BMC Health Services Research

RESEARCH

Open Access

Assessment of surgical capacity and productivity in high-volume Ethiopian hospitals: mixed method study

Amare Hailekiros Gebregzi[1*], Elubabor Buno Teko[2], Abiy Dawit Tantu[3], Natinael Tesfaye Jale[3], Genanaw Kassie Getahun[4] and Yohannes Molla Asemu[5]

Abstract

Background In Ethiopia and other low-and middle-income countries, access to emergency and elective surgical care is still inadequate and inequitable. Ethiopia has initiated a nationwide strategic plan aimed at tackling obstacles within the surgical system. The aim of this study was to assess surgical and anesthesia care capacity and productivity in high volume Ethiopian hospitals.

Methods An explanatory mixed-methods study was conducted in 24 high-volume public hospitals across Ethiopia's 10 regions and 2 city administrations. Data were collected through structured document reviews, site observations, and interviews using a validated WHO-aligned tool. Quantitative data were analyzed using SPSS, and qualitative responses were thematically analyzed using ATLAS.ti.

Results Addis Ababa hosts over 60% of the national surgical workforce, highlighting stark regional disparities. While 80% of hospitals reported adequate infrastructure, site observations revealed functional inconsistencies in PACU design, sterilization units, and equipment availability. Only 77% of hospitals consistently implemented patient monitoring and handover protocols. Surgical productivity was low, with an average of 2.5 surgeries per week per clinician and 52.39% annual workforce productivity. Best practices included the use of EMRs, backlog-reduction campaigns, and daily interdisciplinary briefings. However, persistent challenges included inadequate staffing, poor infrastructure, and uneven adoption of safety protocols.

Conclusion and recommendation Ethiopia's surgical system shows promising innovations in select hospitals, yet national scale-up is hindered by infrastructure gaps, uneven workforce distribution, and inconsistent safety practices. Addressing these challenges requires data-driven planning, targeted investment in underserved regions, and expanded use of digital systems and collaborative networks to promote best practice adoption across facilities.

Keywords Surgical and anesthesia workforce, Infrastructure, Productivity, Ethiopia

*Correspondence:
Amare Hailekiros Gebregzi
amaretom22@gmail.com
[1]USAID Enhanced Anesthesia Activity, Ethiopian Association of Anesthetists, Addis Ababa, Ethiopia
[2]Medical Service Lead Executive Office, Federal Ministry of Health, Addis Ababa, Ethiopia
[3]Medical Service Hospital and Diagnostic Desk, Federal Ministry of Health, Addis Ababa, Ethiopia
[4]Research and Community Service Directorate Office, Menelik Health Science College, Addis Ababa, Ethiopia
[5]USAID Health Workforce Improvement Program, Jhpiego Ethiopia, Addis Ababa, Ethiopia

Background

Surgical conditions account for more than 30% of the worldwide disease burden [1, 2]. It is estimated that five billion people lack access to safe, affordable surgical and anesthesia care when needed [3, 4]. This access gap leads to substantial preventable morbidity and mortality, especially in low and middle income countries (LMICs) [5, 6]. The Lancet Commission on Global Surgery demonstrates that universal access to safe, affordable surgical and anesthesia care saves lives, promotes health, and fuels economic growth [7].

However, huge unmet needs persist globally, with the poorest third of the world's population receiving just 6% of surgical procedures done worldwide [8]. Addressing this inequity can avert an estimated 1.5 million deaths a year [9, 10]. Ethiopia carries approximately 0.5% of the global burden of surgical disease, with recent efforts to accelerate surgical capacity through infrastructure and workforce initiatives [11]. However, system-wide data on existing gaps constraining access remain limited.

The Lancet Commission predicts that addressing unmet surgical needs globally could liberate over $350 billion in economic productivity annually, making the economic evidence for surgical system strengthening effective return of investment [12]. A study indicated that the correction of cleft lip and palate produces health returns that are fifteen times higher than the initial investment [13].

The poor baseline access in Sub-Saharan Africa including Ethiopia makes data-driven systems design vital for the growth of surgical services [14]. Approximately 93% of Ethiopians lack access to timely, affordable safe surgery and anesthesia care – only half of primary health care health facilities nationwide can provide Bellwether procedures like laparotomy or open fracture fixation [15]. In addition, there is a significant unmet gap in surgical capacity, with surgical bed to population ratio at 0.03:1000 and surgical volume to population ratio at 189:100,000 [16].

However, in just five years between 2012 and 2016, the rate of change is accelerating: the volume of surgeries performed increased by 73%, the number of facilities expanded by 15%, and the percentage of cesarean deliveries proceeded from 2% to over 8% [17]. Nevertheless, intraoperative mortality also remains high at 285 per 100,000 cases indicating patient safety and quality challenges [18]. Significant disparities in access and outcomes also persist between urban and rural geographies [19].

These trends spotlight the need for a systematic data on countrywide capacity to inform strategic investments. Moreover, priorities can be identified using validated metrics on the current infrastructure for surgery and anesthesia, staff availability and distribution, variations in the adoption of best practices for patient safety, gaps in perioperative monitoring capabilities, and post-operative care infrastructure [20].

To support progress toward universal health coverage, the Federal Ministry of Health of Ethiopia launched a nationwide joint supportive supervision initiative to strengthen service delivery. Previous applications of this approach have improved infection prevention and control [21] monitoring and evaluation [22], and neonatal sepsis management [23]. This study builds on those successes by assessing surgical and anesthesia capacity in high-volume hospitals to inform quality improvement, resource allocation, and workforce planning. Therefore, the aim of this study was to assess the surgical and anesthesia capacity of health facilities with high surgical volume in Ethiopia, in 2023.

Methods and materials

The survey was conducted in 10 regional states and 2 city administrations of Ethiopia. Ethiopia is located in the Horn of Africa and has an area of around 1.1 million square kilometers. Administratively, the country is organized into eleven regional states and two city administrations. According to the World meters report the population of Ethiopia is estimated to be 129,076,230.

An explanatory mixed method study was carried out and the joint supportive supervision exercise was held over a period of two months in November and December 2023. A convenience sampling technique was used to pick 24 out of the 28 Ethiopian public hospitals that were identified to have a high surgical volume. We included comprehensive specialized and general hospitals distributed across regions and administrative boundaries in all ten regional states and two city administrations. This allowed for an assessment of heterogeneity across different competency levels and regions, covering more than 80% of the national surgical volume.

The surgical and anesthesia workforce distribution, infrastructure adherence and surgical productivity were considered as an outcome variable. Whereas the independent variables of this study include,

- General information like name of health facility, date of visit, region, number of surgical work forces, number of functional operating tables, functional centralized sterilization room, etc.
- Post anesthesia care unit capacity assessment including availability of post-anesthesia care unit, formal handover of patients by the responsible anesthetist, availability of trained staff, etc.
- Anesthesia workforce assessment such as availability of diploma (Nursing plus 1 year of anesthesia training) & level V Anesthetists (Diploma in Nursing plus 2 years of anesthesia training), BSc Anesthetists, MSc Anesthetists, and Anesthesiologists.

Surgical workforce the total number of surgical specialists that are available, such as obstetrician-gynecologists, integrated emergency surgical officers (IESO), general and subspecialty surgeons and anesthetists [24, 25].

Surgical productivity was defined as the concurrent achievement of two WHO benchmarks: (1) ≥ 5,000 annual surgical procedures per 100,000 population (verified through theater logs) and (2) ≥ 20 surgical/anesthetic/obstetric specialists per 100,000 population (verified through workforce inventories), with both metrics adjusted for each facility's catchment population [26–28].

The assessment utilized a standardized tools and metrics focused on facility-level availability of trained workforce and infrastructure capacity relevant to safe surgery and anesthesia provision. The data collection instrument was adopted from WHO surgical assessment tool and World Federation of Anesthesiologists anesthesia facility assessment toolkit, customized for the Ethiopia context. The draft tool went through two rounds of Delphi technique expert review to refine the questions, achieving 94.4% consensus in the final version. The study utilized a structured 79-item assessment tool comprising five sections: (1) General Information and Surgical Workforce (13 items capturing facility demographics and staffing) (2), Operational Infrastructure and Standards (43 items evaluating facility readiness, protocols, and compliance) (3), Surgical Volume and Capacity (9 items quantifying procedural output) (4), Surgical Productivity (8 items analyzing operating table utilization), and (5) Qualitative Research Questions (6 open-ended items exploring contextual challenges and innovations). The tool was digitalized into a tablet-based format for standardized data capture across sites. Data collection teams comprised nurses, anesthetists, surgeons, and planning heads from regional health bureaus and Federal Ministry of Health Ethiopia. The data collectors were trained in a half-day workshop on the assessment framework, methods and tools.

