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Capstone Practicum Report

Assessment of the Essential Emergency Surgical Care Capacity in all District Hospitals across Rwanda using WHO-situational analysis tool for Essential Emergency Surgical care: A Cross-Sectional Survey

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DECLARATION

We, Alexander Habte Habtemariam and Marie Merci Cyuzuzo, hereby declare that the practicum capstone thesis has been written by us without any external unauthorized help, that it has been neither presented to any institution for evaluation nor previously published in its entirety or in parts. Any parts, words or ideas, of the thesis, however limited, which are quoted from or based on other sources, have been acknowledged as such without exception.

Signature:  Date: July 10th , 2025

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Dedication

To the unsung heroes in scrubs and gumboots,
This work is dedicated to the General Practitioners and Non-Physician Anesthetists across Rwanda who step into operating rooms not for glory, but out of necessity. You hold the scalpel when no one else is there. You intubate in silence. You refer not because you lack care, but because you care too much to pretend you have everything.
Your hands may not always hold a surgical title,
but they hold lives and that, in our book, deserves a standing ovation and a systems-level rethink.

And to my mother,
The original emergency responder.
You taught me the first stitches: how to mend broken hearts, stop internal bleeding with hugs, and always check for pulse before speaking.
Your sacrifices were the first surgeries I witnessed.
This project in its heart, its science, and its soul, is for you.

Alexander Habte Habtemariam, MD

To my dearest parents, whose unwavering love and support have been the foundation of my journey.
To my siblings, whose belief in me has been a constant source of strength.
To my friends, who stood by me through every challenge and triumph.
To the quiet Courage that walked with me on every step.
And to the rising generation of global health leaders whose dreams we share in the pursuit of equity for all. This work is yours as much as it is mine.

Marie Merci Cyuzuzo, MD

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Abstract

Background: Access to emergency and essential surgical care (EESC) remains a fundamental yet neglected component of health system strengthening in Low- and Middle-Income Countries (LMICs). In Rwanda, district hospitals serve as the primary surgical care providers for the majority rural population, yet there is limited recent, nationally representative data assessing their readiness and capacity. This study aimed to evaluate the availability, accessibility, and delivery of EESC across all district hospitals in Rwanda and to contextualize these findings within regional benchmarks from Sub-Saharan Africa as well as the Lancet commission on Global Surgery (LCoGS) benchmarks.

Methods: A national cross-sectional assessment was conducted using the World Health Organization's Situational Analysis Tool for Emergency and Essential Surgical Care (SAT-EESC) in all 43 district hospitals in Rwanda. Data was collected from key informants across three main domains, including infrastructure, workforce, and service delivery. Quantitative analysis included descriptive statistics, bivariate comparisons, and multivariate linear regression to identify predictors of surgical volume and spatial analysis for surgical capacity across Rwanda.

Results: Infrastructure was consistently available across all 43 district hospitals, with each reporting at least one functional operating room. Additionally, 93% had uninterrupted electricity and running water, meeting the minimum benchmarks set by the Lancet Commission on Global Surgery (LCoGS). Anesthesia care was predominantly delivered by non-physician anesthetists, with a median of 2 providers per facility (IQR: 1–14).

Specialist surgical providers (surgeons, anesthesiologists, obstetricians) were scarce, with a median SAO density of 0.54 per 100,000 (IQR: 0.00–1.07), far below the Lancet Commission's target of 20 per 100,000. On the other hand, general practitioners, particularly in rural settings, performed most of the obstetric surgical procedures. The median of surgical volume per 100,000 population was 923.97 and an IQR of 585.85–1,508.13, reflecting substantial variability across provinces and between urban and rural settings. Multiple linear regression revealed that hospitals with a higher number of anesthesiologists, hysterectomies, and surgical admissions performed significantly more surgical procedures annually ($p < 0.05$). In contrast, the number of surgeons and obstetricians was not significantly associated with surgical volume. Referral frequency also showed no significant correlation with surgical output.

Conclusion: While Rwanda has achieved notable infrastructure and policy advancements under NSOAP I, district hospitals continue to face critical gaps in workforce capacity, perioperative monitoring, surgical volume, and complex procedure capacity. The predominance of task-shifting underscores the need to redefine workforce metrics to include non-specialist surgical providers. Furthermore, focusing on specific specialties such as anesthesiology may enhance service delivery. These findings provide essential evidence to inform national surgical planning and broader efforts to achieve equitable, timely, and safe surgical care. Despite the aforementioned, future studies should be conducted incorporating longitudinal monitoring, patient outcomes, and cost analyses to deepen insight into surgical system performance and sustainability.

Key words: Essential Surgical Care; Surgical Volume; SAO Density; Surgical Infrastructure; NSOAP (National Surgical, Obstetric and Anesthesia Plan); Surgical Capacity Assessment.

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List of Abbreviations

Abbreviation	Full Term
CHUB	Centre Hospitalier Universitaire de Butare
CHUK	Centre Hospitalier Universitaire de Kigali
CHW	Community Health Worker
DH	District Hospital
FPC	Finite Population Correction
GPs	General Practitioners
IQR	Interquartile Range
IRB	Institutional Review Board
LCoGS	Lancet Commission on Global Surgery
NPAs	Non-Physician Anesthetists
NSOAP	National Surgical, Obstetric, and Anesthesia Plan
OR	Operating Room
QGIS	Quantum Geographic Information System
REDCap	Research Electronic Data Capture
SAO	Surgeons, Anesthesiologists, and Obstetricians
SAT-EESC	Situational Analysis Tool to Assess Emergency and Essential Surgical Care
SPSS	Statistical Package for the Social Sciences
UGHE	University of Global Health Equity
WHO	World Health Organization

Chapter 1. Introduction

1.1 Background

Access to surgical services is an essential component of achieving Universal Health Coverage (UHC), particularly in resource-constrained settings (*Universal Health Coverage (UHC)*, 2025). Sustainable Development Goal (SDG) 3.8 implies surgical care as part of essential health services (*Universal Health Coverage (UHC)*, 2025). Yet, an estimated 5 billion people globally lack access to safe, affordable surgical care, with 90% of them living in low- and middle-income countries (LMICs) (Albutt et al., 2018; Concepcion et al., 2019; Meara & Greenberg, 2015). This surgical access gap undermines health equity and contributes to avoidable morbidity and mortality from otherwise treatable conditions (Meara & Greenberg, 2015).

The Global Burden of Disease Study (GBDS) estimates that surgical conditions account for approximately 25 million disability-adjusted life years (DALYs) annually (Beard et al., 2019). In Sub-Saharan Africa (SSA), the impact is particularly acute, with an estimated 38 DALYs lost per 1,000 population due to surgically treatable conditions (Mock et al., 2015; Luboga et al., 2009; Rios-Diaz et al., 2016). Despite the high burden, many SSA countries lack the infrastructure and systems needed to deliver timely and safe surgical care (Meara & Greenberg, 2015). This mismatch between surgical need and capacity continues to widen health disparities across the region (Mock et al., 2015).

Among the most persistent barriers to surgical scale-up in LMICs are inadequate infrastructure, severe workforce shortages, and fragmented supply chains for essential surgical commodities (Elkheir et al., 2014). Recognizing this challenge, the World Health Organization (WHO) has identified Emergency and Essential Surgical Care (EESC) as a cornerstone intervention for expanding access, particularly at the first-referral level (Albert et al., 2015). Investing in surgical care not only addresses acute life-threatening conditions but also improves long-term population health outcomes and economic productivity (Rios-Diaz et al., 2016).

The Bellagio Essential Surgery Group and subsequent global health frameworks have emphasized the central role of district hospitals in bridging the surgical access gap (Luboga et al., 2009). District-level facilities are often the first and only point of surgical access for rural populations, yet they remain critically under-resourced (Grimes et al., 2011). Strengthening surgical capacity at this level offers the most direct path to expanding equitable access and reducing preventable surgical mortality (K. Chu et al., 2021).

A number of LMICs have been putting much effort into improving their national healthcare, particularly in SSA. Rwanda, for instance, has made substantial progress through the development of a National Surgical, Obstetric, and Anesthesia Plan (NSOAP) and investment in surgical infrastructure (Ministry of Health Rwanda, 2018). However, major workforce gaps remain. The recent 4-year NSOAP review it was reported that the country currently has an estimated 3 surgical providers (surgeons, anesthesiologists, and obstetricians) per 100,000

population, far below the Lancet Commission's recommended minimum of 20 per 100,000 (Ministry of Health Rwanda, 2024). As a result, both the quality and reliability of surgical services remain uneven, particularly at the district level.

1.2 Problem statement

Despite national efforts to strengthen surgical systems through the NSOAP framework, Rwanda's district hospitals continue to face critical challenges in delivering essential and emergency surgical care. These include stark disparities in workforce distribution, variation in infrastructure usage attributed to workforce constraints, and uneven surgical volume (Mpirimbanyi et al., 2017). This fragmentation results in reduced access, delayed care, and suboptimal outcomes, particularly for rural and underserved populations. A systematic assessment of surgical readiness at the district level is needed to guide equitable policy interventions.

1.3 Research Question

Research Question
What is the availability, capacity, and readiness of emergency and essential surgical care (EESC) in the district hospitals of Rwanda as assessed using the WHO Situational Analysis Tool (SAT)-EESC?

Hypothesis
This study hypothesizes that significant disparities may exist between urban and rural district hospitals in Rwanda, with rural facilities demonstrating lower infrastructure readiness, workforce availability, and surgical service delivery capacity.

1.4 Study objectives

Primary Objective

To assess the availability and capacity of essential and emergency surgical care in Rwanda's district hospitals using the WHO SAT-EESC tool.

Specific Objectives

- To evaluate the infrastructure readiness of district hospitals in Rwanda based on the availability of operating rooms, surgical beds, electricity, running water, and oxygen supply.
- To assess the availability and distribution of surgical workforce cadres, including surgeons, obstetricians, anesthesiologists, general practitioners (GPs), midwives, and non-physician anesthetists (NPAs).

- To quantify surgical procedure volumes and case-mix across urban and rural settings and analyze disparities in service delivery across provinces.
- To propose policy recommendations based on findings to guide the refinement of Rwanda's NSOAP and inform surgical system strengthening efforts.

1.5 Organization of the Report

This thesis is organized into six chapters. Chapter One introduces the background, articulates the problem statement, outlines the study objectives and hypothesis, and describes the structure of the report. Chapter Two presents a systematic literature review, providing regional context and establishing the rationale for the study. Chapter Three outlines the methodological approach, including the study design, sampling framework, data collection tools, and statistical analysis plan. Chapter Four presents the results. Chapter Five offers a critical discussion of the findings in relation to existing literature and national policy goals. Finally, Chapter Six concludes with evidence-based recommendations

Chapter 2 Literature Review

2.1 Background

Globally, access to surgical care remains deeply inequitable. Although more than 234 million surgical procedures are performed each year, only 6.3% occur in the poorest countries, which bear over 35% of the global disease burden (Beard et al., 2019; Mock et al., 2009). This mismatch reflects a fundamental disparity in health systems: while surgical conditions are highly prevalent in low-resource settings, they are often neglected in public health planning, policy prioritization, and funding allocations (Bickler et al., 2015; Luboga et al., 2009).

In LMICs, surgical health systems face critical structural deficiencies. These include chronic shortages of trained surgical, anesthesia, and obstetric (SAO) providers, poorly equipped facilities, and fragile supply chains for essential surgical tools and medications (Luboga et al., 2009; Mock et al., 2009; Ng-Kamstra et al., 2018). These systemic constraints limit both the availability and safety of surgical interventions and contribute to persistent service delivery gaps, especially at district and primary care levels (Ng-Kamstra et al., 2018).

The consequences of these deficits extend beyond clinical outcomes. Untreated surgical conditions result in avoidable deaths and long-term disability, and also reduce economic productivity, increase catastrophic health expenditures, and contribute to poverty cycles at both household and national levels (Shrime et al., 2015). Investing in surgical care has been shown to yield high economic and health returns, yet it remains underfunded in most LMIC health budgets (Rios-Diaz et al., 2016; Shrime et al., 2014).

SSA bears a disproportionate share of the global surgical burden (Ologunde et al., 2014). District-level surgical care is especially constrained by low workforce density, unreliable infrastructure, limited anesthesia services, and high perioperative mortality, particularly in rural and underserved areas where patients face long travel distances and delayed referrals (Grimes et al., 2011; Mock et al., 2015; Ologunde et al., 2014).

