pulse oximetry is rarely available.

Strengths and limitations of this study

- Most comprehensive evaluation of a developing country's surgical capacity.
- Based on established well-accepted analysis tool.
- Relies on subjective measures and estimate.

INTRODUCTION

Surgical services at the first-referral level are an essential component of comprehensive primary healthcare. Conditions that can be treated with surgery account for an estimated 11% of the world's disability-adjusted life years.[1] Despite recent data estimating the global volume of surgery at 234 million surgical procedures annually and significant disparities between procedures performed in high- and low-income counties, global public health initiatives have traditionally neglected the necessity for the provision of surgical services.[2] Poor access to surgical services, particularly at rural facilities, results in excess morbidity and mortality from a broad range of treatable surgical conditions including injuries, complications of pregnancy, sequelae of infectious diseases, acute abdominal conditions and congenital anomalies. Improving the access to surgical services in low-income countries requires a systems-based approach addressing gaps in infrastructure, trained/skilled personnel, appropriate equipment and medications.

Tanzania, similar to other sub-Saharan African countries, faces significant challenges in the provision of health services. Infant mortality is 68 per 1000 live births and

maternal mortality rate is 578 per 100 000 live births.[3] The leading causes of maternal death (haemorrhage, unsafe abortion, eclampsia and obstructed labour) can all be addressed with appropriate emergency obstetric care, which often require surgical and/or anaesthesia interventions. In a 1999 Tanzanian Ministry of Health and Social Welfare (MoHSW) census, health facilities numbered 4714 with 280 hospitals, 479 health centres and 3955 dispensaries for a total of 32 000 beds (1:896 people). There were 110 surgeons (1/3 in cities, 1/3 in administration and 1/3 emigrated) and 16 anaesthesiologists. Human resources for health were critically absent, with fewer than 1/3 of posts filled in primary hospitals.[4]

As funders and public health experts adopt the expansion of primary healthcare services, the inclusion of surgical services at the first-referral level is critical. The purpose of this survey was to collect knowledge gained from comprehensive quantitative assessments of surgical capacity in sub-Saharan African countries such as Tanzania in order to assist in planning strategies for universal access to life-saving and disability-preventing surgical services.

MATERIALS AND METHODS

The WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care was developed as a comprehensive questionnaire to quantify the surgical capacity in a wide range of health facilities.[5] This online tool captures a health facility's capacity to perform basic surgical (including obstetrics and trauma) and anaesthesia interventions by investigating four categories of data: infrastructure, human resources, interventions available and equipment. The tool queries the availability of eight types of care providers, 35 surgical interventions and 67 items of equipment.

WHO situation analysis tool to assess Emergency and Essential Surgical Care was completed at 48 health facilities representing 16 of 26 regions in Tanzania. The health facility data were obtained during site visits by representatives from the Tanzania MoHSW, WHO country office and members of Global Initiative for Emergency and Essential Surgical Care (GIEESC) between March 2009 and October 2010. Data on various indices were entered into and analysed from WHO Global DataCol Database for Emergency and Essential Surgical Care (table 1). Some results, such as the average distance travelled prior to admission, were expressed as a weighted mean to better reflect the distance travelled by the average patient seeking surgical care in the country. To calculate the weighted mean, we summed the products of annual admissions and average distance travelled for each facility and then divided by the sum of annual admissions for all facilities.

By local convention, a physician who has trained in general surgery is considered a surgical specialist. Further specialisation, such as urologic, orthopaedic or cardiothoracic surgery, is termed as super specialty. Facilities were asked the size of the 'population served', intending to quantify the population living in the catchment area. This value thus represents the number of residents who would use the facility as their first-referral health facility, not the number of patients seen.

RESULTS

Forty-eight facilities, representing 16 of 26 regions and serving 18.6 million residents (46% of the population), completed the WHO Integrated Management for Emergency and Essential Surgical Care (IMEESC) Situational Analysis research tool. The average population served per facility was 425 000, though five facilities served 10 000 or fewer residents. A total of 9085 hospital beds were reported, averaging 189 beds per facility (range 15–350 beds). One hundred eighteen operating rooms were identified.

The weighted mean of distance travelled prior to admission was 119 km (74 miles). Figure 1 displays the locations of facilities with markers sized to the population served. This map demonstrates that the six facilities serving the largest population are located on the southern and northern periphery. The central regions are dominated by health facilities in rural areas serving small populations.

Annual admissions averaged 2001 per facility (range 350–5000). On average, 34% of all admissions required either minor or major surgical interventions.