The data collection process involved.

1. Document Review - Review of pertinent surgical, anesthesia, and quality documents was conducted; these included clinical manuals, standard operating procedures, and indicators monitored by healthcare facilities.
2. Direct Site Observation - Systems and procedures, infrastructure accessibility, workflows, and processes were all meticulously examined.
3. Interview - To obtain further practical insights, structured questionnaires were used to interview surgical workforces and leaders to identify the best practice and prominent gaps identified on their health facilities surgical care as a qualitative data.

This three-pronged approach enabled triangulation of findings to improve validity and reliability. Regional and national stakeholders provided consultative inputs to validate interpretations support contextualization. The insights aim to inform strategic planning and coordinated efforts to strengthen comprehensive capacity.

For the qualitative component, semi-structured interviews were conducted with key informants using a predefined guide covering six domains: digital tools, surgical efficiency, leadership, infrastructure challenges, staffing issues, and local innovations. Interviews were performed in participants' preferred language (Amharic or English) by trained bilingual researchers, with real-time transcription and immediate respondent verification. Transcripts underwent further validation through structured review by three stakeholder groups: frontline surgical staff, quality improvement teams, and hospital administrators.

Data entry and analysis were done using MS excel, ODK and Statistical Package for Social Sciences (SPSS) version 26. Data analysis involved simple descriptive statistics, summary visualizations and qualitative synthesis. For the qualitative data, the analysis employed ATLAS.ti for inductive thematic analysis following Braun and Clarke's framework [29]. Two researchers independently coded transcripts, with iterative theme development incorporating feedback and validation with participating facilities' during debriefing sessions. The compiled findings are structured across health system domains fundamental to safe surgical and anesthesia services delivery.

Ethical approval was obtained from Ethiopian Association of Anesthetists institutional research ethics review committee. Informed consent was obtained from all participants prior to their involvement in the study.

Results

Surgical workforce

Addis Ababa has the highest number of surgical workforces in Ethiopia with more than 60% of the national capacity. Tikur Anbessa as the main specialized teaching hospital has the highest number of surgeons (67), OBGYNs (23), anesthesiologists (15) and OR nurses (135). Conversely, Zewditu memorial hospital (ZMH), Yekatit 12 and Menelik comprehensive specialized hospital have significantly fewer specialists in these categories with less than 35 staff each. Overall, there is uneven distribution of critical workforce for surgery across hospitals in the capital city in the sampled high volume comparable hospitals (Fig. 1).

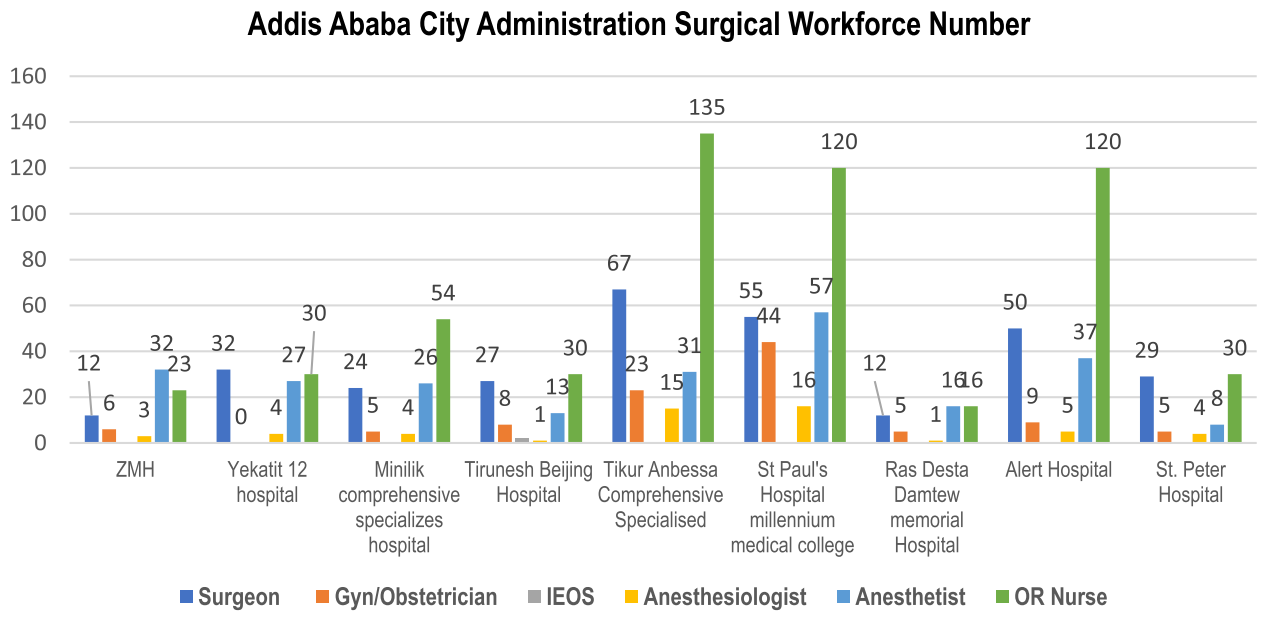

Fig. 1 Surgical workforce in the Addis Ababa city administration, January 2024. (IEOS -Integrated Emergency Surgical Officer)

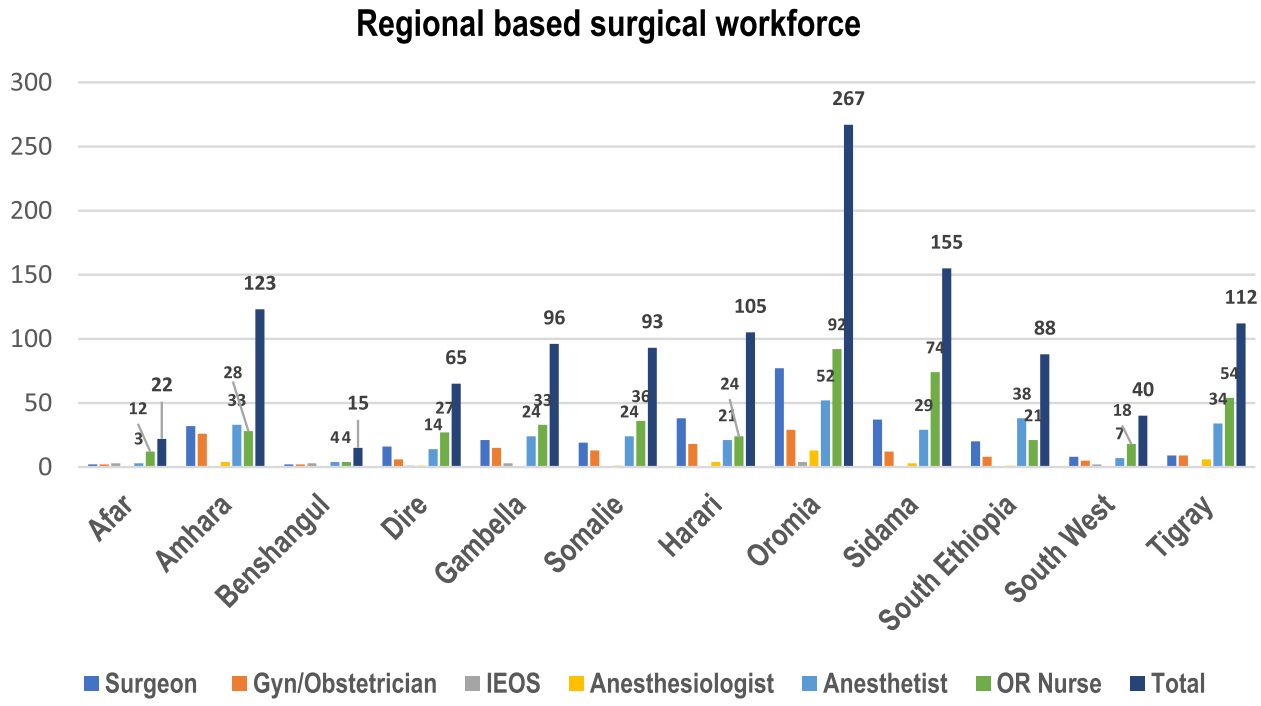

Fig. 2 Regional surgical workforce disparity, January 2024. (IEOS -Integrated Emergency Surgical Officer)

Regional surgical workforce disparity

There were notable differences in the surgical workforce distribution between Ethiopia's regions. Addis Ababa has the highest number of surgeons (308), OBGYNs (105), Integrated Emergency Surgical Officers (IESO) (2), anesthesiologists (53), anesthetists (247) and OR nurses (558). In contrast, emerging regions like Afar, Gambella, Harari and Sidama have less than 40 total surgical workforces. Three regions - Amhara, Oromia and South Ethiopia - have over 100 total surgical workforces. Overall, uneven distribution of specialized surgical labor for safe surgery and anesthesia were identified (Fig. 2).