To support targeted assessment and system strengthening in such settings, the World Health Organization developed the SAT-EESC (Osen et al., 2010). This tool offers a standardized and validated framework to assess facility-level readiness across key domains, including infrastructure, equipment, workforce, and service availability (Osen et al., 2010). While limitations such as reliance on self-reported data and weak integration with health information systems exist (Iverson et al., 2020; Kushner, 2010), the SAT-EESC has played a pivotal role in informing national surgical policy. Price et al., (2015) linked the tool to the advancement of World Health Assembly Resolution WHA68.15(Price et al., 2015). Peters et al., (2020) also argued that assessments like the SAT-EESC are foundational to developing NSOAPs, especially in SSA, where surgical access and quality remain inequitable and under-resourced.

Rwanda has made strategic strides to strengthen surgical care through the development of its NSOAP, first implemented in 2018 (Ministry of Health Rwanda, 2018). The plan aims to decentralize surgical services, train more surgical providers, and invest in infrastructure and equipment across all levels of care (Ministry of Health, Rwanda, 2018). Despite these efforts, major gaps persist.

As of 2024, Rwanda has only three SAO providers per 100,000 population, far below the LCoGS-recommended minimum of 20. Most district hospitals rely on general practitioners to perform surgical procedures due to the lack of specialized staff (Ministry of Health Rwanda, 2024). Infrastructure constraints also remain a significant barrier: many facilities lack fully equipped operating rooms, reliable anesthesia services, and essential surgical instruments, limiting the ability to deliver timely and safe emergency care (Mpirimbanyi et al., 2017).

To conduct a comprehensive assessment of emergency surgical capacity in Rwanda's district hospitals, this study utilizes the WHO SAT-EESC. This tool is structured to evaluate key domains of surgical system readiness, including infrastructure, equipment, workforce, and service availability. Each domain provides critical insights into whether facilities can deliver safe, timely, and essential surgical services, particularly in emergency contexts (Meara & Greenberg, 2015). These components reflect the core building blocks of a functional surgical system and are aligned with the priorities outlined in the LCoGS and Rwanda's NSOAP (Meara & Greenberg, 2015). The following sections synthesize findings from studies across Sub-Saharan Africa using this framework, with each domain discussed in turn to contextualize Rwanda's current capacity and remaining challenges.

2.2.1 Surgical Infrastructure

Surgical infrastructure encompasses the essential physical and technical resources required to deliver operative care, including operating rooms (ORs), sterilization units, diagnostic imaging, post-anesthesia care units (PACUs), and consistent access to utilities such as electricity, oxygen, and clean water (Osen et al., 2010).

These infrastructures play a pivotal role in determining a facility's capacity to provide emergency and essential surgical services. Without reliable and adequately equipped systems, even well-trained clinicians are unable to deliver safe and timely surgical care (Elkheir et al., 2014; Omar et al., 2024; Osen et al., 2010). Deficiencies in infrastructure directly impact patient outcomes, contributing to delayed procedures, perioperative complications, and mortality (Ng-Kamstra et al., 2018). Studies have estimated that perioperative mortality rates in LMICs can reach up to 4%, and that up to 70% of surgically treatable conditions remain unmanaged due to infrastructure and workforce deficits (Butler et al., 2021; Concepcion et al., 2019; Ng-Kamstra et al., 2018).

Across SSA, the availability and quality of surgical infrastructure at district hospitals are highly variable. In the Democratic Republic of Congo, hospitals were found to have a median of one OR per facility, with limited ICU beds (Malemo et al., 2024). While in Sierra Leone, only 50% of hospitals had monitored surgical beds, making them ill-equipped for complex procedures (Lindheim-Minde et al., 2021). Similarly, reports from Somalia mention just 56% of hospitals offered 24/7 surgical coverage, and only 58% maintained a nurse-to-patient ratio of 1:7 in surgical wards (Omar et al., 2024). Moreover, Kenya showed similarly concerning figures, only 49% of facilities had functional major ORs, and just 63.5% had piped water in their surgical units (Chaker et al., 2025).

In context of surgical infrastructure Rwanda presents a mixed picture of facility readiness. LeBrun et al., (2014) reported that all 21 surveyed district hospitals performed surgical procedures and had an average of 2.5 ORs per facility. While this represents a relatively high baseline for OR availability, deeper facility assessments indicate gaps in functional readiness. (Mpirimbanyi et al., 2017) noted that many district hospitals lacked adequately equipped ORs and had inconsistent access to anesthesia services and surgical instruments. The NSOAP 4-Year Review confirmed persistent infrastructure gaps, including non-functional equipment, inadequate operating theater capacity, and unreliable supply chains, these issues were particularly pronounced in rural facilities, which often serve large catchment areas with limited technical support (Ministry of Health Rwanda, 2024).

Although Rwanda's NSOAP outlines goals for infrastructure improvement, national-level audits to monitor progress remain limited in scope and standardization. Existing assessments rely on qualitative reports or semi-structured surveys without the use of validated benchmarking tools (LeBrun et al., 2014; Mpirimbanyi et al., 2017). This study addresses that gap by using the WHO SAT-EESC to systematically evaluate the availability and functionality of essential surgical infrastructure across all district hospitals and compare with international benchmarks.

2.2.2. Surgical Volume

Surgical volume refers to the number of procedures performed within a health facility over a defined period, typically monthly or annually and can be population-standardized to assess service delivery efficiency (Osen et al., 2010). It is a key indicator of a health system's capacity to address surgical needs, and is closely associated with infrastructure, staffing, and patient outcomes (Meara & Greenberg, 2015; Osen et al., 2010). The LCoGS recommends that countries aim for at least 5,000 surgical procedures per 100,000 population annually to ensure adequate access to life-saving and essential surgeries (Meara & Greenberg, 2015).

Across SSA, surgical volumes vary substantially based on health system capacity and hospital readiness. In Ethiopia, Meshesha et al., (2022) documented 69,717 surgeries across 172 hospitals within 90 days, projecting to 230,886 surgeries annually, with 58% considered major surgeries and 33,052 identified as bellwether procedures. The ability to perform bellwether procedures, cesarean section, laparotomy, and open fracture management, is widely used to assess surgical readiness, especially at the district level (Meara & Greenberg, 2015). However, several studies have highlighted significant variability in bellwether capacity. In South Africa, Tefera et al., (2020) found that 96.5% of bellwether procedures were cesarean sections, indicating limited capacity to manage general or trauma-related emergencies. In contrast, Albutt et al., (2018) found that only 56% of hospitals in Uganda could perform all three bellwether procedures.

Rwanda has a higher surgical volume compared to neighboring regional countries. LeBrun et al., (2014) reported a mean of 2,052 surgeries per hospital annually, corresponding to 726 operations per 100,000 catchment population, with 58% classified as emergency procedures, and the recent

Rwanda NSOAP review 2024, a 127% increase in surgical volume from 2017 (4,804/100,000 population) has been reported (Ministry of Health Rwanda, 2024). These figures, even though higher than the regional measures, remain significantly below the 5,000 per 100,000 population LCoGS target (Meara & Greenberg, 2015). Moreover, the national averages mask potential disparities in volume between urban and rural hospitals and between emergency and elective procedures (Ministry of Health Rwanda, 2024). This study aims to address this gap by generating comparable, facility-level data on surgical volume across all district hospitals in Rwanda to support evidence-based policy and service planning.

2..2.3 Surgical Workforce

The surgical workforce refers to the pool of trained professionals who deliver operative care, typically categorized as surgeons, anesthesiologists, and obstetricians (SAO providers) (Meara & Greenberg, 2015). A robust surgical workforce is a cornerstone of effective health systems, and its availability directly impacts surgical access, safety, and quality of care (Grimes et al., 2011; Meara & Greenberg, 2015; Ng-Kamstra et al., 2018). The LCoGS recommends a minimum density of 20 SAO providers per 100,000 population to meet essential surgical needs and ensure equitable service delivery (Meara & Greenberg, 2015).

Across SSA, SAO provider density remains alarmingly low (Grimes et al., 2011). In the Democratic Republic of Congo, the SAO density was reported at 1.05 per 100,000 population, despite a broader perioperative workforce density of 13.1, supported largely by 59 non-surgeon providers (Malemo et al., 2024). In Somalia, there were 160 surgeons, 22 anesthesia specialists, and 54 OB/GYN providers, totaling 238 SAO providers, but with over 80 of them foreign trained, the effective domestic capacity remains limited. This equates to a national SAO density of 1.8 per 100,000, still far below global benchmarks (Omar et al., 2024). LeBrun et al., (2014) reported an average of 1 SAO provider per hospital, 3.3 anesthesia technicians, and 10.7 physicians overall, indicating a high degree of task delegation to non-physician personnel.

Majority of SAO professionals are disproportionately concentrated in urban tertiary hospitals, while rural district facilities often operate with only general practitioners and minimal surgical training support (Meshesha et al., 2022; Omar et al., 2024). This imbalance exacerbates regional disparities in surgical access and undermines the delivery of emergency care in underserved areas (Grimes et al., 2011).

Task-shifting to non-specialist providers was a recurring strategy across multiple contexts. In Malawi, 92.7% of all surgical care was delivered by non-specialists such as clinical officers and anesthesia clinical officers (Gajewski, Bijlmakers, Mwapasa, et al., 2018). In Rwanda, the situation was similar: general practitioners commonly performed surgeries in district hospitals due to the lack of specialist staff (LeBrun et al., 2014; Mpirimbanyi et al., 2017; Petroze et al., 2012).

In Rwanda, the Ministry of Health has acknowledged these workforce constraints, noting the continued shortage of surgeons, anesthetists, and perioperative nurses across district hospitals (Ministry of Health Rwanda, 2024). However, the country still lacks a comprehensive national strategy to map, and monitor surgical personnel based on local facility needs. This study aims to

fill that gap by providing standardized workforce data from all district hospitals, thereby supporting future policy decisions and equitable workforce distribution.

2.2.4 Equipment and Supplies

Surgical safety and effectiveness rely heavily on the consistent availability of essential equipment and supplies. These include anesthesia machines, sterilization units, pulse oximeters, suction devices, and diagnostic tools such as imaging systems (Chaker et al., 2025; Oosting et al., 2018). Without functional equipment, even well-trained surgical teams and operating rooms cannot deliver timely or safe care (Oosting et al., 2018).

Studies in SSA consistently reported widespread deficiencies in core surgical equipment. In Malawi, Albert et al., (2015) found that only 14 of 27 hospitals had pulse oximeters in every operating room, compromising intraoperative monitoring. Similar findings were documented in East and Central Africa. In Kenya, just 44.5% of facilities had adequate intraoperative equipment and only 47% had anesthesia machines, while availability of general patient care equipment hovered around 59.8% (Chaker et al., 2025). While, in Democratic Republic of Congo, only 40% of facilities had functional anesthesia equipment, and imaging availability was limited to 8%, posing major diagnostic limitations (Malemo et al., 2024). A study by Esquivel et al., (2016) found that only 17 out of 103 facilities assessed in Zambia met WHO's minimum surgical safety standards, highlighting broader systemic gaps.

Early facility-level data from Rwanda, showed that only 57% of operating rooms had pulse oximeters, 86% had oxygen sources, and 81% had continuous electricity, although running water was available in 95% of facilities (LeBrun et al., 2014; Petroze et al., 2012). Persistent deficits such as routine shortages of essential surgical supplies and stockouts of anesthesia medications were also reported by the Ministry of Health (Ministry of Health Rwanda, 2024).

These findings collectively reveal that even when infrastructure and human resources are present, inadequate equipment continues to compromise the quality and safety of surgical care. Despite progress made thus far, the continued absence of reliable anesthesia machines, sterilization equipment, and essential supplies limits full implementation of safe surgical practices, particularly at the district hospital level, hence this study aims to assess the availability of essential equipment for essential surgery.

2.2.5 Access time to care

Timely access to surgical care remains one of the most significant barriers in SSA. Among the reviewed articles, K. M. Chu et al., (2020) estimated that 86–89% of South Africa's population lived within two hours of a surgical-capable facility. However, only 58% of district hospitals met surgical readiness criteria, revealing that physical proximity alone does not guarantee functional access.

Senegal's readiness was moderate, with 54.6% of facilities equipped with a dedicated emergency operating room for abdominal surgery (Ndong et al., 2024).In contrast, Liberia presented a more critical situation Adde et al., (2023) reported that just 38.7% of the population lived within two hours of a bellwether-capable hospital, and only 5.9% of facilities met all three readiness criteria,

workforce, infrastructure, and equipment. These results underscore how spatial access is compounded by systemic readiness constraints, especially in rural or fragile health systems.