A total of 4965 healthcare providers were reported in the 48 facilities. Sixty-four surgical specialists (ie, physicians with dedicated surgical training) were identified, and 56 (88%) of identified surgical specialists were employed by the six largest hospitals. The great majority of anaesthesia providers (176/203=87%) were non-physicians, and only 11 formally trained anaesthesiologists were identified. Other medical staff providing surgical and anaesthesia services in the facilities included 4017 assistant medical officers (non-physician medical officers, paramedics and midwives).

Of the 35 basic interventions listed in the tool, only suturing was available at all facilities. Additionally, incision and drainage, male circumcision and wound debridement were widely available and provided at 98%, 98% and 92% of facilities, respectively. Caesarean section was available at 67% of facilities.

Equipment was largely inadequate, including a significant gap in availability of functioning anaesthesia machines. Running water and electricity were widely available with only two facilities having no access to either water or electricity. However, only 37.5% of facilities reported both consistent running water and electricity. Greater than half of facilities reported never using eye protection and 46% reported no access to this critical piece of personal protective equipment. Six facilities had all essential equipment consistently available: Bombo Regional Hospital, Dodoma Regional Hospital, St Francis District Hospital, Ilembula Hospital, Besha Health Centre and Muhimbili National Hospital. Oxygen supplies were inconsistent in many facilities.

Table 1 Results of Situational Analysis Tool

			C	I	N
General and congenital					
		Blood bank	29	48	23
Personnel		Electricity	44	52	4
General physician performing surgery	113	Emergency guidelines	25	13	63
Non-physicians performing surgery	122	Emergency room	33	15	52
Paramedics and midwives	4017	Generator	58	2	40
Physicians trained in surgery (specialist)	64	Haemoglobin and urine analysis	96	4	0
		Medical records	98	2	0
Procedure	P	Running water	56	35	8
Appendectomy	69	Surgery guidelines	58	6	35
Biopsy	81	Cotton wool	77	21	2
Burn care	90	Adhesive tape	96	4	0
Cataract repair	35	Apron, plastic, reusable	81	15	4
Cleft lip repair	25	Bandages sterile	98	2	0
Congenital hernia repair	71	Batteries for flashlight	58	33	8
Cystotomy	63	Bucket, plastic	94	6	0
Hernia repair	69	Capped bottle, alcohol solution	79	13	8
Hydrocele	88	Disposable needles # 25, 21, 19	98	2	0
Incision and drainage	98	Drum for sterile dressings	83	8	8
Laparotomy	75	Examination table	90	10	0
Male circumcision	98	Eye protection	40	15	46
Neonatal surgery	35	Face masks	69	25	6
Suturing	100	Forceps, Kocher	73	19	8
Tubal ligation/vasectomy	71	Forceps, artery	81	10	8
Urethral stricture	46	Gloves (non-sterile)	92	8	0
		Gloves (sterile)	90	10	0
		Kidney dishes, stainless steel	88	13	0
		Light source (lamp and flashlight)	73	17	10
		Nail brush, scrubbing	85	10	5
		Nasogastric tubes 10 to 16 FG	71	17	13
		Needle holder	90	10	0
		Needles, cutting and round	94	6	0
		Retractors	77	17	6
		Scalpel handle with blade	94	4	2
		Scissors blunt 14 cm	83	15	2
		Scissors straight 12 cm	77	21	2
		Sharps disposal container	98	2	0
		Sheeting, plastic for exam table	65	23	13
		Soap	98	2	0
		Sterile gauze dressing	96	4	0
		Steriliser	85	13	2
		Suction pump (manual or electric)	96	4	0
		Suture, synthetic absorbable	90	10	0
		Syringes 10 ml	100	0	0
		Syringes 2 ml	100	0	0
		Thermometer	96	4	0
		Towel cloth	85	13	2
		Urinary catheter disposable #12, 14, 18	58	33	8
		Wash basin	94	4	2
		Waste disposal container	98	2	0
Anaesthesiology/airway management					
		Anaesthesia guidelines	27	4	69
Personnel		Anaesthesia machine	67	0	33
General practitioners performing anaesthesia	16	Blood pressure measuring equipment	98	2	0
Non-physicians performing anaesthesia	176	Cricothyroidotomy set	27	21	52
Physicians trained in anaesthesiology (specialist)	11	Endotracheal tubes, cuffed sizes 5.5 to 9	65	8	27
		Endotracheal tubes, uncuffed sizes 3.0 to 5.0	54	19	27