Operating room infrastructure

We did a critical infrastructure capacity assessment using the four main areas, namely functional sterilization services, blood bank services accessibility, operational

theater table functionality, and availability of functional laundry equipment for sterile processing requirements.

According to the findings, most hospitals surveyed 19 (80%) have sufficient infrastructure in place for all categories. This suggests that the majority of facilities have central sterilization rooms for instrument processing and sterilization, regular access to blood bank services, functional operating tables and laundry facilities available for thoroughly cleaning medical supplies.

Specifically, 96% of hospitals (23 out of 24) demonstrated fully functional central sterilization rooms (CSRs) capacity for sterilizing medical equipment. 88% (21 hospitals) also confirmed adequate access to blood bank services for transfusions when clinically necessary and 76% of facilities had laundry equipment in working for sanitization.

According to this survey, there were twenty fully functioning operation theater tables in the Tikur Anbessa specialized hospital. Conversely, Gambella Town Hospital stated that it has just one functional OR table (Fig. 3).

Key patient monitoring and anesthesia care protocols availability and utilization

Regarding patient monitoring and assessment of anesthesia care protocol, every hospital surveyed reported that regular pre-anesthesia evaluation and basic intraoperative anesthesia monitoring services were carried out at all times. Particularly, continuous patient monitoring using pulse oximetry, blood pressure and circulation monitoring during anesthesia, and the availability of audible monitor signals in the operating room were stated as always implemented. But in certain areas, such as post-operative ventilation, a handover protocol for the transfer of postoperative patients, and post-operative pain evaluation score were found to be performed poorly. The overall evaluation of hospital performance regarding patient monitoring and anesthesia treatment protocols reveled that, 77% of hospitals reported always, 13% some times, and 15% never (Fig. 4).

Compliance with post anesthesia care unit (PACU) standards

The evaluation of PACU standards demonstrated partial compliance with established guidelines. While facilities successfully maintained proper medication administration and continuous vital sign monitoring, and ensured PACUs were strategically located near operating theaters, several critical deficiencies were identified. Notably, many units lacked staff certified in basic and advanced life support, failed to consistently implement patient privacy protocols, and did not meet the recommended 1:2 staff-to-patient ratio. These gaps represent significant risks to postoperative patient safety and underscore the urgent need for targeted improvements in staffing and protocol adherence (Fig. 5).

Design and features of PACU

The design and features of the PACU were evaluated, and the adequacy of space allocated per bed at the patient head, as well as the availability of a PACU isolation room for infection control, were found to be

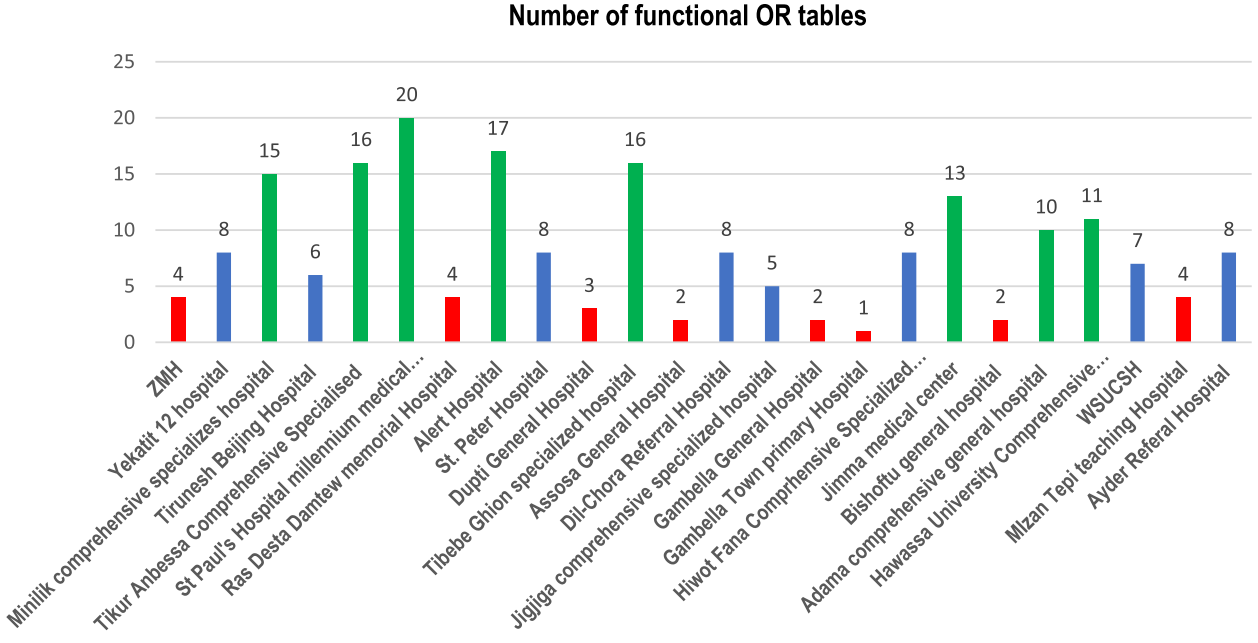

Fig. 3 Number of functional OR tables, January 2024. ZMH - Zewditu memorial hospital, WSUCSH – Woliyta Sodo University Comprehensive Specialized Hospital