In Rwanda, LeBrun et al., (2014) reported an average patient travel distance of 27 km to reach a district hospital. While this figure indicates relatively good geographic distribution of hospitals, the Rwanda NSOAP 4-Year Review reaffirms that 100% of the population is within two hours of a Bellwether-capable facility, based on road distance models (Ministry of Health Rwanda, 2024). However, only 10 out of the 42 district hospitals in 2024 offered all three Bellwether procedures consistently, undermining the operational validity of this metric (Ministry of Health Rwanda, 2024).

These findings reinforce a critical flaw in using proximity as a proxy for access. Geographic closeness alone does not ensure the presence of trained surgical providers, adequate infrastructure, or critical equipment at the point of care. Even in areas with nearby hospitals, delays often arise due to inconsistent surgical staffing. This mismatch between proximity and preparedness reflects a critical system-level weakness. In this study we aim to assess the surgical functionality of each district hospital, by assessing the referral numbers for each hospital.

2.3 Justification and Relevance of the Study

From our review, the reports gathered focused on aggregated data presentation on infrastructure, workforce, and surgical volume. While this information is vital, it risks generalizability where facility-level discrepancies are not evaluated. Additionally, while some studies report on the availability of surgical equipment, to our knowledge, no study has assessed whether a correlation exists between surgical volume and equipment availability. Moreover, with an ongoing emphasis on strengthening primary healthcare, this is crucial, as it will dictate national health investment policies. And while there is a persisting urban-rural disparity in the distribution of surgical facilities and services, leaving rural populations disproportionately underserved (LeBrun et al., 2014; Ministry of Health Rwanda, 2024; Mpirimbanyi et al., 2017; Petroze et al., 2012). This study aims to address these gaps by applying the SAT-EESC tool across all 43 district hospitals, offering reliable, actionable, and internationally comparable evidence for targeted investment in surgery.

Chapter 3: Methodology

3.1 Study Setting

This study was conducted across all 43 district hospitals in Rwanda. Rwanda is a landlocked country located in East-Central Africa, with a land area of 26,338 km² and a population of 13.2 million (National Institute of Statistics of Rwanda, 2022). The country is administratively divided into four provinces (Northern, Southern, Eastern, and Western) and the City of Kigali. Each region hosts several district hospitals under decentralized health governance (National Institute of Statistics of Rwanda, 2022).

District hospitals serve as the main providers of emergency and essential surgical care, bridging primary care and tertiary hospitals. They are strategically located to ensure access to life-saving surgical interventions (Rwanda medical & Dental Council, n.d.). A complete list of participating hospitals, including their geographic coordinates retrieved from the Ministry of Health, is provided in Appendix 2.

3.2 Study Design

This study employed a cross-sectional design integrating both primary and secondary data sources to assess surgical system capacity across Rwanda's 43 district hospitals.

Primary data were collected prospectively using the adapted WHO SAT-EESC. These included structured facility assessments and key informant interviews covering domains such as infrastructure availability, workforce distribution, referral practices, and service readiness. Data was collected directly from hospital personnel and on-site observations during field visits during the data collection period (between May 5th and June 15th, 2025).

Secondary data consisted of retrospective surgical volume and procedural records extracted from routine hospital documents, including operating room logs, District Health Information System (DHIS2), and surgical registries. These data covered the 12-month period from May 1st ,2024 to April 30th, 2025 and were used to calculate total surgical output, monthly procedural volume, and frequency of specific operations such as cesarean sections, laparotomies, and open fracture treatments.

Data collection referred to a 12-month period spanning May 1st 2024 to April 30th 2025. Both the facility assessments and the retrospective extraction of surgical data were conducted with reference to this period. At each hospital, six key informants were purposively selected for in-person interviews based on their roles and knowledge of facility operations. These included the data manager, operating theatre nurse, surgeon, anesthetist, clinical coordinator, and human resources focal person. Only staff who had worked at their respective facilities for 12 months or more were eligible to participate.

Each informant provided unique and non-overlapping insights critical for a comprehensive assessment aligned with the WHO SAT-EESC domains. The Data Manager offered validated records on surgical admissions, patient load, and referrals; the theater nurse and surgeon provided procedural insights; the anesthesiologist gave first-hand knowledge on infrastructure

and equipment functionality; and the HR focal person contributed essential data on workforce numbers, cadres, and staffing arrangements.

The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

3.3 Included Facilities

The study utilized total sampling method. Population comprised of all public district hospitals in Rwanda (N = 43). Inclusion criteria required hospitals to be District Hospitals according to the Rwanda MoH definition. Hospitals were excluded if they were tertiary or specialized institutions, private facilities, or undergoing renovation and unable to provide surgical services during the study period.

3.3.1 justification for Sampling method

Although statistical calculations estimated a minimum required sample size of 39 district hospitals, this study employed a total population sampling approach, including all 43 district hospitals in Rwanda. This decision was made to ensure full national representation, eliminate selection bias, and enhance the external validity and policy relevance of the findings. Given the manageable sample size and logistical feasibility of conducting one-on-one assessments per facility, total sampling was practical.

3.4 Data Collection Tools and Procedures

3.4.1. Tool description and adaptation

The primary data collection instrument was the WHO SAT-EESC. Developed by the WHO Global Initiative for Emergency and Essential Surgical Care, this standardized facility assessment tool covers five core domains: infrastructure, human resources, equipment, supplies, and surgical volume. For the purposes of this study, the tool was adapted, not in its core content, but through the following refinements:

- Translation to Kinyarwanda to ensure comprehension among all respondents based on the back- forward translation method (World Health Organisation, 2010).
- Digitization using REDCap for efficient mobile-based data collection.
- Reorganization of question order to align survey content with respondent roles. Questions were grouped by key informant type (e.g., data manager, anesthetist, HR officer), enabling focused interviews with each cadre and reducing the likelihood of missed items.
- Supplementation with custom modules to capture monthly surgical volume and the availability and performance of Bellwether procedures (cesarean section, laparotomy, and open fracture management), disaggregated by provider cadre (e.g., general practitioners, obstetricians, surgeons). These additions were collaboratively developed by the principal investigator and research team based on national NSOAP indicators and global surgery benchmarks.

The final Research Electronic Data Capture (REDCap) based tool maintained the structure of the original WHO SAT-EESC but was reorganized into sequential modules aligned with the roles of six hospital key informants. The finalized version is included in Appendix 3.

3.4.2 Data Collection Procedures

Data collection was conducted by a team of trained research assistants (RAs) under the supervision of the principal investigators (PIs). Fieldwork spanned all 43 district hospitals across Rwanda. At each facility, six purposively selected key informants, the data manager, operating theatre nurse, surgeon, anesthesiologist, clinical coordinator, and human resources focal person, participated in structured interviews based on their domain-specific knowledge.

To enhance the internal validity of the study and reduce selection and information bias, triangulation was built into the process: each facility's findings were cross verified through document reviews such as surgical logbooks and structured walk-through observations. All data were entered in real-time into the REDCap platform, and automatic validation rules minimized entry errors.

3.4.3 Pilot testing and Quality assurance

Prior to the national rollout, a pilot phase was conducted in four district hospitals located in Kigali City (Kaciyiru DH, Kibagbaga L2TH, Muhima DH, and Nyarugenge DH). This pilot aimed to test the usability of the adapted WHO SAT-EESC tool, assess interviewer comprehension, and refine the logistical workflow for field implementation. One PI alternated between the two RA teams during this phase, providing direct supervision and immediate feedback to ensure consistency in data collection procedures. While no major modifications were made to the tool's core content, the pilot phase led to minor refinements in interview sequencing and adjustments to REDCap skip logic based on user experience. Importantly, because the study employed a total population sampling strategy and the pilot facilities were part of the national sample, the data collected during the pilot was retained in the final dataset. The pilot phase also played a critical role in enhancing inter-rater reliability and standardizing data collection protocols across the research team.

3.5 Measures

Using the adapted WHO SAT-EESC, we collected data on quantitative variables, which will provide objective measurements of emergency surgical service availability, workforce distribution, infrastructure reliability, and surgical volume (see **Error! Reference source not found.**).

Table 1 Overview of variables from the WHO -SAT EESC and DHIS 2

Variable	Measurement	Type
Infrastructure		
Number of beds, admissions, deliveries, ORs, etc.	Absolute count	Continuous

Availability of running water, electricity, oxygen source, sterilization, etc.	Availability status (All the time / Sometimes / Not available)	Categorical
Workforce		
Number of surgeons, anesthetists, nurse anesthetists, general practitioners, midwives, etc.	Absolute count (full-time, part-time)	Continuous
Surgical Capacity		
Performance of 35 tracer procedures	Yes / No	Categorical
Referral pattern for procedures not performed	Referred: Yes / No	Categorical
Reason for referral	Lack of skill / Equipment / Supplies	Categorical
Surgical Volume		
Total number of surgeries in 3 months	Absolute count	Continuous
Proportion of procedures by provider type (surgeon vs non-surgeon)	Percentage	Categorical
Type of procedure (Major vs Minor)	Classification	Categorical

For the purpose of analysis and to align with international benchmarks, we define the following key measures that will inform the assessment of emergency surgical care delivery in Rwanda (Table 2).

Table 2 Measures

Objective	Key Measure	Threshold / Benchmark	Source
1. Infrastructure Readiness	Availability of essential infrastructure (ORs, oxygen source, electricity, water, sterilization, etc.)	≥70% of essential items available *all the time* at each hospital	WHO SAT-EESC
2. Workforce Availability	SAO (Surgeon, Anesthetist, Obstetrician) density	≥20 per 100,000 population	Lancet Commission on Global Surgery
	Task-sharing capacity (e.g., GPs performing major procedures)	Proportion of surgeries performed by non-specialists	WHO SAT-EESC and DHIS2
3. Surgical Volume	Surgical volume rate	≥5,000 procedures per 100,000 population/year	Lancet Commission

4. Service Availability	Performance of Bellwether procedures (CS, laparotomy, open fracture)	All 3 procedures available = basic capacity	WHO SAT-EESC

3.6 Data Management and Cleaning Process

Following completion of data collection, the full dataset was exported from REDCap into Statistical Package for the Social Sciences (SPSS) in both CSV and Excel formats for cleaning and analysis. A rigorous multi-step data management protocol was implemented to ensure completeness, consistency, and integrity of the dataset. The original raw dataset was immediately backed up in a secure, password-protected repository to preserve an unaltered version for reference.

The first stage of cleaning involved a preliminary assessment of data completeness. Variables were examined for missingness using summary statistics functions in Excel. Any variable with more than 5% of missing data was flagged for review, and a log of missing values was maintained. Incomplete responses were reviewed against original field notes, and where necessary, clarification was sought from data collectors.

Next, consistency and validity checks were performed. Categorical variables were examined to ensure alignment with the WHO SAT-EESC tool's predefined categories. Any discrepancies, typographical errors, or misclassifications were corrected. For continuous variables, logic checks were applied to identify implausible values such as negative surgical volumes or extreme outliers in workforce counts. Implausible entries were flagged and reviewed for correction through data collector follow-up or triangulation with administrative records.

Duplicate data entries were identified using Excel filters. Confirmed duplicates were removed after verifying with field teams. Outliers were detected using interquartile range (IQR) rules and visualized using boxplots and Z-scores. Outliers were either retained (if reflecting genuine variability) or corrected/removed with documented justification.

Cross-variable logic checks were then conducted to assess internal consistency. For example, hospitals indicating that they performed orthopedic procedures but reported zero general surgeons or orthopedic surgeons were flagged for contradiction. Logical inconsistencies were reviewed and clarified with data collectors where needed.

Standardization of variables was a final essential step. Categorical response codes were unified (e.g., "1" for Yes, "0" for No), and date and numeric formats were standardized for consistency. All data transformations were documented thoroughly. A comprehensive data cleaning log was maintained, detailing all corrections, transformations, and justifications, ensuring full transparency and reproducibility.

A final validation step was carried out using descriptive statistics, including frequency tables, histograms, and cross-tabulations, to confirm that the cleaned dataset was accurate and analytically robust. This review was conducted collaboratively with the research supervisor and

data team. The finalized clean dataset was saved as Cleaned_WHO_EESC_Rwanda_ [24/06/2025].csv, archived securely, and used for subsequent analysis.

3.7 Data Analysis

All data were analyzed using IBM SPSS Statistics version 27 (I. B. M. Corp, 2020). Continuous variables were evaluated for normality using visual (histograms, boxplots, Q-Q plots) and statistical (Shapiro-Wilk) methods.