Continued

Table 1 Continued

			C	I	N
Procedure	P	IV cannula sizes 18, 22, 24	92	8	0
Airway foreign body	83	IV infusion set	90	10	0
Cricothyroidotomy	44	IV Infusor bags	73	10	17
General anaesthesia	65	Laryngoscope handle	71	15	15
Ketamine IV	67	Laryngoscope Macintosh blades (adult)	73	15	13
Regional anaesthesia	42	Laryngoscope Macintosh blades (paediatric)	46	21	33
Resuscitation	88	Magills forceps (adult)	56	27	17
Spinal anaesthesia	77	Magills forceps (paediatric)	38	23	40
		Mask and tubing to connect to oxygen supply	46	27	27
		Oropharyngeal airway (adult)	42	35	23
		Oropharyngeal airway (paediatric)	21	23	56
		Oxygen concentrator	75	13	13
		Oxygen cylinder	33	31	35
		Pain management guidelines	25	13	63
		Post-operative recovery room	29	10	60
		Pulse oximetry	13	4	83
		Resuscitator bag valve and mask (adult)	67	15	19
		Resuscitator bag valve and mask (paediatric)	38	17	46
		Scalp vein infusion set	98	2	0
		Spare bulbs and batteries for laryngoscope	44	27	29
		Stethoscope	98	2	0
		Suction catheter sizes 16 Fr	77	15	8
		Tongue depressor, wooden, disposable	83	13	4
Orthopaedics and traumatology					
		Radiography	33	44	23
Procedure	P	Chest tube insertion equipment	54	25	21
Chest tube placement	63	Splints for arm, leg	63	21	17
Clubfoot repair	35	Tourniquet	96	4	0
Contracture release	33				
Debridement	92				
Fracture management, closed	88				
Fracture management, open	61				
Joint dislocation reduction	92				
Limb amputation	65				
Osteomyelitis/septic arthritis	63				
Obstetrics/gynaecology					
		Vaginal speculum	90	10	27
Personnel					
Physicians trained in OBGYN (specialists)	74				
Procedure	P				
Caesarean delivery	67				
Dilation and curettage	77				
Obstetric fistula repair	21				

C, % of facilities with consistent access; I, % of facilities with intermittent access; N, % of facilities with no access; P, % of facilities which offer the procedure.

Twenty facilities (42%) had uninterrupted access to oxygen, with most relying on oxygen concentrators. Fifteen facilities (32%) had no access to an anaesthesia machine of any kind. Of all facilities surveyed, only six pulse oximeters were located. In Tanzania, the regional blood bank system is independent of any hospital facility and 77% of facilities reported having a blood bank. The x-ray was fully functional in 33% of facilities and interrupted in 44%, leaving 23% of facilities with no radiographic capacity. All facilities have access to haemoglobin and urine analysis testing.

Complete results from the evaluation are shown in table 1. Information was placed into one of four mutually exclusive and comprehensive medical fields. For simplification, in table 1, laboratory tests and other infrastructure (ie, blood bank, electricity) were included under equipment.

DISCUSSION

More than 5 million people die from injuries every year and many more are left with permanent disabilities. Significant disparities in care exist between high- and