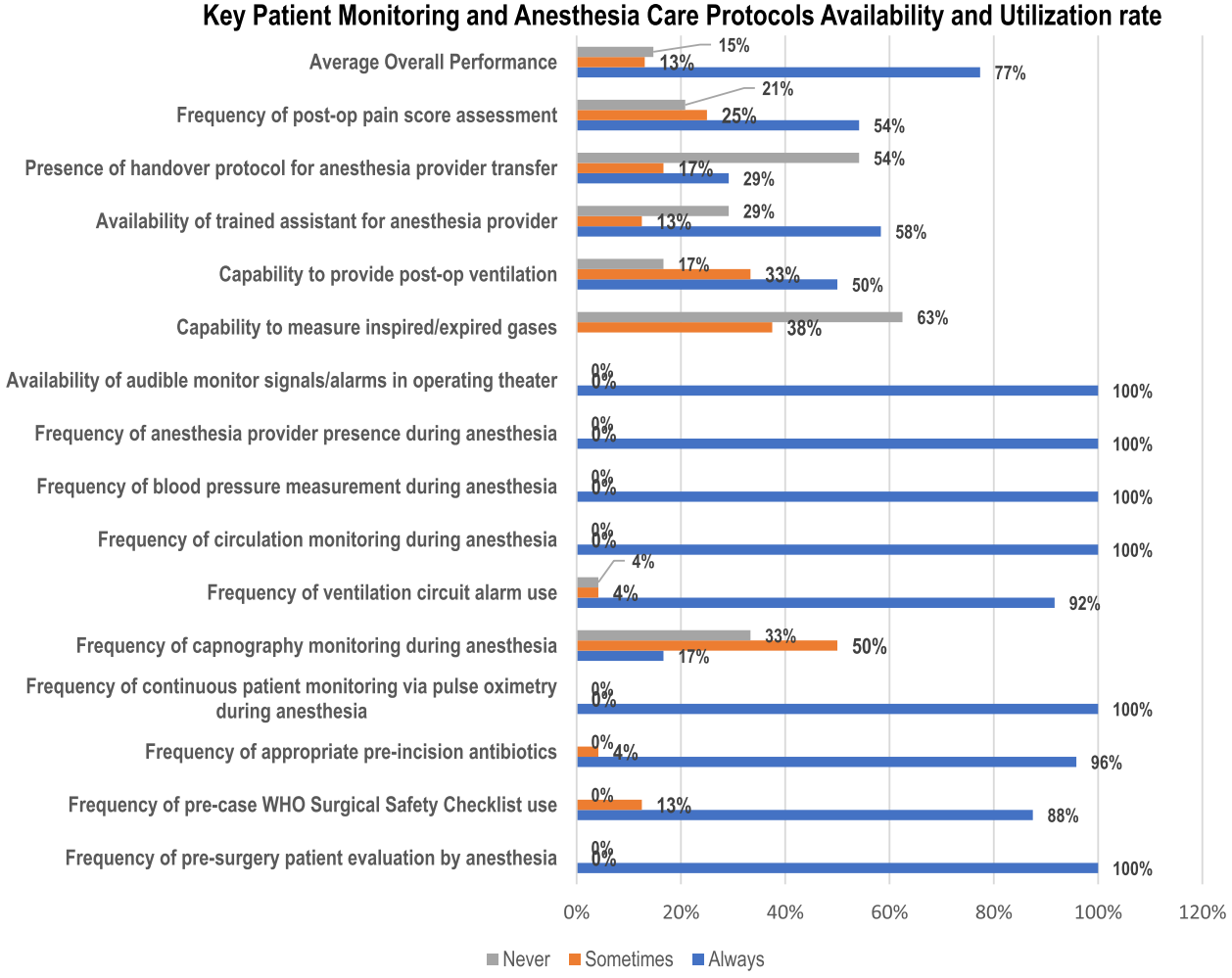

Fig. 4 Key patient monitoring and anesthesia care protocols availability and utilization, January 2024

relatively superior (77%). However, just half (50%) of the mechanisms for promptly evacuating patients during an emergency were discovered to be operational (Fig. 6).

PACU standard compliance per bed

According to the results of this survey, the PACU standard compliance aspects of pulse oximetry monitoring, stethoscope, blood pressure monitoring, and sufficient lighting were determined to be properly applied. However, there was a significant scarcity of vital equipment like perfusor, defibrillator, ECG, and refrigerator (Fig. 7).

Surgical volume and productivity

The overall surgical work force (all surgeons and anesthetists) working in the 24 high volume hospitals in Ethiopia were 1432. The average weekly surgical performance was 2.5 surgeries. Anesthetists, surgeons, and nurses' weekly surgical performance were 5.9, 4.3, and 3.7 respectively. Moreover, the average annual productivity of all surgical work forces was 52.39% (Table 1).

Functional operating tables productivity

In the study facilities, by 198 functional operating tables a total of 187,548 surgical procedures were performed annually. The surgical OR production per OR table was also estimated based on the surgical volume for ten days, and it indicated that on average 25 and 35 major surgeries were performed in the specialized and general hospitals per table every ten days respectively. Moreover, public specialized hospitals and general hospitals contributed to 83.5% and 16.5% of the total surgical volume respectively (Table 2).

Qualitative findings on best practices and enabling factors for surgical services

A thematic analysis of qualitative data collected from all 24 hospitals revealed three major themes

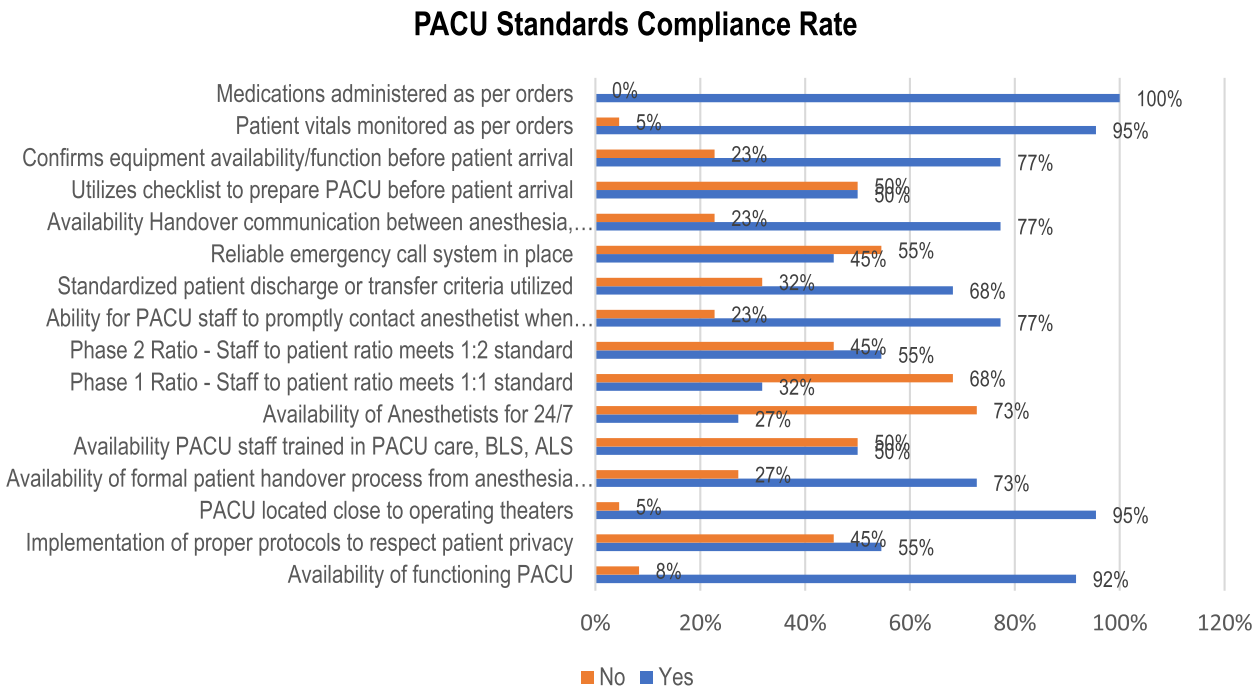

Fig. 5 3.4. Compliance with Post Anesthesia Care Unit (PACU) Standards, January 2024. BLS - Basic Life Support, ALS - Advanced Life Support