Descriptive statistics were first computed. For the comparison of variables between urban and rural hospitals, the Mann–Whitney U test was used for non-normally distributed continuous variables, and Chi-square tests were used for categorical variables.

To assess regional variations across Rwanda's provinces and Kigali, the Kruskal–Wallis H test was used to compare surgical volume, procedure types, workforce availability, and infrastructure indicators across more than two independent groups. Where significant differences were detected ($p < 0.05$), post hoc pairwise comparisons were conducted using Mann–Whitney U tests with Bonferroni correction to identify the source of variation.

Spearman's rank correlation was used to assess the bivariate relationships between surgical volume and potential continuous predictors such as number of beds, surgical providers, and operating room capacity.

Variables that were theoretically considered important and that showed a statistically significant association with surgical volume in bivariate analysis ($p < 0.05$) were entered into a multivariable linear regression model using the backward method. The dependent variable was total annual surgical volume. Independent variables included the number of hospital beds, surgeons, anesthesiologists, obstetricians, midwives, and operating rooms. Assumptions of linearity, independence of residuals (assessed via Durbin-Watson statistics), homoscedasticity, and multicollinearity (assessed via Variance Inflation Factor [VIF] and tolerance values) were examined and met. Variables with VIF > 5 or condition indices > 10 were evaluated for multicollinearity and excluded if necessary.

Statistical significance was set at $p < 0.05$ for all analyses. For the post hoc pairwise comparisons following the Kruskal–Wallis test across five regions (four provinces and Kigali), Bonferroni correction was applied to control for multiple testing. Since there are 10 possible pairwise comparisons [$(5 \times 4) / 2 = 10$], the adjusted alpha level was set at 0.005 (0.05/10).

Spatial analysis was conducted using QGIS version 3.40.2 (QGIS Geographic Information System, 2024) to generate thematic maps depicting district-level variations in surgical workforce density (SAO and non-specialist providers), and surgical volume per 100,000 population. This visual mapping highlighted geographic inequities and informed regional targeting for surgical system strengthening. Maps are categorized to reflect national targets.

Furthermore, a sub-analysis was conducted in four purposively selected district hospitals (two urban and two rural) to explore task-shifting practices. Operative registers were reviewed to determine the cadre (specialist vs. general practitioner) responsible for performing general surgery and obstetric procedures. The proportion of procedures conducted by general

practitioners was calculated to quantify the extent of task-sharing in district-level surgical care delivery.

3.8 Ethical consideration

This study received ethical approval from the Institutional Review Board (IRB) of the University of Global Health Equity. Participation involved minimal risk, primarily related to time constraints during survey administration. To mitigate these risks, interviews were scheduled at times convenient to participants. Informed consent was obtained both verbally and in writing. No clinical interventions or sensitive personal data were involved, and no monetary compensation was offered; however, participants were offered a summary of the study findings in appreciation of their time. Data security was maintained through password-protected electronic storage and locked cabinets for physical materials. In line with UGHE's ethical guidelines, all data will be retained for ten years before secure destruction.

Chapter 4 Results

4.1. Overview

After receiving IRB approval, MoH clearance, and administrative clearance from each district hospitals director generals, data from all the 43 district hospitals across Rwanda was collected using the WHO SAT-EESC, encompassing facilities from all five provinces: East, West, North, South, and Kigali City. The findings provide a comprehensive picture of the availability, capacity, and readiness of essential surgical care services at the district level. IRB approval and MoH clearance are presented in Appendix 4 and 5.

4.2. Descriptive Analysis

Descriptive analysis was conducted to summarize surgical workforce distribution, infrastructure availability, and surgical volume across the 43 district hospitals. Normality tests revealed that most continuous measures were not normally distributed; therefore, results are presented using medians and interquartile ranges for continuous variables, while categorical variables are presented with frequencies and proportions. These descriptive findings formed the basis for subsequent regional and facility-level comparisons.

4.2.1 Infrastructure

Overall, infrastructure availability was robust across district hospitals, with more than half (88%) of the assessed items available consistently in over 80% of facilities. Table 3 presents the availability status of 17 essential infrastructure and utility items assessed using the WHO SAT-EESC tool. Items are ordered by the proportion of facilities reporting uninterrupted availability ("All the time"). The five items that were available *all the time* in over 95% of facilities included: medical records (100%), hemoglobin and urine testing (100%), functional x-ray machine (95.3%), functional pulse oximeter (95.3%), and electricity (93%). These represent core inputs for both routine and emergency surgical care.
Conversely, the two items with *less than 50% availability* "all the time" were the oxygen concentrator (58.1%) and the blood bank (32.6%).

Table 3. Availability of Key Infrastructure and Utilities

	All the time N (%)	**Sometimes N (%)**	**Not Available N (%)**
Medical records	43 (100)	0 (0)	0 (0)
Hemoglobin and Urine Test	43 (100)	0 (0)	0 (0)
Generator	42 (97.7)	1 (2.3)	0 (0)
Functional x-ray machine	41 (95.3)	2 (4.7)	0 (0)
Functional pulse oximeter	41 (95.3)	1 (2.3)	1 (2.3)
Electricity	40 (93)	3 (7)	0 (0)

Designated for post-operative area	40 (93)	1 (2.3)	2 (4.7)
Oxygen Cylinder	39 (90.7)	1 (2.3)	3 (7)
Anesthesia machine	39 (90.7)	2 (4.7)	2 (4.7)
Management guideline for anesthesia	39 (90.7)	0 (0)	4 (9.3)
Management guideline for pain management	39 (90.7)	1 (2.3)	3 (7)
Designated area for emergency care	39 (90.7)	2 (4.7)	2 (4.7)
Management guideline for emergency care	36 (83.7)	2 (4.7)	5 (11.6)
Running Water	35 (81.4)	8 (18.6)	0 (0)
Management Guideline for surgery	32 (74.4)	1 (2.3)	10 (23.3)
Oxygen Concentrator	25 (58.1)	3 (7)	15 (34.9)
Blood Bank	14 (32.6)	3 (7)	26 (60.5)

4.2.2 Workforce

Overall, workforce distribution was highly variable, with notable disparities across regions and facilities. In total, the distribution of key surgical workforce across all 43 district hospitals included 42 surgeons, 46 anesthesiologists, 52 obstetricians, 530 general practitioners, and 286 non-physician anesthetists.

Rwanda's SAO density at the district hospital level remains significantly below the LCoGS benchmark of 20. Only 17 out of 43 hospitals (39.5%) had at least one full-time surgeon, and even fewer met minimum thresholds across all three SAO cadres.

The median number of surgeons and obstetricians per hospital was 1 (IQR 0–3, and 0–5 respectively), while anesthesiologists ranged from 0 to 11 with a median of 1. Notably, 15 hospitals (34.9%) had no anesthesiologist at all. Reliance on general practitioners and non-physician anesthetists (NPA) for surgical service delivery was widespread, especially in rural or under-resourced hospitals lacking full-time specialists. Midwives were the most evenly distributed cadre, with a median of 9 per hospital (IQR 6–12), while non-physician anesthetists had a median of 2 (IQR 1–4). A facility-level comparison of workforce availability is detailed in

Table 4.

Table 4. Distribution of Surgical Human Resources

District Name	Facility Name	Surgeons	Anesthesiologists	Ob/Gyn	GPs	Mid-wives	Nurse Anesthetists
East							
Bugesera	Nyamata L2 DH	1	1	3	12	51	12
Gatsibo	Kiziguro DH	0	0	0	16	20	6

Gatsibo	Ngarama DH	1	0	0	16	11	6
Kayonza	Gahini DH	6	2	1	12	17	8
Kayonza	Rwinkwavu DH	1	0	1	15	21	5
Kirehe	Kirehe DH	1	1	3	11	12	10
Ngoma	Kibungo L2 DH	2	0	1	13	29	9
Nyagatare	Gatunda DH	0	0	0	11	14	3
Nyagatare	Nyagatare DH	1	1	2	20	17	7
Rwamagana	Rwamagana L2DH	2	1	4	12	36	10
Kigali City							
Gasabo	Kacyiru DH	0	0	5	26	52	12
Gasabo	Kibagabaga L2DH	7	1	3	7	66	14
Kicukiro	Masaka DH	0	0	1	24	42	11
Nyarugenge	Muhima DH	0	0	5	15	53	8
Nyarugenge	Nyarugenge DH	0	0	1	10	31	8
North							
Burera	Butaro L2DH	2	2	0	9	12	6
Gakenke	Gatonde DH	0	0	0	10	5	12
Gakenke	Nemba DH	0	0	0	15	15	4
Gakenke	Ruli DH	1	4	1	18	11	4
Gicumbi	Byumba L2DH	1	1	3	16	32	10
Musanze	Ruhengeri L2DH	4	11	3	30	39	10
Rulindo	Rutongo DH	0	0	0	8	12	5
South							
Gisagara	Kibilizi DH	0	0	0	8	16	5
Gisagara	Gakoma DH	0	0	0	9	13	1
Huye	Kabutare DH	0	0	1	11	15	4
Kamonyi	Remera Rukoma DH	0	0	0	15	12	5
Muhanga	Nyabikenke DH	0	0	0	9	2	4
Muhanga	Kabgayi L2DH	2	1	1	13	36	9
Nyamagabe	Kigeme DH	0	5	0	11	13	5
Nyamagabe	Kaduha DH	0	0	0	6	6	4
Nyanza	Nyanza DH	0	0	1	15	24	7
Nyaruguru	Munini DH	1	0	0	8	5	4
Ruhango	Gitwe DH	0	4	1	10	6	4
West							
Karongi	Mugonero DH	1	0	0	11	10	4
Karongi	Kirinda DH	0	0	0	7	8	3
Rutsiro	Murunda DH	0	0	0	10	7	5
Rubavu	Gisenyi DH	1	1	2	11	30	12
Nyabihu	Shyira DH	0	0	0	17	17	6
Ngororero	Muhororo DH	1	4	0	9	9	4
Ngororero	Kabaya DH	0	0	0	11	4	3
Rusizi	Mibilizi DH	0	0	2	11	10	6

Rusizi	Gihundwe Dh	1	0	1	0	12	2
Nyamasheke	Kibogora L2DH	4	1	2	15	18	8

4.2.3 Surgical Volume

In the study period, surgical volume was assessed as the total number of procedures from all district hospitals which amounted to 151,032. The surgical volume also showed notable variation, 15 out of the 43 (34.9%) district hospitals had bellwether procedure capabilities. The median total number of surgical procedures per hospital was (3,356), with interquartile range (1,340 to 4,882). Level two teaching hospitals such as Ruhengeri L2TH (15,826), and Kibungo L2TH (9,301) reported the highest surgical volumes, while hospitals like Gitwe DH (855) and Nyabikenke DH (1,150) reported significantly lower volumes. Cesarean sections were the most performed procedure, with a median of 1,200 per year, followed by hysterectomies and laparotomies. (Summary of Descriptive Statistics is given in Table 5)

Table 5. Summary Descriptive Statistics for All Variables (N = 43)

Variable	Median (IQR)	Min	Max
Infrastructure			
Number of hospital beds	28 (21–54)	4	83
Number of operating rooms	2 (1–2)	1	6
Referrals/year	106 (63–159)	0	1515
Average distance travelled to facility (km)	19 (12–28)	2	94
Distance travelled referred elsewhere (km)	75 (47–139)	3	382
Workforce			
Surgeons	1 (0–2)	0	3
Anesthesiologists	1 (0–1)	0	4
Obstetricians	1 (1–3)	0	5
Midwives	9 (6–12)	2	30
Anesthetists (non-physician)	2 (1–4)	2	14
Surgical Volume			
Total surgical procedures	2,909 (1,554–4,300)	600	15,826
Cesarean sections	1,205 (804–2,463)	266	3,385
Hysterectomies	4 (0–21)	0	86
Laparotomies	25 (2–69)	0	290
Hernia repairs	4 (1–95)	0	316
Debridement	18 (38–95)	0	367
Fracture reductions	29 (31–71)	0	2309
External fixators	0 (0–0)	0	447
Amputations	0.5 (0–11)	0	33
Clubfoot surgeries	0 (0–3)	0	363
Skin grafts	0 (0–2)	0	48
Cleft lip/palate repairs	0 (0–0)	0	33

Drainage for osteomyelitis	0 (0–3)	0	134

4.3. Inferential Analysis

4.3.1. Analysis of correlation between surgical volume and referral to higher centers

The capacity of each district hospital to perform key surgical procedures was assessed through provider interviews and direct facility walkthroughs. Table 6 presents a summary of the availability of 30 surgical procedures across Rwanda's 43 district hospitals.
Basic emergency interventions such as incision and drainage, suturing, wound debridement, and cesarean sections were universally available. In contrast, access to advanced or specialized procedures was markedly limited. For example, only 1 facility reported the ability to perform cleft lip/palate repair, and fewer than 30% could manage cricothyroidotomy, open fractures, or neonatal surgery. Laparotomy, one of the Bellwether procedures, was available in 34 hospitals (79.1%), while appendectomy was available in just 16 (37.2%).