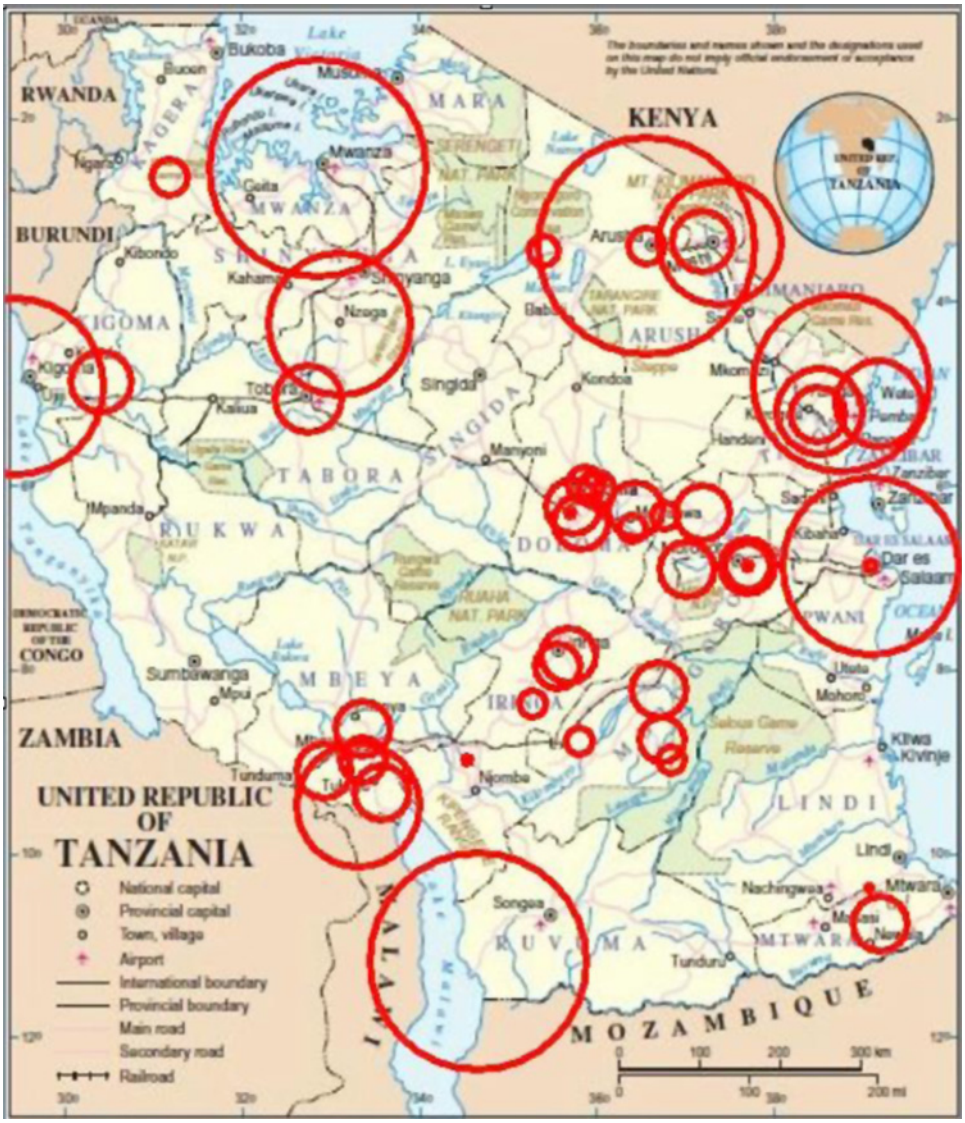

Figure 1 Facilities evaluated. Ring size proportional to population served.

low-income countries for patients with surgically treatable conditions. An estimate of the global burden of surgery showed that only 26% of estimated surgical procedures were performed in low-income countries, despite these countries accounting for 70% of the global population.[2] Of the estimated 536 000 maternal deaths in 2005, developing countries accounted for 99% of these deaths[6]; much of this mortality could be prevented by timely access to emergency and basic surgical services.

The provision of surgical services has historically been neglected in public health programmes.[7] It is often assumed that surgery and anaesthesia interventions are expensive, technologically demanding and can only be delivered in large hospitals and by specialists. However, limiting surgical care to large facilities in developing countries makes it inaccessible to the large segment of the population in decentralised areas. Experience shows that basic surgical services can be cost-effective and safely delivered even in settings with limited resources.[8]

Two studies have examined the cost-effectiveness of small hospitals performing basic surgical operations in resource poor settings.[9 10] The cost per DALY averted in each study for all patients seen was US$10.93 and US $32.78. Although these studies did not separate surgical from non-surgical patients in calculating cost/DALY, both hospitals had a significant percentage (29%–67%) of surgical diagnoses contributing to the calculation. These costs compare favourably with other primary health interventions in developing countries.[1]

WHO developed the IMEESC toolkit that has been implemented in 37 countries including Tanzania in January 2007.[5] Targeted activities to improve surgical capacity have included the formation of a formal 'Surgical Task force' in Tanzania MoHSW, training courses, the adoption of IMEESC toolkit by the Tanzania Surgical Association and hosting the biennial WHO GIEESC meeting in Dar es Salaam, Tanzania.

WHO GIEESC was established in 2005 as a collaboration of local and international organisations, academia, health authorities and WHO, in response to the recognition of surgery as a critical component of population based health.[5] The research arm of WHO GIEESC developed WHO situational analysis tool to provide data in surgical care capacity to assist ministries of health in

low- and middle-income countries for making evidence-based improvements.

This study provides an overview of the capacity for surgical care in 16 regions of Tanzania and demonstrates the significant gaps in infrastructure, human resources, life-saving and disability-preventive surgical interventions and essential equipment.