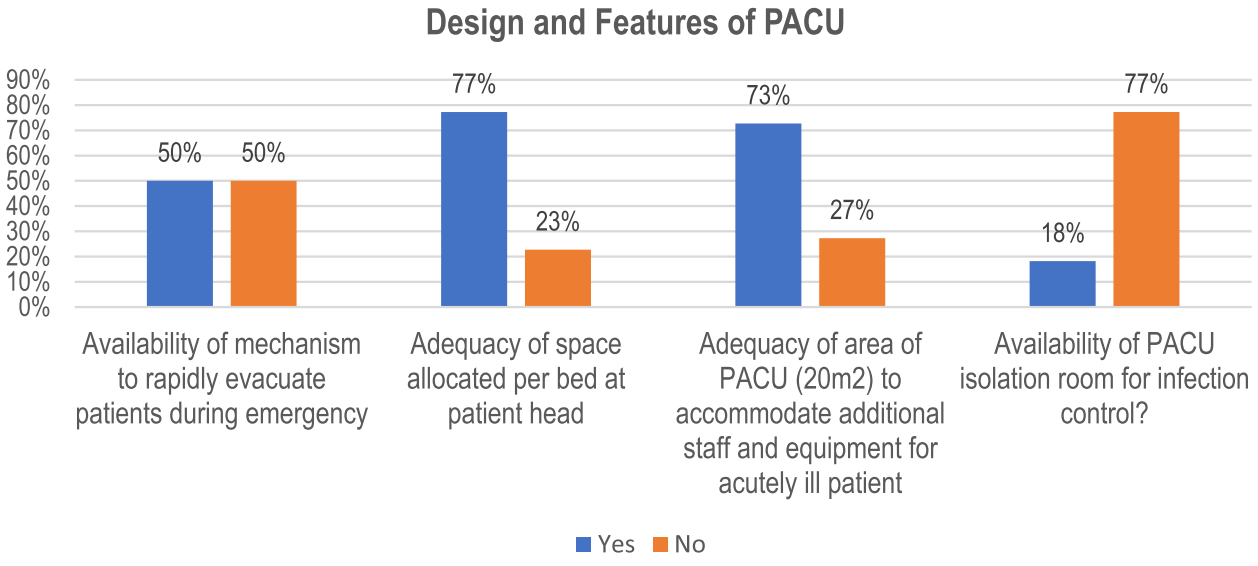

Fig. 6 Design and features of PACU, January 2024

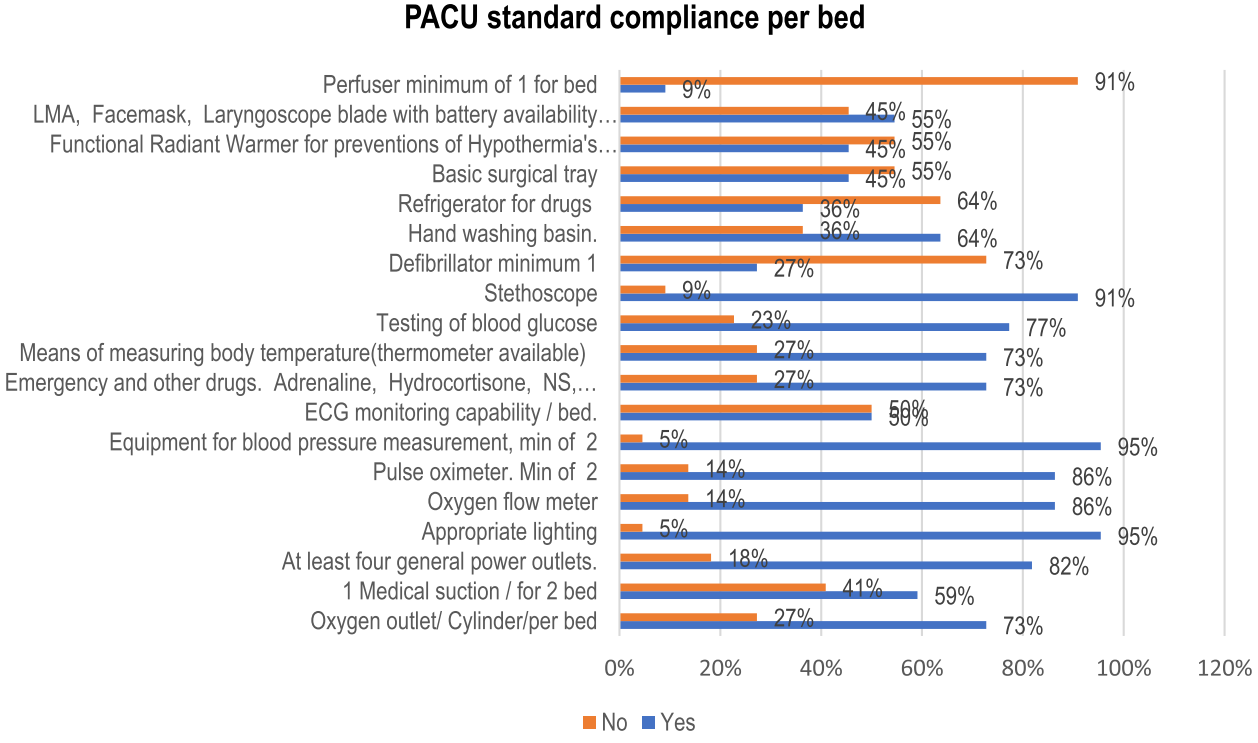

Fig. 7 PACU standard compliance per bed, January 2024

contributing to enhanced surgical services: Digitalization and data system, surgical efficiency and backlog reduction, and leadership, teamwork and communication. These enablers were consistently reported as practical solutions to improving the efficiency, and capacity of surgical services.

Digitalization and data systems

Many facilities have adopted electronic medical records (EMR), dashboards, and scheduling tools to streamline operations and improve transparency in the OR.

"In our hospital, we have integrated fully functional EMR in all service areas." – Staff, Tirunesh Beijing Hospital
"We have impressive utilization of dashboard for tracking surgical indicators." – Quality Officer, Tibebe Ghion Specialized Hospital
"We institutionalized an email-based OR scheduling system to avoid overlaps and delays." – OR Coordinator, Jimma Medical Center
"EMR supports our weekly KPI discussions. Data is instantly available." – Data Manager, Ras Desta Damtew Memorial Hospital
"Our anesthesia and surgical teams now enter postoperative orders/notes directly into the EMR." – Clinician, Tikur Anbessa Specialized Hospital

Surgical efficiency and backlog reduction

Hospitals implemented various measures to reduce surgical backlogs, including surgical campaigns, better handover mechanisms, and expanded operating hours.

"A surgical campaign has been held every weekend to address the backlog of cases." – OR Nurse, Yekatit 12 Hospital
"We have short waiting time for surgery—less than 4 days." – Administrator, Hiwot Fana Comprehensive Specialized Hospital
"The waiting time for elective surgery is less than 3 days. We organized this through a backlog-clearing campaign." – Surgical Coordinator, Dil-Chora Referral Hospital
"We conduct early morning surgeries at 1:30 AM to maximize operating time." – Staff, Yekatit 12 Hospital
"Daycare surgeries are increasing; this frees space for more complex cases." – Nurse, Minilik Hospital

Leadership, teamwork, and communication

Strong leadership and interdisciplinary collaboration were commonly associated with improved efficiency and responsiveness in surgical services.

"OR managers instituted a daily performance monitoring channel to track issues in real time." – OR Team Lead, St. Paul's Hospital Millennium Medical College
"The medical director follows each OR activity closely with the OR manager. This keeps everyone accountable." – Senior Surgeon, Tirunesh Beijing Hospital
"Leadership commitment contributed to improved surgical outcomes and productivity in our hospital." – OR staff, Gambella Town Hospital
"We have daily interdisciplinary briefings that help flag any safety concerns early." – Nurse, St. Peter Hospital
"Teamwork here is exceptional. Everyone respects the surgical schedule and helps each other." – Staff, Zewditu Memorial Hospital

Table 1 Annual surgical volume and productivity, January 2024

Name of surgical workforce	Number of surgical workforces	Total surgeries per year	Total surgeries performed Per year per individual	Total surgeries performed per month per individual	Total surgeries performed per week per individual	Total surgeries performed per day per individual	Total expected surgical volume per year	Surgical productivity
Surgeon /Gyn./IESO*	830	187,548	225.9614	18.83012	4.345412	0.619072	207,500	**52.39%**
Anesthetist	602	187,548	311.5415	25.96179	5.991183	0.853538	150,500	
OR Nurse	967	187,548	193.9483	16.16236	3.729775	0.531365	241,750	
All SWF	1432	187,548	130.9693	10.91411	2.51864	0.35882	358,000	

All SWF: includes only Surgeon /Gyn./IESO and Anesthetists, IESO – Integrated Emergency Surgical Officer

Qualitative findings on major challenges observed in surgical care systems

Thematic analysis of qualitative responses from facility staff revealed two major challenge areas affecting surgical care delivery across high volume Ethiopian hospitals, inadequate infrastructure and facility conditions, and human resource shortages and inconsistent deployment. Direct quotations from staff are included to reflect the lived realities and operational bottlenecks they encounter.

Inadequate infrastructure and facility conditions

Health workers frequently described structurally deficient facilities, overcrowded operating rooms, and poorly designed perioperative spaces.

"Our operation rooms are very narrow and overcrowded, and the PACU is not even close to the OR. It's a huge barrier during emergencies." – Staff, Dil-Chora Referral Hospital

"The OR floor is cracked, the lighting is poor, and only one operation table is functional. We revisit HYPOXY standards, but nothing changes." – Nurse, Mizan Tepi University Teaching Hospital

"There is no proper demarcation of OR zones, no preparation room, and the central sterilization unit is substandard." – Team Lead, Tikur Anbessa Hospital

Human resource shortages and inconsistent deployment

There were widespread reports of inadequate staffing, unfilled posts, and inconsistent deployment, especially among anesthetists, OR nurses, and PACU staff.