This wide disparity in surgical volume, especially for complex interventions, raised important questions about functional surgical capacity across the system. A preliminary review of the data revealed considerable variability in both surgical volume and the number of inpatient referrals to higher-level centers, suggesting possible gaps in local service delivery. For instance, some high-volume facilities had relatively few referrals, while others with moderate surgical output referred large numbers of patients.

Table 6 *Availability* of Surgical Procedures*

	Available N (%)	**Not Available N (%)**
Biopsy	26 (60.5)	17 (39.5)
Incision and Drainage	43 (100)	0 (0)
Male circumcision	42 (97.7)	1 (2.3)
Removal of foreign body	38 (88.4)	5 (11.6)
Suturing	43 (100)	0 (0)
Wound Debridement	43 (100)	0 (0)
Acute Burn care	43 (100)	0 (0)
Chest tube	23 (53.5)	20 (46.5)
Cricothyroidotomy	9 (20.9)	34 (79.1)
Resuscitation	41 (95.3)	2 (4.7)
Appendectomy	16 (37.2)	27 (62.8)
Contracture release and skin grafts	14 (32.6)	29 (67.4)
Hernia repairs	25 (58.1)	18 (41.9)
Hydrocele	27 (62.8)	16 (37.2)
Laparotomy	34 (79.1)	9 (20.9)
Cesarean Section	43 (100)	0 (0)
Dilatation and Curettage	33 (76.7)	10 (23.3)

Obstetric Fistula Repair	17 (39.5)	26 (60.5)
Tubal Ligation and Vasectomy	41 (95.3)	2 (4.7)
Amputation	18 (41.9)	25 (58.1)
Closed Treatment of Fracture	40 (93)	3 (7)
Club foot repair	12 (27.9)	31 (72.1)
Drainage of osteomyelitis and Septic arthritis	24 (55.8)	19 (44.2)
Joint Dislocation management	36 (83.7)	7 (16.3)
Open fracture treatment	15 (34.9)	28 (65.1)
Cataract Surgery	12 (27.9)	31 (72.1)
Cleft lip/ Cleft palate repair	1 (2.3)	42 (97.7)
Neonatal Surgery	5 (11.6)	38 (88.4)
Cystotomy	20 (46.5)	23 (53.5)
Urethral stricture dilation	5 (11.6)	38 (88.4)

"Available" refers to facilities reporting they **have the capacity and resources to perform the listed procedures when indicated, regardless of whether the procedure was actually performed during the study period.*

A preliminary review of facility-level data shown in Table 7 revealed marked variation in both surgical volume and the number of inpatient referrals to higher centers, with no immediately apparent linear pattern across districts. For example, Ruhengeri Level 2 Teaching Hospital reported the highest surgical volume (15,826 procedures) but only 112 referrals, while Byumba Level 2 Teaching Hospital had a high referral count of 1,515 despite performing only 4,293 surgeries. Similarly, Kibogora L2TH reported 8,734 surgeries but still referred to 822 patients. In contrast, Muhima DH conducted 3,781 surgeries and reported no referrals at all. These mixed patterns suggested the need for formal statistical assessment.

Table 7. Surgical Volume and Referral frequency

District Name	Facility Name	Number of Referrals to higher centers	Total Procedures
East			
BUGESERA	Nyamata L2TH	95	5025
GATSIBO	Kiziguro DH	108	2021
GATSIBO	Ngarama DH	59	1711
KAYONZA	Gahini DH	42	3527
KAYONZA	Rwinkwavu DH	77	1790
KIREHE	Kirehe DH	160	4538
NGOMA	Kibungo L2TH	104	5145
NYAGATARE	Gatunda DH	87	2452
NYAGATARE	Nyagatare DH	164	3290
RWAMAGANA	Rwamagana DH	73	3453
Kigali City			

GASABO	Kacyiru DH	22	3600
GASABO	Kibagabaga L2TH	82	5004
KICUKIRO	Masaka DH	99	3168
NYARUGENGE	Muhima DH	0	3781
NYARUGENGE	Nyarugenge DH	19	3566
North			
BURERA	Butaro L2TH	81	1792
GAKENKE	Gatonde DH	55	944
GAKENKE	Nemba DH	30	1941
GAKENKE	Ruli DH	90	859
GICUMBI	Byumba L2TH	1515	4293
MUSANZE	RUHENGERI L2TH	112	15826
RULINDO	Rutongo DH	17	1428
South			
GISAGARA	Kibilizi DH	200	1242
GISAGARA	Gakoma DH	109	1667
HUYE	Kabutare DH	478	2806
KAMONYI	Remera Rukoma DH	112	1657
MUHANGA	Nyabikenke DH	1	600
MUHANGA	Kabgayi L2TH	92	9124
NYAMAGABE	Kigeme DH	147	3012
NYAMAGABE	Kaduha DH	348	700
NYANZA	Nyanza DH	265	3025
NYARUGURU	Munini DH	112	1006
RUHANGO	Gitwe DH	129	1738
West			
KARONGI	Mugonero DH	115	1421
KARONGI	Kirinda DH	0	2087
RUTSIRO	Murunda DH	204	4045
RUBAVU	Gisenyi DH	145	9945
NYABIHU	Shyira DH	619	5059
NGORORERO	Muhororo DH	31	5529
NGORORERO	Kabaya DH	54	1877
RUSIZI	MIBILIZI DH	157	2298
RUSIZI	GIHUNDWE DH	674	4306
NYAMASHEKE	Kibogora L2TH	822	8734

To assess the hypothesis, whether the number of surgical referrals to higher levels is associated with surgical volume, a Spearman's rank correlation was conducted using data from all 43 district hospitals across Rwanda. This approach was chosen after normality tests (Shapiro-Wilk)

indicated that both surgical volume ($W = 0.767$, $p < 0.001$) and referral counts ($W = 0.579$, $p < 0.001$) were not normally distributed.

No statistically significant correlation was found between surgical volume and surgical referrals ($r = 0.14$, $p = 0.38$), suggesting that referral frequency does not meaningfully track with surgical output. In other words, higher-volume facilities do not consistently refer more or fewer patients than lower-volume facilities.

We visualized the relationship between referral frequency and surgical volume using a quadrant-based scatter plot (Appendix 1), although no clear clustering or consistent typologies emerged. While some high-volume hospitals such as Kabgayi and Ruhengeri fall into the "High Volume, Low Referral" quadrant, this pattern was not uniform across all facilities. Several hospitals with similar surgical volumes showed widely varying referral behaviors, and no quadrant appeared to dominate in size or composition.

Given the weak and non-significant Spearman correlation ($\rho = 0.19$, $p = 0.22$) and the absence of visually distinct groupings, the scatter plot primarily serves as a descriptive illustration rather than a foundation for inferential conclusions.

4.3.2 Comparing Surgical Capacity between Urban and Rural Hospitals

The Mann–Whitney U test was conducted for all continuous and ordinal variables. Significant differences were observed in the distribution of workforce and select surgical procedures between the two settings as shown in (Table 8).

The number of midwives was significantly higher in urban hospitals, with a median of 11 compared to 7 in rural hospitals ($U = 120.0$, $p = .003$). Similarly, urban facilities had more non-physician anesthetists (NPAs') than rural facilities ($U = 138.0$, $p = .017$). No statistically significant differences were found between urban and rural settings for the number of surgeons, anesthesiologists, or obstetricians.

In terms of surgical procedures, cesarean sections were more frequently performed in urban hospitals, with a statistically significant difference ($U = 140.0$, $p = .041$). Hysterectomy volumes also differed, favoring urban hospitals ($U = 141.5$, $p = .038$). Other procedures, including laparotomy, hernia repair, debridement, and amputations, did not show statistically significant differences between the two settings.

There were no significant differences in infrastructure availability such as access to oxygen, electricity, water, and anesthesia machines, or in the average distance to the facilities between urban and rural hospitals, except on the distance travelled if patients were referred elsewhere ($U= 93.5$, $p= 0.003$).

Table 8. Urban vs. Rural Comparison of Key Variables (Median values and P values, N = 43)

	Variable	Mean Rank		p-value
		Rural	Urban	
Infrastructure	Number of beds	23.23	21.34	0.637
	Annual surgical admission	22.07	21.96	0.98
	Operating rooms	23.93	20.96	0.44
	Average distance traveled to facility (km)	19.93	23.11	0.352
	Referral frequency	24.43	20.7	0.352
	Distance travelled if referred elsewhere (km)	29.77	17.84	0.003*
Workforce	Surgeons	24.6	20.61	0.267
	Anesthesiologists	21.03	22.52	0.642
	Obstetricians	18.5	23.88	0.192
	GPs'	22.03	21.98	0.99
	Midwives	18.3	23.98	0.003*
	Anesthetists (non-physician)	19	23.61	0.017*
Surgical Volume	Total surgical procedures	20.67	22.71	0.507
	Cesarean sections	20.6	22.75	0.041*
	Hysterectomies	20.5	22.8	0.038*
	Fistula Repair	20.43	22.84	0.502
	Laparotomies	21.03	22.52	0.432
	Hernia repairs	22.37	21.8	0.569
	Debridement	23.03	21.45	0.288
	Amputations	21.5	22.27	0.324
	Fracture reductions	17.8	24.25	0.127
	External fixators	22.53	21.71	0.58
	Clubfoot surgeries	20.97	22.55	0.618
	Cleft lip/palate repair	21.7	22.16	0.394
	Skin grafts	24.07	20.89	0.513
	Osteomyelitis drainage	22.7	21.63	0.254

** Indicates statistical significance at $p < 0.05$.*

4.3.3 Geographic Disparities in Surgical Capacity: A Provincial-Level Analysis

Kruskal– Wallis H test revealed statistically Kruskal–Wallis H test revealed significant differences in total surgical volume across the five regions ($\chi^2(4) = 10.18$, $p = 0.037$), with the Southern and Western provinces exhibiting higher volumes. Significant disparities were also detected in the number of cesarean sections ($p = .036$), hysterectomies ($p = .026$), and laparotomies ($p = .019$), again with Southern and Western hospitals performing more procedures on average. In contrast, no significant regional variation was found for other procedures such as hernia repairs, amputations, or fracture management. Regarding workforce distribution, the number of midwives ($p = .002$), obstetricians ($p = .030$), and non-physician anesthetists ($p = .007$) differed significantly by region. Southern and Western provinces consistently demonstrated

stronger workforce presence, which likely contributes to their higher surgical volumes. However, no statistically significant differences were identified for the number of surgeons (p = .103) or anesthesiologists (p = .477) across regions, suggesting a more uniform, albeit limited distribution of surgical specialists nationally.