Despite the introduction of WHO programme for emergency and essential surgical care in Tanzania in 2007 and the efforts by the Tanzanian MoHSW to train non-physicians to deliver select surgical services such as caesarean sections, skilled health personnel to deliver surgical services remain inadequate for a significant portion of the country. This deficit is most pronounced in the rural areas, where patients travel great distances to reach health facilities and consequently face significant delays in care.

Although most facilities had a functioning operating theatre, fewer than half had uninterrupted access to oxygen and a third of facilities did not have access to an anaesthesia machine as is seen in many sub-Saharan African countries.[11] Significant improvements in surgical mortality in developed countries have resulted from improvements in the delivery of safe anaesthesia. The existing gap of safe anaesthesia services likely limits the availability of life-saving surgeries in Tanzania or results in significant complications and unnecessary patient suffering when anaesthesia is not available.

Of the 35 basic surgical interventions, many hospitals did not have the capacity to deliver all the basic services. As demonstrated in figure 2, this survey showed that facilities in the central and southern region had less capacity to provide basic surgical services. Additionally, the consistent lack of oxygen tubing, pulse oximeters and paediatric airway equipment is a significant barrier to the provision of life-saving services in the regions studied.

Delivery of surgical services is dependent on the availability of all components inherent in a functioning health system. Systematic changes that address human resources, supplies/equipment and infrastructure are necessary to improve mortality from surgically treatable conditions. The benefits of these changes will significantly impact the mortality of patients with obstetric-related emergencies and traumatic injuries, particularly women and children. However, the efforts made to improve disease-specific surgical interventions will not