"We are short-staffed on every shift. One PACU nurse is expected to monitor two to three beds with no support." – Nurse, Mizan Tepi University Teaching Hospital

"We don't have enough anesthetists or trained ENT and plastic surgeons. This backlog keeps growing, and we can't keep up." – OR Coordinator, Yekatit 12 Hospital

"Every year trained staff rotate out. We train them, and then we start over. There's no continuity." – Supervisor, Jimma Medical Center

"There is no anesthetists assigned to PACU, and no protocols in place. We do what we can, but it's not safe." – Clinician, Hawassa University Comprehensive Specialized Hospital

Discussion

This national-level assessment of surgical capacity and productivity across 24 high-volume hospitals in Ethiopia highlights significant structural, workforce, and operational variations that continue to shape the delivery of essential and emergency surgical care. Using a mixed-methods approach grounded in WHO frameworks, this study provides a comprehensive view of the enablers and barriers to surgical system performance. Ethiopia's health care workforce and infrastructure is still being developing and is often inadequate, much as in most low-income countries [19].

Table 2 Functional operating tables' productivity, January 2024

Level of Health Facilities	Number of Facilities	Number of OR Tables	Average OR Tables per Facility	Total Surgeries in 365 Days	Total Surgeries in 10 Days	Average Surgeries per OR Table for 10 Days,	Average Surgeries per OR Table per Day
Specialized hospital	16	174	11	156,654	4292	25	2.5
General hospital	8	24	3	30,894	846	35	3.5
Total	24	198	198	187,548	5138	60	6

Disparities in surgical workforce distribution and productivity

The findings of our study highlight significant inequities in the distribution of Ethiopia's surgical workforce, with pronounced geographical disparities. Over 60% of the nation's surgical workforce are concentrated in Addis Ababa, with Tikur Anbessa Specialized Hospital alone accounting for the highest proportion of specialized providers [30]. In stark contrast, emerging regions such as Gambella, Afar, Harari, and Sidama report fewer than 40 surgical staff in total. These disparities align with existing evidence demonstrating persistent workforce imbalances despite national efforts to improve surgical capacity through strategic health sector reforms [16]. The surgical workforce to population ratio varies widely, ranging from 1.13:100,000 in public specialized hospitals to 10.8:100,000 in health center operation room blocks [16]. Such inequalities extend beyond workforce distribution, reflecting broader systemic gaps in healthcare infrastructure, resource allocation, and surgical outcomes [31]. Notably, the Gini index for specialist physicians (0.704) underscores severe inequity in workforce distribution, surpassing disparities observed among other healthcare cadres [31]. These imbalances pose a critical barrier to equitable healthcare access and optimal surgical outcomes, necessitating strengthened monitoring mechanisms and systemic efficiency improvements to ensure timely and safe surgical care nationwide [30, 32].

The underrepresentation of surgical workforce in rural and underserved regions remains a major impediment to achieving universal access to essential surgical services [33]. While Ethiopia has made efforts to train non-physician providers (Integrated Emergency Surgical Officers, or IESOs), additional cadres are required to bridge the surgical workforce deficit [34]. In line with previous studies., our findings emphasize the need for targeted recruitment and retention strategies, particularly in underserved regions, to achieve WHO-recommended surgical workforce density benchmarks [35].

Despite incremental increases in surgical workforce density, overall productivity remains suboptimal, with facilities performing an average of two surgeries per day and an annual productivity rate of 52.39%. General hospitals demonstrate marginally higher efficiency (3.5 surgeries/day) compared to specialized hospitals (2.5 surgeries/day), suggesting potential operational inefficiencies in tertiary referral centers [30]. Contributing factors include high case cancellation rates (35.8%), delayed procedure initiations, and prolonged operating room turnover times [36]. Persistent challenges such as workforce shortages, equipment scarcity, and inadequate infrastructure further constrain surgical output, with specialist-to-population ratios as low as 0.58 per 100,000 in some regions [37]. Compounding these issues are systemic barriers, including weak patient safety cultures, communication gaps, and sociopolitical instability, all of which hinder progress toward surgical system strengthening [37]. A comprehensive, multi-sectoral approach encompassing workforce expansion, infrastructure investment, and process optimization, is imperative to enhance surgical capacity and efficiency across all regions.

Infrastructure capacity and functional constraints

Although 80% of hospitals reported having adequate infrastructure in key domains—sterilization, laundry, OR tables, and blood bank services—the qualitative findings highlight a nuanced reality. Several facilities described deteriorating infrastructure, overcrowded OR spaces, and insufficient post anesthesia care (PACU) design. In some hospitals, staff reported, *"The OR floor is cracked, the lighting is poor, and only one operation table is functional."* (Mizan Tepi Hospital). This indicates that while infrastructure may exist in form, functionality and maintenance are inconsistent.

The lack of basic PACU infrastructure and essential clinical resources, such as emergency equipment, trained personnel, and standardized protocols, emerged as a consistent concern. Similar findings have been reported in assessments from Ethiopia and Guatemala, where critical shortages of equipment, medications, and skilled providers were observed [38, 39]. In this settings, only 17% of hospitals had end-tidal carbon dioxide detectors, while postoperative care and resuscitation equipment were lacking [38]. Likewise, in rural Southeast Nigeria, hospitals encountered challenges related to unstable electricity, inadequate water supply, and limited access to blood banking services [40].

Quality and safety protocols: gaps in implementation

While all surveyed hospitals reported adherence to intraoperative monitoring and anesthesia care standards, significant gaps were observed in postoperative protocols, including ventilation, pain scoring, and patient handover mechanisms. Only 77% of facilities reported consistent use of such protocols, and many lacked standardized operating procedures (SOPs) and handoff tools. As a clinician from Hawassa University noted, *"There is no anesthetist assigned to PACU, and no protocols in place. We do what we can, but it's not safe."* These findings highlight a critical implementation gap that undermines continuity of care and compromises patient safety, particularly in high-volume and resource-constrained settings.

Similar gaps have been widely reported in the literature. Studies from Ethiopia and other LMICs have consistently documented poor uptake of postoperative care protocols, limited use of the WHO Surgical Safety Checklist, and inconsistent application of handover and pain management practices [41–43]. Contributing factors include inadequate continuing medical education, insufficient access to essential equipment and medications, and the absence of institutionalized quality improvement frameworks [44]. Addressing these barriers through standardized protocol implementation, capacity-building, and integration of quality improvement tools is critical to improving perioperative outcomes in LMIC surgical systems.

Best practices and local innovations

Despite systemic limitations, several hospitals demonstrated effective local innovations that enhanced surgical efficiency and patient outcomes. The adoption of electronic medical records (EMRs) and dashboards was among the most frequently cited enablers. As reported by staff at Tirunesh Beijing Hospital, *"We have integrated fully functional EMR in all service areas,"* with similar accounts highlighting improved scheduling, data tracking, and performance monitoring. These findings align with global evidence indicating that EMRs can improve patient safety, quality of care, and operational efficiency [45]. Although barriers such as limited training, technical support, and infrastructure often hinder EMR implementation in low-resource settings [46, 47], some Ethiopian hospitals have successfully adapted these systems to their contexts [36], illustrating the feasibility of digital health transformation in LMICs.

In addition, several hospitals implemented backlog reduction strategies, including weekend surgical campaigns and extended OR hours, as observed at Yekatit 12 Hospital. These efforts significantly reduced waiting times and increased surgical throughput—approaches consistent with literature advocating for improved evaluation workflows, punctual start times, and optimized staffing to enhance OR utilization [36]. Leadership and teamwork also played a central role, with facilities like St. Paul's Hospital using daily performance monitoring and interdisciplinary briefings to streamline operations. These practices reflect broader global findings that highlight leadership and collaborative care as critical enablers for quality improvement in surgical systems reinforcing the importance of systems-based approaches in strengthening surgical capacity in resource-constrained settings [48].

Human resource challenges

Shortages of trained personnel, particularly in PACUs and anesthesia care, were widely reported across facilities, with inconsistent staffing and frequent rotation undermining service continuity. As one nurse from Mizan Tepi Hospital stated, *"One PACU nurse is expected to monitor two to three beds with no support."* In several hospitals, the absence of bachelor- or master-level anesthetists led to reliance on diploma-level providers without adequate supervision or protocols, posing serious risks to patient safety.