Furthermore, no significant regional disparities were found in infrastructure availability, including access to critical resources such as electricity (p = .716), oxygen (p = .509), water (p = .828), anesthesia machines (p = .598), or blood bank availability (p = .654). This suggests that while physical infrastructure is generally consistent nationwide, differences in surgical output may be more attributable to human resource capacity and clinical service organization.
(see Table 9)

Table 9 Regional Comparison of Variables Using Kruskal–Wallis H Test (N = 43)

	Variable	χ^2 (df = 4)	p-value	Median				
				Kigali	**North**	**East**	**South**	**West**
	Number of beds	0.465	0.977	32	26	26.5	26	33
	Annual Surgical Admissions	9.486	0.05	4684	2204	5917.5	1749	2788.5
Infrastructure	Number of OR	1.078	0.898	3	2	2.5	3	2
	Average distance to facility (km)	16.147	0.003*	17	10	15	18	20
	Distance if referred elsewhere (km)	18.819	0.001*	25	35	30	45	38
	Access to electricity	2.103	0.716	2	2	2	2	2
	Access to oxygen	3.294	0.509	2	2	2	2	2
	Access to water	1.487	0.828	2	2	2	2	2
	Blood bank	2.941	0.654	1	1	1	1	1
	Access to anesthesia machines	3.678	0.598	2	2	2	2	2
Workforce	Surgeons	7.7	0.103	1	0	1	0	0
	Anesthesiologists	3.506	0.477	0	0	1	0	0
	Obstetricians	10.735	0.03*	1	0	1	0	1
	GPs	6.776	0.148	10	5	9	6	8
	Midwives	16.724	0.002*	36.5	13	21	15	24
	Anesthetists (non-phys.)	14.026	0.007*	12	5	8	6	10
Surgical Volume	Total surgical procedures	10.184	0.037*	3625	1792	3453	3012	5059
	Cesarean sections	10.3	0.036*	3673	1590	3285	2965	4924
	Hysterectomies	11.027	0.026*	25	10	19	21	34
	Laparotomies	11.779	0.019*	61	30	54	57	81
	Hernia repairs	7.166	0.127	100	85	95	110	105
	Debridement	5.101	0.277	120	90	115	105	130
	Amputations	6.659	0.155	30	20	35	25	40

Fracture reduction	0.891	0.926	15	12	18	14	20
External fixator	2.868	0.58	6	5	7	6	8
Skin grafts	3.276	0.513	5	4	5	6	7
Drainage for osteomyelitis	5.338	0.254	10	9	11	8	12
Clubfoot surgeries	2.649	0.618	2	1	3	1	2
Cleft lip/palate repair	4.092	0.394	1	0	0	0	1

** Indicates statistical significance at $p < 0.05$.*

For variables where the Kruskal–Wallis test revealed significant results, we conducted post hoc pairwise comparisons to determine which specific regional pairs differed. These comparisons were performed using Mann–Whitney U tests between region pairs. To mitigate the increased risk of Type I error from multiple comparisons, we applied a Bonferroni correction, adjusting the significance threshold to $\alpha = 0.005$. A Bonferroni-adjusted alpha of 0.005 (0.05/10) was used to control for multiple comparisons.

Significant differences in were found primarily between Southern and Western provinces vs. Kigali or Eastern province, especially in midwives, NPAs, and distance travelled if referred elsewhere. (seeTable 10)

Table 10. Pairwise Bonferroni-Adjusted P-values for Regional Differences in Surgical Capacity Indicators among Rwanda's Provinces

		P-value				
		Kigali	**North**	**East**	**South**	**West**
Total Surgical procedures	**Kigali**		0.167	1	0.026*	0.072
	North			0.205	0.01*	0.635
	East				0.013*	0.7
	South					0.029*
	West					
Cesarean Sections	**Kigali**		0.62	1	0.01 *	0.025*
	North			0.079	0.031*	1
	East				0.011*	0.082
	South					0.756
	West					
Hysterectomies	**Kigali**		0.103	1	0.034*	0.069
	North			0.353	0.024*	1
	East				0.018*	0.064
	South					0.458
	West					
Laparotomies	**Kigali**		0.167	1	0.026*	0.072
	North			0.205	0.01*	0.635

	East				0.013*	0.7
	South					0.231
	West					
Midwives	**Kigali**		0.291	1	0.004*	0.14
	North			0.26	0.011*	0.503
	East				0.023*	0.344
	South					0.515
	West					
Obstetricians	**Kigali**		0.053	1	0.043*	0.14
	North			0.767	0.011*	0.503
	East				0.023*	0.344
	South					0.916
	West					
Anesthetists	**Kigali**		0.102	1	0.013 *	0.032*
	North			0.384	0.025*	1
	East				0.006*	0.068
	South					0.914
	West					
Number of in-patient referrals	**Kigali**		0.291	0.066	0.011*	0.043*
	North			0.495	0.093	0.083
	East				0.035*	0.257
	South					0.673
	west					
Distance Traveled to Facility	**Kigali**		0.015*	0.357	0.047*	0.537
	North			0.017	0.785	0.003
	East				0.105	0.053
	South					0.006*
	West					
Distance traveled if referred elsewhere	**Kigali**		0.004*	0.02*	0.004*	0.002*
	North			0.261	0.751	0.017*
	East				0.481	0.096
	South					0.018
	West					

4.4. Spatial Analysis

4.4.1. Surgical Workforce Density and Distribution,

The spatial distribution SAO density (calculated by summing the total number of specialists in these three cadres, dividing by the hospital's estimated catchment population, and multiplying the result by 100,000) is presented in Figure *1*.

Across the 43 facilities with available data, the median SAO density was 0.78 per 100,000, with an interquartile range (IQR) from 0.00 to 1.07. This reflects substantial variability in workforce distribution, with over 25% of facilities reporting no specialists at all. The analysis revealed a clear geographic disparity in specialist distribution. Districts located in urban or peri-urban areas, particularly Nyarugenge (Muhima DH), Kayonza (Gahini DH), and Musanze DH demonstrated higher SAO densities, often exceeding 3.0 per 100,000. For example, Musanze DH reported 18 specialists, yielding an SAO density of 3.59 per 100,000; Muhima DH followed closely with a density of 3.66.

In contrast, 10 rural hospitals, including Kabaya, Shyira, Kirinda, Kiziguro, and Gatunda reported zero SAOs, reflecting a critical shortage of formally trained surgical specialists.

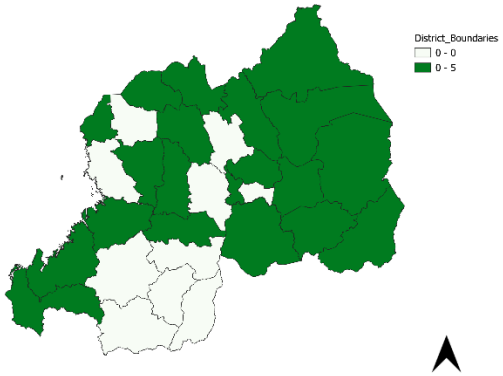


Figure 1 SAO Density Map by District; illustrates the district with SAO workforce and those with no SAO workforce

While SAO density remained low in many districts, Figure 2 illustrates the widespread presence of non-specialist surgical providers. For the purposes of this study, non-specialist surgical providers are defined as clinically trained personnel who perform or support surgical and anesthesia care but do not hold board-certified specialization in surgery, obstetrics/gynecology, or anesthesiology. This group includes general practitioners who perform essential surgeries and non-physician anesthetists who provide the majority of anesthesia services at district hospitals.

Across all district hospitals, the median non-specialist density was 6.76 per 100,000 population, with an interquartile range (IQR) of 4.83 to 8.69. Hospitals such as Gatonde DH, Kacyiru DH, and Muhima DH exhibited some of the highest non-specialist densities, exceeding 10 per 100,000 population. In Gatonde DH, for example, 22 non-specialist providers yielded a density of 21.36, one of the highest nationwide. Even facilities with no SAOs, such as Gakoma DH and Nyabikenke DH, relied on a cadre of general practitioners and surgical nurses to maintain services.

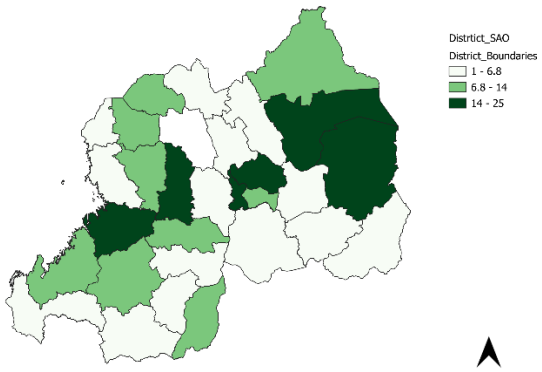


Figure 2. Non-Specialist Surgical Workforce Density Map, Illustrated the distribution of non-specialist surgical workforce compared to the calculated median (6.83) and the National Benchmark (25)

When specialist and non-specialist cadres were combined, the total surgical workforce density offered a more complete view of the national distribution of surgical personnel. In Figure 3 total workforce density was shown to be more evenly spread than SAO density alone. Across all facilities, the median total surgical workforce density was 6.89 per 100,000 population, with an interquartile range (IQR) from 5.47 to 10.79). This suggests that while central values were relatively consistent, some hospitals achieved much higher densities, often due to a strong presence of non-specialist providers.

District hospitals such as Muhima DH (20.47), Mugonero DH (18.27), and Kacyiru DH (13.28) stood out for having robust surgical teams with this calculation despite some lacking formal specialists. Conversely, facilities like Kabutare DH, Rutongo DH, and Nyabikenke DH had both low SAO and non-specialist densities, indicating broader system-level workforce challenges. The composition of the workforce varied by setting. Urban hospitals typically had a higher proportion of specialists, while rural hospitals depended predominantly on non-specialists. This variance reflects Rwanda's pragmatic model of mixed surgical service delivery, one that leverages generalist capacity while seeking to expand specialist coverage.

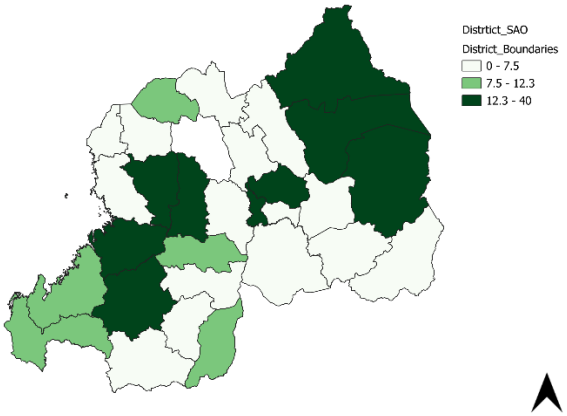


Figure 3 . Total Surgical Workforce Density Map; illustrates the distribution of the Workforce in totality against the national benchmark.

4.4.2. Surgical Volume

Figure 4 illustrates district-level variation in surgical volume (measured as the number of total surgical procedures performed per 100,000 catchment population). The analysis revealed substantial disparities in productivity. Across all facilities, the median surgical volume was 923.97 per 100,000, with an interquartile range (IQR) from 585.85 to 1,508.13. This wide range reflects variability in both service capacity and utilization across district hospitals.
Urban facilities such as Gisenyi DH (1,768.75), Muhima DH (2,764.72), and Gahini DH (1,579.67) reported consistently high surgical volumes. Notably, several rural hospitals, including Kibogora L2TH (3,200.16), Kabgayi L2TH (3,810.96), and Muhororo DH (2,944.98) achieved per capita surgical volumes that matched or exceeded urban centers.

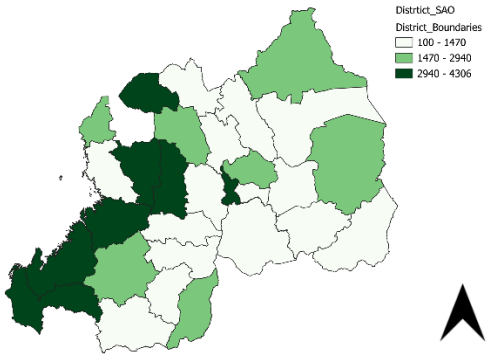


Figure 4 Surgical Volume per 100,000 Population; illustrates the distribution of surgical Volume clustered against the calculated median and the national target (5000)

4.5. Task-Shifting and Task-Sharing: Surgical Contributions of General Practitioners vs. Specialists

Across the four hospitals included in the sub-analysis a total of 17,965 surgical procedures were recorded during the study period. Overall, obstetric procedures accounted for 9,595 surgeries, or 53.4% of all procedures in the sample. General surgery comprised 4,448 procedures. Of the total procedures, Kibagabaga accounted for 7,965 surgeries and Gisenyi DH for 7,316, representing the highest volumes within the cohort. While complete emergency vs. elective breakdowns were only available at Gisenyi, it reported 2,739 emergency and 1,094 elective surgeries.

The analysis revealed striking differences in the extent of task-sharing between urban and rural settings. In rural hospitals, such as Kibungo and Rwinkwavu, GPs were responsible for the majority of obstetric procedures: 67.3% (1,393 of 2,070) in Kibungo and 93.7% (1,392 of 1,485) in Rwinkwavu. In contrast, Kibagabaga, an urban Level 2 teaching hospital, reported only 3.2% of obstetric procedures being conducted by GPs. Gisenyi DH, though urban, displayed atypical patterns, with 81.2% (2,553 of 3,146) of obstetric cases performed by GPs.

General surgical procedures, in contrast, were overwhelmingly performed by specialists across the sample. In Kibagabaga, Kibungo, and Rwinkwavu, 100% of general surgeries were conducted by specialists. The only exception was Gisenyi, where 13% (89 of 687) of general surgical procedures were performed by GPs.

Table 11 summarizes the distribution of surgical procedures by cadre and facility across the four hospitals assessed.