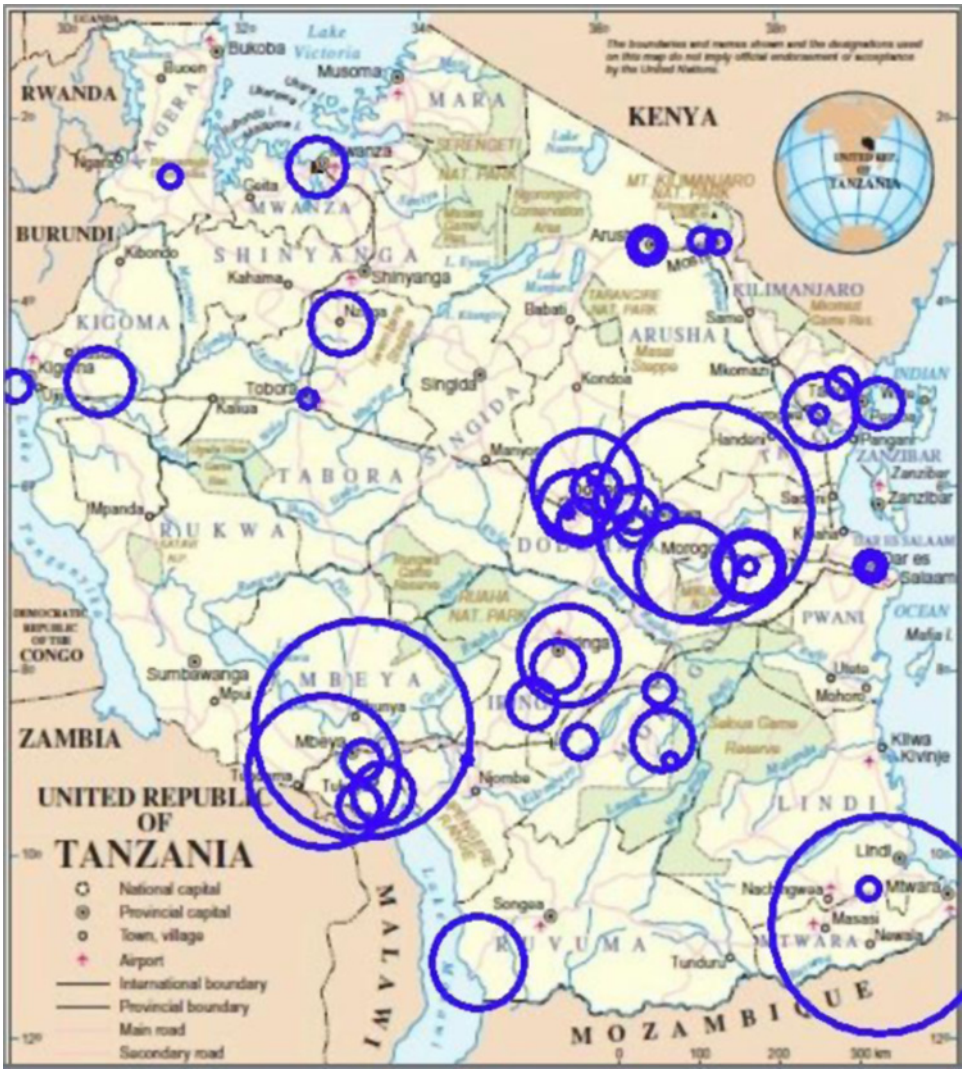

Figure 2 Rings sized on ratio of (population served: annual procedures). Large rings are underserved.

have an isolated impact on surgically treatable conditions and meet the Millennium Development Goals 4, 5 and 6. Systematic changes such as investments in oxygen and related equipment and appropriately trained surgical workforce will also serve to benefit patients suffering from a range of conditions including sepsis, pneumonia, HIV-related conditions and other infectious diseases.

There are several limitations to this survey. First, it provides only a brief overview of the capacity for surgical care and cannot be used for detailed programme planning. Second, an independent observer did not verify the answers provided in the survey by the health provider or director of the health facilities. Third, it does not capture data from every first-referral health facilities of the country.

This survey presents the first snapshot of life-saving surgical services in Tanzania using WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care. This snapshot view provides additional evidence that investments in human resources, essential equipment and infrastructure are needed to strengthen district surgical services in Tanzania to benefit rural population. Addressing the unmet need of surgical (including anaesthesia, obstetrics and trauma) services within existing related national programmes for maternal and child health will strengthen health systems, particularly at the district level.[12] These investments will have the secondary effect of improving the overall healthcare system and the treatment of many non-surgical conditions. Further research is needed to quantify the true burden of surgical disease in Tanzania and the cost–benefit of specific interventions to improve surgical services.

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Acknowledgements The following members of GIEESC in Tanzania were instrumental in obtaining the reported data: Professor Neboth Mbembati, Professor Victor Mwafongo, Dr Paul Mareale, Dr Jasper Mbwambo, Dr Amani Malima, Dr Mtumwa Ibrahim and Dr Rashid Mayoka.

Contributors TP analysed and interpreted the data, drafted the article, revised it and finally approved the submitted version. HC contributed to conception and design, acquisition and interpretation of data, made critical revisions and finally approved the submitted version. PK contributed to acquisition of data, made critical revisions and finally approved the submitted version. AM contributed to acquisition of data, made critical revisions and finally approved the submitted version. GS contributed to acquisition of data, made critical revisions and finally approved the submitted version. LN contributed to conception and design, interpretation of data, made critical revisions and finally approved the submitted version. SG contributed to conception and design, interpretation of data, made critical revisions and finally approved the submitted version. DHM contributed to acquisition of data, made critical revisions and finally approved the submitted version. MC contributed to conception and design, acquisition and interpretation of data, helped draft the article, made critical revisions and finally approved the submitted version.

Funding None.

Disclaimer The authors include staff members of WHO. They are responsible for the views expressed in this publication and do not necessarily represent the decisions or stated policy of WHO.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available, all has been included.

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"Thank you Dr Gosselin and Dr Silimperi for your comments. We agree with their suggestions and incorporated what we felt was appropriate for the scope of the paper. Dr Gosselin's reference was indeed incorrect and has been fixed. Dr Silimperi raised some very relevant points about the short-comings of the paper. We appreciated her suggestion about data ranges and we have included those ranges in the paper. Regarding participants medical qualifications, this highlights one of the great challenges of medical research in developing countries, the fact that every nation and region has different qualifications. All our on-site visits were performed by a licensed "western" physician (USA, Canada or Western Europe) or a local licensed physician. Plus, the survey tool was not designed to require an MD to complete, so we feel our survey personnel were adequate."

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

PAGE NUMBER	Item No	Recommendation
1 Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
2 Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
2 Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
3 Study design	4	Present key elements of study design early in the paper
3 Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
3 Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants
3 Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
3 Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
3 Bias	9	Describe any efforts to address potential sources of bias
3 Study size	10	Explain how the study size was arrived at
3 Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
3 Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses
Results		
3 Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
3 Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
4 Outcome data	15*	Report numbers of outcome events or summary measures
5-6 Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
N/A Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
7 Key results	18	Summarise key results with reference to study objectives
7, 8 Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
8 Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
8 Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
9 Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.