These challenges are consistent with findings from other LMICs, where limited anesthesia workforce capacity is linked to poor perioperative outcomes [49, 50]. Studies from Ethiopia and beyond highlight concerns over training quality, workforce retention, and lack of essential equipment [37, 51]. Addressing these issues requires scaling up training programs, enhancing supervision, and adopting context-specific strategies such as simulation-based learning to strengthen perioperative care in low-resource settings [50].

Implications for policy and practice

This study underscores the importance of regionally tailored health workforce planning, supported by infrastructure investments and the standardization of surgical protocols. Horizontal learning mechanisms—such as regional hospital networks and knowledge-sharing platforms—could facilitate the scaling up of proven innovations from high-performing hospitals. For instance, successful EMR implementations and surgical backlog campaigns could be adapted by facilities with similar contexts.

Furthermore, policymakers must address the foundational inequities in infrastructure and staffing between city centers and peripheral regions. Resource allocation should be data-driven and aligned with evidence-based benchmarks, including the Lancet Commission's recommendation of 5,000 surgical procedures per 100,000 population annually [52].

Strengths and limitations

The strength of this study lies in its comprehensive scope and triangulated methodology, which included direct observation, document review, and structured interviews across all regions. The use of WHO-aligned tools enhances the comparability of findings across global studies. However, the use of convenience sampling may limit generalizability. In addition, qualitative responses may be influenced by social desirability bias or respondent roles within their institutions.

Conclusion and recommendation

The assessment of hospitals across regions in Ethiopia revealed a range of best practices and strengths in delivery of safe surgery and anesthesia care. In Addis Ababa, advanced infrastructure like integrated EMR systems, and organized liaison services enabled effective coordination and patient care. Regions like Tigray and Gambella also demonstrated strong leadership commitment and team collaboration as best practice areas.

However, gaps persist in infrastructure and systems even at advanced centers in Addis Ababa. Prolonged turnover times between surgical cases, understaffed biomedical engineering teams, and variable adoption of EMR systems constrain potential. Moreover, the overall productivity surgical workforces were 52.39%.

In summary, while there are a number of positive deviations that can be expanded upon by similar hospitals, access to safe and emergency surgery is limited by workforce, productivity, and underlying infrastructure deficiencies. Opportunities therefore center upon hospital networking to facilitate horizontal learning and share clinical and administrative best practices in order to elevate standards across the country.

Abbreviations

ECG	Electrocardiography
PACU	Post anesthesia care unit
OR	Operating room
EMR	Electronic medical record
MOH	Ministry of health
EAA	Ethiopian association of anesthetists
USAID	United States agency for international development
WSUCSP	Woliyta Sodo University comprehensive specialized hospital
ZMH	Zewditu memorial hospital

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12892-6.

Supplementary Material 1.

Acknowledgements

The authors would like to acknowledge Ministry of Health, Medical Service Lead Executive Office and USAID Health Workforce Improvement Program.

Authors' contributions

All Authors Contributed Equally for the production of the manuscript and original research.

Funding

The study is conducted with funding from Ministry of Health Medical Service Lead Executive Office and USAID's Health Workforce Improvement Program.
Acknowledgment.
We would like to acknowledge the Ministry of Health, USAID Health Workforce Improvement Program, Ethiopian Association of Anesthetists, study participants and data collectors.

Data availability

The data is available up on request to amaretom22@gmail.com or can be accessed on "C: \Users\Amare H\OneDrive - University of Gondar, \Surgical Capacity and Productivity".

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Ethiopian Association of Anesthetists Institutional Research Ethics Review Committee (Protocol number: ኢኢማ/0895/007/2016). Informed consent was obtained from all participants prior to their participation. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.16/3

Competing interests

The authors declare no competing interests.

Received: 4 September 2024 / Accepted: 13 May 2025
Published online: 27 May 2025

References

1. Bendix P, Havens JM. The global burden of surgical disease. Curr Trauma Rep. 2017;3(1):25–31.
2. Shrime MG, Bickler SW, Alkire BC, Mock C. Global burden of surgical disease: an Estimation from the provider perspective. Lancet Global Health. 2015;3:S8–9.
3. Kurlberg G, Lancet Commission on Global Surgery - A Public Health Initiative. J Inst Med. 2020;42(1). Available from: https://www.nepjol.info/index.php/JIOM/article/view/37413. [cited 2024 Sep 14].
4. Henker R, Taki M. Challenges to Global Access to Anesthesia and Surgical Care. In: Thomas SL, Rowles JS, editors. Nurse Practitioners and Nurse Anesthetists: The Evolution of the Global Roles. Cham: Springer International Publishing; 2023. pp. 313–29. (Advanced Practice in Nursing). Available from: https://link.springer.com/10.1007/978-3-031-20762-4_25. [cited 2025 Apr 8].
5. Blake C, Alkire, Alkire BC, Abebe Bekele, Bekele A, Isabelle Citron, Citron I, et al. Building capacity for surgery, obstetrics and anesthesia in support of universal health coverage and achievement of the sustainable development goals. East Cent Afr J Surg. 2019;24(1):3–8.
6. Wurdeman T, Menon G, Meara JG, Alkire BC. A country-level comparison of access to quality surgical and non-surgical healthcare from 1990–2016. Fitzgerald T, editor. PLoS ONE. 2020;15(11):e0241669.
7. Samper AFG, Samper AFG, Herrera-Almario G, Herrera-Almario GE, Tulloch D, Tulloch DL, et al. A granular analysis of service delivery for surgical system strengthening: application of the lancet indicators for policy development in Colombia. Lancet Reg Health - Americas. 2022;10:100217–100217.
8. Meara JG, Meara JG, Andrew JM, Leather, Leather AJM, Lars Hagander, Hagander L, et al. Global surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Int J Obstet Anesth. 2016;25:75–8.
9. Henry JA, Volk AS, Kariuki SK, Murungi K, Firmalo T, Masha RL, et al. Ending neglected surgical diseases (NSDs): definitions, strategies, and goals for the next decade. Int J Health Policy Manag. 2020;1. https://doi.org/10.34172/ijhpm.2020.140.
10. Dunlap JL, Haider AH. Global disparities in surgical care. 2017:3–12. https://doi.org/10.1007/978-3-319-49482-1_1.
11. El-Saharty SE-SS, El-Saharty S, Sosena Kebede, Kebede S. Petros Olango Dubusho, Ethiopia - Improving Health Service Delivery. 2009;1–72.