Table 11 Proportion of Procedures Performed by GPs vs. Specialists in Selected Hospitals

Facility Name	Obstetric Procedures	Performed by GPs, n (%)	Performed by Specialists, n (%)	General Surgery Procedures	Performed by GPs, n (%)	Performed by Specialists, n (%)	Emergency Procedures	Elective Procedures
Kibungo L2 TH	2,070	1,393 (67.3%)	677 (32.7%)	1,065	0 (0%)	1,065 (100%)	N/A	N/A
Kibagabaga L2 TH	2,202	71 (3.2%)	2,131 (96.8%)	1,013	0 (0%)	1,013 (100%)	N/A	N/A
Gisenyi District Hospital	3,146	2,553 (81.2%)	593 (18.8%)	2,335	89 (13%)	598 (87%)	2,615	531
Rwinkwavu District Hospital	1,485	1,392 (93.7%)	93 (6.3%)	67	0 (0%)	67 (100%)	N/A	N/A

4.6. Regression Analysis of Predictors of Surgical Output

Building on the descriptive and comparative analyses presented earlier, we used inferential statistical methods to identify factors independently associated with surgical output. While initial tests, such as the Mann–Whitney U, Kruskal–Wallis, and Spearman correlation, assessed associations and group differences, this section presents a multiple linear regression model to identify independent predictors of surgical output across district hospitals in Rwanda.

Prior to modeling, bivariate screening was conducted to examine the relationship between surgical volume and continuous hospital-level variables using Spearman's rank correlation. The number of midwives ($\rho = .633$, $p < .001$), anesthetists ($\rho = .550$, $p < .001$), obstetricians ($\rho = .600$, $p < .001$), anesthesiologists ($\rho = .396$, $p = .009$), hospital beds ($\rho = .484$, $p = .001$), operating room count ($\rho = .438$, $p = .003$), and surgeons ($\rho = .455$, $p = .002$) all showed significant positive associations with annual surgical volume.

Categorical variables, including oxygen source availability, presence of anesthesia machines, designated operating areas, and clinical guidelines, were evaluated using the Kruskal–Wallis H test. None of the infrastructure indicators showed statistically significant differences in surgical output at the $p < 0.05$ level and were excluded from the multivariate analysis.

Due to non-normality in the distribution of total surgical procedures, a logarithmic transformation of the dependent variable was applied to make the distribution normal (shown in Figure 5).

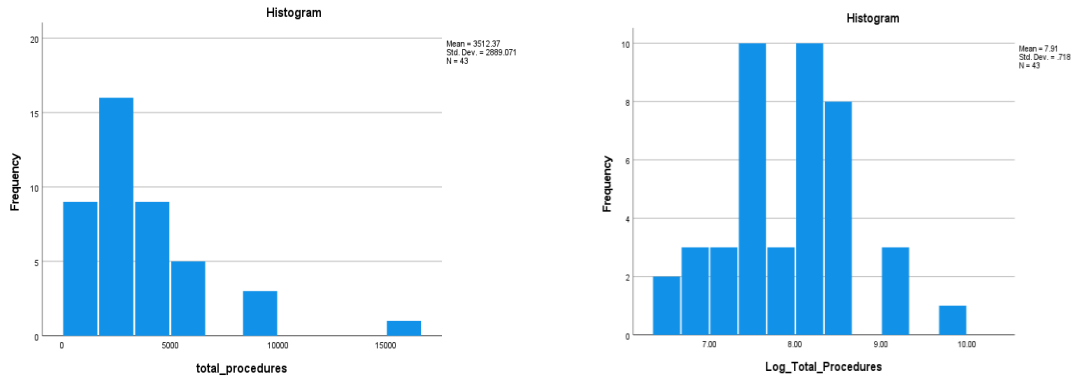


Figure 5 Histogram showing Right sked distribution of total procedure (Right) and normal distribution of natural log of total histogram (Left)

The final regression model was statistically significant, $F(3, 39) = 22.03$, $p < .001$, explaining 60.0% of the variance in log-transformed surgical volume (Adjusted $R^2 = 0.600$). Three predictors remained significant in the adjusted model as it was presented in Table 12:

- **Surgical admissions per year** ($B = 0.000096$, $p = .002$): Each additional surgical admission was associated with a proportional increase in surgical volume.

- **Number of hysterectomies** (B = 0.012, p = .004): Hospitals performing more hysterectomies saw a significant increase in total surgical output.
- **Number of anesthesiologists** (B = 0.076, p = .039): Each additional anesthesiologist was associated with a 0.076 unit increase in the log of annual surgical procedures.

The regression equation is:

Log (Surgical output) = 7.215 +0.000096×surgical admissions per year + 0.012× Number of Hysterectomies + 0.076× Anesthesiologists

All regression assumptions were adequately met, validating the model for interpretation and policy recommendations. Figure 6 illustrates the estimated coefficients and corresponding 95% confidence intervals for each predictor in the linear regression model. Multicollinearity was minimal, with all VIFs < 2. The Durbin–Watson statistic was 2.235, indicating residual independence. Homoscedasticity and normality of residuals were also confirmed via visual inspection of standardized residual plots and a histogram of residuals.

Table 12 Association Between Facility Characteristics and total procedures: Multiple Linear Regression Results

Variable	Coefficient (B)	Lower CI	Upper CI	p-value
Surgical Admissions	0.000096	0	0.00016	0.002*
Hysterectomies	0.012	0.004	0.02	0.004*
Anesthesiologists	0.076	0.004	0.148	0.039*
Midwives	0.007	-0.005	0.019	0.259
Surgeons	-0.057	-0.175	0.063	0.348
Obstetricians	-0.151	-0.341	0.21	0.662
Operating Rooms	-0.142	-0.205	0.045	0.251
Surgical Beds	0.007	-0.003	0.016	0.152

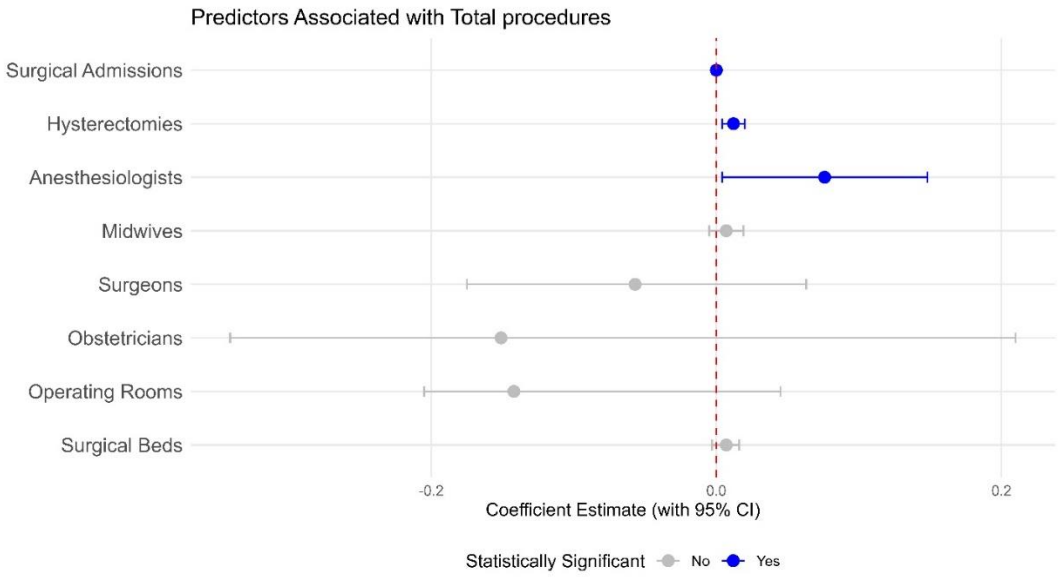


Figure 6 Forest plot showing the estimated regression coefficients and their 95% confidence intervals for predictors of total procedures. Predictors with confidence intervals that do not cross zero are considered statistically significant ($p < 0.05$) and are marked in blue. The red dashed vertical line represents the null effect ($B = 0$).

Chapter 5: Discussion

This comprehensive nationwide assessment of EESC in Rwanda provides critical insight into the status of district-level surgical capacity through the lens of the LCoGS indicators. This study found that Rwanda has made measurable strides in infrastructure and basic surgical procedure coverage compared to other countries in SSA, however, the study also reveals key systemic bottlenecks in human resources, referral logistics, and procedural breadth. These challenges mirror patterns observed in other SSA countries, reinforcing the need for targeted investment and policy reform. This chapter critically interprets the main findings of the assessment, organized into the three core domains of the LCoGS framework: infrastructure, workforce, and surgical volume.

5.1 Infrastructure

The findings revealed a high level of infrastructure readiness in Rwanda's district hospitals. Over 70% of essential infrastructure elements were reported as "available all the time," meeting the WHO SAT-EESC standard for functional readiness. Notably, five critical inputs; medical records, diagnostic testing (hemoglobin and urine tests), electricity, pulse oximeters, and functional X-ray machines, were available in over 93% of hospitals, suggesting strong baseline support for emergency surgical care. Additionally, there was no disparity seen in infrastructure availability across urban and rural facilities except if patients were referred elsewhere for surgical interventions. Compared to these benchmarks, Rwanda has made remarkable improvements since the 2012 findings by Petroze et al., (2012), who reported limited oxygen availability (13%) and unreliable electricity (87%) in district hospitals.

When benchmarked against SSA norms, Rwanda's infrastructure performance is exceptional. Data from multiple country-level assessments in SSA, including Somalia, Cameroon, and Madagascar, show that consistent access to electricity and imaging equipment is often limited to fewer than 50% of facilities, with oxygen availability reported inconsistently across rural sites (Bruno et al., 2017; Chichom-Mefire et al., 2017; Elkheir et al., 2014).

Although only 32.6% of hospitals reported having an on-site blood bank, nearly all hospitals reported that blood was reliably available within two hours of request via Zipline's drone-based delivery system. Oxygen concentrators were available all the time at only 58.1%, however this was reported to be due to the availability of oxygen cylinders hence concentrators were not needed.

Infrastructure alone does not guarantee high surgical volume. In our study, some rural hospitals with relatively modest infrastructure reported surgical volumes comparable to better-equipped urban facilities. This pattern mirrors findings from Uganda and Malawi; For instance, Albutt et al., (2018) noted that despite standardized surgical infrastructure in Uganda, surgical output

varied widely across facilities due to differences in workforce and managerial efficiency. Similarly, Albert et al., (2015) found that in Malawi, over 90% of surgeries were conducted by non-specialists in district hospitals with minimal physical resources, yet procedural volumes remained relatively high.

Moreover, despite the above-mentioned robust infrastructure in the Rwandan district hospitals, regression analysis showed no statistically significant association between infrastructure availability and surgical volume. This finding echoes data from Cameroon and Madagascar, where functional infrastructure did not necessarily translate into higher surgical output. In Cameroon, Chichom-Mefire et al., (2017) reported that although most facilities had operating rooms and basic utilities, surgical services were limited by the absence of trained personnel and inconsistent utilization of available infrastructure. Similarly, in Madagascar, Bruno et al., (2017) found that despite 89% of district hospitals having at least one functional operating room and over 90% having electricity, the average surgical volume remained critically low at just 163 procedures per 100,000 population per year, where inputs are available but underutilized, signals a maturing health system that must pivot from expanding physical infrastructure to optimizing its operational efficiency.

5.2 Workforce

One of the most critical findings of this assessment is the marked shortage of specialist surgical personnel across Rwanda's district hospitals. Only 30.2% of hospitals had full-time surgeons, and just 14.0% reported having a full-time anesthesiologist staff with a slight difference in workforce distribution between rural and urban areas where urban areas had more midwives and NPAs than rural areas, indicating heavy reliance on non-specialist providers. These figures fall dramatically short of the LCoGS recommended SAO density of 20–40 per 100,000 population, the threshold estimated to be necessary to meet a country's basic surgical burden (Meara & Greenberg, 2015). By contrast, Rwanda's SAO density in district hospitals is 0.54/ 100000, consistent with regional averages reported in studies from SSA, including 1.2/100,000 in Uganda, 1.5/100,000 in Zambia, and 0.8/100,000 in Ethiopia (Albutt et al., 2018; Alemayehu et al., n.d.; Cheelo et al., 2018). These findings confirm that Rwanda's workforce constraints are not an anomaly but reflective of broader trends in Sub-Saharan Africa.