12. Abubakar I, Dalglish SL, Angell B, Sanuade O, Abimbola S, Adamu AL, et al. The lancet Nigeria commission: investing in health and the future of the Nation. Lancet. 2022;399(10330):1155–200.
13. Hamze H, Mengiste A, Carter J. The impact and cost-effectiveness of the Amref health Africa-Smile train cleft lip and palate surgical repair programme in Eastern and central Africa. Pan Afr Med J. 2017;28:35.
14. Parker AS, Hill KA, Steffes BC, Mangaoang D, O'Flynn E, Bachheta N, et al. Design of a novel online, modular, Flipped-classroom surgical curriculum for East, central, and Southern Africa. Annals Surg Open. 2022;3(1):e141.
15. Meshesha BR, Sibhatu MK, Beshir HM, Zewude WC, Taye DB, Getachew EM, et al. Access to surgical care in Ethiopia: a cross-sectional retrospective data review. BMC Health Serv Res. 2022;22(1):973.
16. Merga KH, Gebreegziabher SB, Getachew EM, Sibhatu MK, Beshir HM, Kumssa TH, et al. Surgical capacity in public and private health facilities after a Five-Year strategic plan implementation in Ethiopia: A cross sectional study. Annals Global Health. 2023;89(1):18.
17. Kelly CM, Starr N, Raykar NP, Yorlets RR, Liu C, Derbew M. Provision of surgical care in Ethiopia: challenges and solutions. Glob Public Health. 2018;13(11):1691–701.
18. Degu S, Kejela S, Zeleke HT. Perioperative mortality of emergency and elective surgical patients in a low-income country: a single institution experience. Perioper Med. 2023;12(1). https://doi.org/10.1186/s13741-023-00341-z.
19. Oh JH. Educational expansion and health disparities in Ethiopia, 2005–2016. Soc Sci Med. 2019;235:112316.
20. Jumbam DT, Amoako E, Blankson PK, Xepoleas M, Said S, Nyavor E, et al. The state of surgery, obstetrics, trauma, and anaesthesia care in Ghana: a narrative review. Global Health Action. 2022;15(1):2104301.
21. Tenager Tadesse TT, Fekadu Abebe FA, Hawkins AB, A H et al. Improving infection prevention and control in Ethiopia through supportive supervision of health facilities. 2012.
22. Marshall AM. AH, J F. Supportive supervision in monitoring and evaluation with community-based health staff in HIV programs. A case study from Ethiopia. 2014.
23. Tiruneh GT, Karim AM, Yihun BY, et al. Effectiveness of supervision on the consistency of neonatal Sepsis management skills of health extension workers. Ethiop Med J. 2019;(3). https://www.emjema.org/index.php/EMJ/article/view/1398/549.
24. Meara JG, Greenberg SLM. The lancet commission on global surgery global surgery 2030: evidence and solutions for achieving health, welfare and economic development. Surgery. 2015;157(5):834–5.
25. Davies JI, Gelb AW, Gore-Booth J, Martin J, Mellin-Olsen J, Åkerman C, et al. Global surgery, obstetric, and anaesthesia indicator definitions and reporting: an Utstein consensus report. PLoS Med. 2021;18(8):e1003749.
26. Watters DA, Guest GD, Tangi V, Shrime MG, Meara JG. Global surgery system strengthening: it is all about the right metrics. Anesth Analgesia. 2018;126(4):1329–39.
27. Lindheim-Minde B, Gjøra A, Bakker JM, Van Duinen AJ, Van Leerdam D, Smalle IO, et al. Changes in surgical volume, workforce, and productivity in Sierra Leone between 2012 and 2017. Surgery. 2021;170(1):126–33.
28. Bolkan HA, Hagander L, Von Schreeb J, Bash-Taqi D, Kamara TB, Salvesen Ø, et al. The surgical workforce and surgical provider productivity in Sierra Leone: A countrywide inventory. World J Surg. 2016;40(6):1344–51.
29. Maguire M, Delahunt B. Doing a thematic analysis: a practical, step-by-step guide for learning and teaching scholars. 2017;9(3). http://ojs.aishe.org/index.php/aishe-j/article/view/335.
30. Sibhatu MK, Getachew EM, Bete DY, Gebreegziabher SB, Kumsa TH, Shagre MB, et al. Surgical system efficiency and operative productivity in public and private health facilities in Ethiopia: A Cross-Sectional evaluation. Glob Health Sci Pract. 2024;12(1):e2200277.
31. Woldemichael A, Takian A, Akbari Sari A, Olyaeemanesh A. Inequalities in healthcare resources and outcomes threatening sustainable health development in Ethiopia: panel data analysis. BMJ Open. 2019;9(1):e022923.
32. Iverson KR, Garringer K, Ahearn O, Alidina S, Citron I, Esseye S, et al. Mixed-methods assessment of surgical capacity in two regions in Ethiopia. Br J Surg. 2019;106(2):e81–90.
33. Derbew M, Laytin AD, Dicker RA. The surgical workforce shortage and successes in retaining surgical trainees in Ethiopia: a professional survey. Hum Resour Health. 2016;14(S1):29.
34. Harrison MS, Kirub E, Liyew T, Teshome B, Jimenez-Zambrano A, Muldrow M et al. Performance of Integrated Emergency Surgical Officers at Mizan-Tepi University Teaching Hospital, Mizan-Aman, Ethiopia: A Retrospective Cohort Study. Atan IK, editor. Obstetrics and Gynecology International. 2021;2021:1–10.
35. Bouchard ME, Justiniano J, Vervoort D, Gore-Booth J, Emmanuel A, Langer M. Cross-sectional analysis tracking workforce density in surgery, anesthesia, and obstetrics as an indicator of progress toward improved global surgical access. Int J Surgery: Global Health. 2020;3(6):e26–26.
36. Negash S, Anberber E, Ayele B, Ashebir Z, Abate A, Bitew S, et al. Operating room efficiency in a low resource setting: a pilot study from a large tertiary referral center in Ethiopia. Patient Saf Surg. 2022;16(1). https://doi.org/10.1186/s13037-021-00314-5.
37. Mulugeta H, Zemedkun A, Mergia G, Abate SM, Gebremariam M, Jemal B, et al. Perioperative capacity and contextual challenges in teaching hospitals of Southern Ethiopia: explanatory sequential mixed-methods research. Perioper Med. 2024;13(1):61.
38. Zha Y, Truché P, Izquierdo E, Zimmerman K, De Izquierdo S, Lipnick MS, et al. Assessment of anesthesia capacity in public surgical hospitals in Guatemala. Anesth Analgesia. 2021;132(2):536–44.
39. Kifle F, Belihu KD, Beljege BZ, Dhufera HT, Keno FB, Taye DB, et al. Perioperative care capacity in East Africa: results of an Ethiopian National cross-sectional survey. Int J Surgery: Global Health. 2021;4(3):e57–57.
40. Ogbuanya AU, Anyanwu SNC, Ajah A, Otuu O, Ugwu NB, Boladuro EA, et al. Surgical capacity in rural Southeast Nigeria: barriers and new opportunities. Annals Global Health. 2021;87(1):118.
41. Mihretu F. The current state of anesthesia safety in a third world country: a cross-sectional survey among anesthesia providers in Ethiopia. Patient Saf Surg. 2021;15(1):17–17.
42. Zemedkun A, Destaw B, Hailu S, Milkias M, Getachew H, Angasa D. Assessment of postoperative patient handover practice and safety at post anesthesia care unit of Dilla University Referral Hospital, Ethiopia: A cross-sectional study. Ann Med & Surg. 2022;79. Available from: https://journals.lww.com/10.1016/j.amsu.2022.103915. [cited 2025 Apr 7].
43. White MC, Michelle White, Ahuja S, Shalini Ahuja K, Peven K, Peven, et al. Scaling up of safety and quality improvement interventions in perioperative care: a systematic scoping review of implementation strategies and effectiveness. BMJ Global Health. 2022;7(10):e010649–010649.
44. Ravi Oodit, Oodit R, Bruce Biccard, Biccard BM, Gregg Nelson, Nelson G, et al. ERAS society recommendations for improving perioperative care in Low- and Middle-Income countries through implementation of existing tools and programs: an urgent need for the surgical safety checklist and enhanced recovery after surgery. World J Surg. 2021;45(11):3246–8.
45. Silow-Carroll SS-C, Jennifer S, Edwards N, Edwards JN, Jennifer N, Edwards D, Rodin, et al. Using electronic health records to improve quality and efficiency: the experiences of leading hospitals. Issue Brief. 2012;17:1–40.
46. Emwodew D, Tariku B, Desalegn A, Seid E. Barriers to the Adoption of Electronic Medical Record System in Ethiopia: A Systematic Review (Preprint). 2021. Available from: http://preprints.jmir.org/preprint/29568. [cited 2025 Apr 8].
47. Bisrat A, Minda D, Assamnew B, Abebe B, Abegaz T. Implementation challenges and perception of care providers on electronic medical records at St. Paul's and ayder hospitals, Ethiopia. BMC Med Inf Decis Mak. 2021;21(1):306.
48. Aboueid S, Beyene M, Nur T. Barriers and enablers to implementing environmentally sustainable practices in healthcare: A scoping review and proposed roadmap. Healthc Manage Forum. 2023;36(6):405–13.
49. Shahbaz S, Zakar R, Howard N. Anaesthesia provision challenges in public hospitals of Pakistan's Punjab province: a qualitative study of expert perspectives. 2023. Available from: https://doi.org/10.1101/2023.04.13.23288520. [cited 2025 Apr 8].
50. Gathuya Z, Nabukenya MT, Aaron O, Gray R, Evans FM. Children's anaesthesia and perioperative care challenges, and innovations. Semin Pediatr Surg. 2023;32(6):151355.
51. Holmaas G, Abate A, Woldetsadik A, Hevrøy O. Establishing a sustainable training programme in anaesthesia in Ethiopia. Acta Anaesthesiol Scand. 2022;66(8):1016–23.
52. Patil P, Nathani P, Bakker JM, Van Duinen AJ, Bhushan P, Shukla M, et al. Are LMICs achieving the lancet commission global benchmark for surgical volumes?? A systematic review. World J Surg. 2023;47(8):1930–9.

Publisher's Note