Despite these specialist shortages, the survey found that all district hospitals were staffed by GPs and NPAs. This consistent presence of non-specialist cadres highlights a significant reliance on task-shifting. Although such models have been validated in numerous LMIC contexts, including the surgical systems of Malawi and Tanzania, they remain underrecognized in national workforce indicators (DiMeo et al., 2021; Gajewski, Bijlmakers, & Brugha, 2018; Gajewski, Bijlmakers, Mwapasa, et al., 2018). Importantly, Rwanda's NSOAP I defined surgical capacity primarily through the lens of formally trained SAO providers, thereby overlooking the functional contributions of the very personnel driving surgical service delivery on the ground. This

disconnects between workforce definitions and actual practice risks misalignment in future workforce investments and planning.

The four-hospital sub-analysis conducted as part of this study provides compelling evidence that task-shifting is not a stopgap measure but should be a structural cornerstone of Rwanda's surgical service delivery model. In the selected rural and peri-urban hospitals, general practitioners performed more than 85% of general and obstetric surgeries, including cesarean sections and laparotomies. This included procedures typically regarded as requiring specialist-level expertise yet routinely conducted by GPs due to the lack of on-site specialists. These findings are consistent with patterns observed in Malawi, where 93% of surgical procedures in district hospitals were performed by non-specialists (Cheelo et al., 2018), and in Zambia, where more than 80% of cesarean sections were performed by clinical officers or mid-level providers (Cheelo et al., 2018).

Evidence of reliance on non-specialist providers points to task-shifting becoming more established in routine service delivery. However, despite its ubiquity, task-shifting remains poorly integrated into formal workforce planning and national surgical indicators. Rwanda's existing NSOAP doesn't fully capture the volume, or outcomes of task-sharing cadres (Ministry of Health Rwanda, 2024). As a result, GPs and NPAs, who conduct most surgeries, operate without targeted continuing medical education, supervisory frameworks, or pathways for professional advancement. This has implications not only for workforce morale and retention but also for surgical safety and quality. Global evidence suggests that task-shifting models perform best when implemented within structured, well-regulated systems (Gajewski, Bijlmakers, & Brugha, 2018).

These insights, while illuminating, must also be interpreted within the methodological limitations of the study. While this sub-analysis offers valuable insight into real-world patterns of task-shifting across different facility types, its small sample size (N = 4 hospitals) inherently limits the generalizability of these findings to the national level. The analysis was conducted as an exploratory exercise, aimed at uncovering practical dynamics in task allocation and workforce adaptation under conditions of specialist scarcity. Rather than providing nationally representative estimates, it illustrates the prevailing reliance on general practitioners to sustain surgical services in the absence of full-time specialists. Future research involving larger, nationally representative samples and routine surgical log reviews will be essential to validate these trends, quantify procedural caseloads by cadre, and inform workforce planning and training priorities under NSOAP.

Perhaps the most revealing insight from the multivariate regression analysis is the strong predictive power of procedural and workforce variables on surgical volume. The number of anesthesiologists showed the strongest independent association with surgical output (B = 0.076, p = .039), indicating that each additional anesthesiologist was associated with an 8.7% increase in total annual surgical procedures. The number of hysterectomies performed was also a

significant predictor (B = 0.012, p = .004), with each additional hysterectomy contributing approximately a 2.8% increase in surgical volume. Additionally, surgical admissions per year were independently associated with increased output (B = 0.000096, p = .002), translating to a 0.022% increase in surgical volume per admission. Interestingly, other variables such as the number of surgeons, midwives, obstetricians, and operating rooms did not retain statistical significance in the final model. This may suggest that the most critical constraints to surgical throughput in Rwanda lie not in surgical staffing or infrastructure alone, but in anesthesia capacity and procedure-related service readiness.

These findings echo those from Liberia and Nigeria, where studies found that district hospitals with at least one full-time anesthesia provider performed significantly more surgeries than similarly equipped but understaffed counterparts. In Liberia, Adde et al., (2023) reported that hospitals meeting all three safety criteria, including the presence of trained personnel such as anesthesia providers, had a median monthly surgical volume of 14 procedures, compared to just 6.0 procedures at facilities with equipment alone but no trained staff. Similarly, in Nigeria's Federal Capital Territory, Anderson et al., (2019) found that hospitals staffed with at least one anesthesiologist or nurse anesthetist reported an average annual surgical volume of 783 operations (range: 235–1,601), substantially higher than facilities lacking anesthesia personnel despite having similar infrastructure.

5.3 Surgical Volume

Surgical output across Rwanda's 43 district hospitals revealed wide disparities, ranging from 271 to 4,305 procedures per 100,000 population, a nearly 16-fold difference, with cesarian section and hysterectomies more performed in rural area than urban areas compared to general surgery procedures and this is attributable to the fact that most obstetrical procedures were done by non-specialist providers. This variation underscores a highly uneven distribution of surgical services at the district level, despite relatively uniform infrastructure readiness and the availability of general practitioners across facilities.

Hospitals at the higher end of the volume spectrum demonstrated procedural counts that exceeded those reported in most SSA countries. In contrast, several low-performing district hospitals recorded volumes as low as 271 per 100,000, which is below the national averages documented in Liberia (462), Tanzania (195–2,000), Zambia (188), Madagascar (163), and Uganda (144.5) (Adde et al., 2023; Albutt et al., 2018; Bruno et al., 2017; Cheelo et al., 2018; DiMeo et al., 2021). These disparities highlight that while Rwanda outperforms many regional peers on average, internal inequities persist and must be addressed through region-specific surgical planning.

This internal heterogeneity is not unique to Rwanda. For instance, DiMeo et al., (2021) reported that Tanzanian districts had surgical volumes varying from 195 to 2,000 per 100,000, largely driven by the presence or absence of key personnel and effective referral linkages. Similarly, in

Madagascar, despite relatively well-equipped facilities, surgical output remained as low as 163 per 100,000 (Bruno et al., 2017). These patterns suggest that wide intra-country disparities are often a symptom of broader systemic imbalances, including workforce distribution, patient referral inefficiencies, and inconsistent access to consumables.

Despite the large variability in surgical output, no statistically significant correlation was found between surgical volume and referral rates (Spearman's $\rho = 0.14$, $p = 0.38$). This finding implies that hospitals with lower surgical volumes are not systematically referring patients to higher-level centers, nor are high-volume hospitals necessarily acting as referral hubs. In a well-functioning system, one might expect an inverse relationship, where low-capacity hospitals compensate for limited volume by actively referring out, and higher-capacity centers absorb this overflow. The absence of such a pattern indicates a lack of flexibility and responsiveness within the existing referral framework.

However, it is important to acknowledge a potential limitation in our dataset: referral counts were extracted exclusively from hospital admission registries, meaning that outpatient surgical referrals, which often occur before admission, may not have been captured. This could have led to an underestimation of true referral activity, particularly for elective or non-emergent surgical conditions. Nevertheless, even within this constraint, the absence of a meaningful pattern in referral behavior among hospitals with vastly different surgical volumes is noteworthy and may suggest systemic rigidity.

Similar rigidity has been reported in studies from Ethiopia and Somalia, where district hospitals lacked both transportation infrastructure and standardized referral protocols, resulting in fragmented patient pathways and unmet surgical need (Alemayehu et al., 2019.; Elkheir et al., 2014). These findings point toward the need for NSOAP to incorporate a referral audit mechanism. Developing clearly defined criteria for when, where, and why referrals occur can help reduce inappropriate transfers, ease congestion at urban centers, and strengthen accountability among district-level facilities.

Taken together, these findings suggest that Rwanda is making steady progress toward LCoGS targets especially in infrastructure and basic procedural coverage, but still faces critical challenges in achieving workforce density, surgical volume and anesthesia capacity. These systemic issues identified in our primary fieldwork are mirrored across the region, reinforcing the relevance of Rwanda's experience to other SSA countries seeking to implement or refine their NSOAP strategies.

5.4 Strengths and Limitations

One of this study's principal strengths lies in the assessment of all district hospitals, eliminating sampling bias and providing robust internal validity. This total population approach enhances the relevance of findings for national policy. Furthermore, the study employed a standardized

methodology. Data collection was conducted uniformly across all facilities using structured interviews and facility walk-throughs, supported by a well-trained team of research assistants. This consistency, along with the absence of missing data or disruptions during data collection, reinforces the reliability and validity of the findings.

Another major strength of the study is the expansion of the tool's dimensions, the research team was able to capture a more holistic picture of infrastructure, workforce, surgical capacity, and more importantly surgical output. Informants across all hospitals were consistent in their roles and demonstrated strong knowledge of relevant data, reducing the risk of reporting bias. In addition, the analytical design benefited from the power of total population sampling, enabling statistically meaningful subgroup comparisons across regions and facility types. The inclusion of spatial analysis and regression modeling further enhanced the depth of the study, allowing for identification of predictors of surgical capacity and visual mapping of disparities.

Nonetheless, several limitations must be acknowledged. First, the cross-sectional nature of the study restricts the ability to assess changes over time or seasonal variations in surgical care availability. Although valuable for providing a baseline, the design does not capture dynamic trends or fluctuations in service delivery. Second, while the adapted EESC tool covers multiple domains, it remains limited in assessing the quality of surgical care, particularly regarding patient safety, outcomes, and adherence to clinical protocols. These dimensions require longitudinal or observational methodologies not encompassed in this assessment. Third, although all informants were knowledgeable and role-consistent, the reliance on self-reported data introduces the potential for institutional or social desirability bias, especially in areas like equipment functionality or service availability. Additionally, while the study is tailored for Rwanda, generalizing findings to other countries in the region should be done cautiously due to variations in health system structure, financing, and workforce distribution

Moreover, workforce data was reported by hospital administrative teams using counts of both full-time and part-time personnel. This may have introduced duplication bias, particularly for part-time workers who serve across multiple facilities and may have been reported at more than one site. As a result, workforce density may be slightly overestimated in some districts.

Chapter 6: Conclusion and Recommendations

6.1. Conclusion

This nationwide assessment of Rwanda's EESC system reveals both significant achievements and persistent challenges in delivering equitable, safe, and timely surgical care. Rwanda has surpassed many SSA counterparts in infrastructure readiness and the availability of basic surgical procedures. However, the study identifies five key bottlenecks that hinder further progress toward the LCoGS goals: (1) persistent gaps in human resources, particularly anesthesia providers; (2) regional disparities in SAO density and surgical volume; (3) limited capacity to deliver complex surgeries; (4) underutilization of surgical infrastructure in some facilities despite sufficient resources; and (5) a misalignment between geographic proximity to surgical services and actual procedural access. These challenges, though deeply rooted in structural and workforce-related constraints, present an opportunity for targeted, data-driven interventions that can accelerate Rwanda's progress toward universal surgical access.

6.2. Recommendations

6.2.1 Policy Recommendations

As stated above our study has identified critical gaps and inequities in Rwanda's surgical system. The following evidence-based recommendations are organized around the five key themes identified in this thesis and are designed to support the Ministry of Health, NSOAP planners, and key stakeholders in advancing surgical equity, efficiency, and resilience across Rwanda. Each recommendation aligns with the core indicators set forth by the Lancet Commission on Global Surgery (LCoGS), namely SAO density, surgical volume, access within two hours, and infrastructure utilization.

1. Prioritize Anesthesia Workforce Expansion as a National Strategic Imperative

Given the finding that anesthesia provider availability was the most important statistically significant predictor of surgical volume, scaling anesthesia workforce capacity must be a top priority. The MoH should urgently expand anesthesia training programs, incorporating decentralized approach modeled on successful regional efforts in Zambia and Sierra Leone (Furre et al., 2025; Gajewski, Bijlmakers, & Brugha, 2018).

This should include the scaling of anesthesiologists and nurse anesthetist training programs, decentralized district-level training tracks, and rural bonding contracts. Additionally, simulation-based training, continuing professional development (CPD) programs, and anesthesia-specific equipment standardization must be rolled out to support the safe delivery of both routine and complex surgeries.

2. Target Surgical Volume Disparities through Region-Specific Planning

The substantial intra-national variation in surgical volume, ranging from 271 to 4,305 procedures per 100,000 population, demonstrates a pressing need to rebalance surgical service delivery

across Rwanda. While high-performing district hospitals are exceeding regional benchmarks, several facilities remain far below functional thresholds, despite comparable infrastructure.

To address these inequities, the Ministry of Health should incorporate region-specific surgical volume targets into NSOAP. Underperforming hospitals should receive focused investments in leadership development, procedural training, and surgical logistics. A national surgical volume dashboard, disaggregated by hospital, cadre, and procedure type, should be developed within the HMIS to monitor progress and guide performance-based resourcing. This data-driven approach will enable targeted interventions in "cold spot" regions and ensure that infrastructure translates into surgical access.

3. Rebalance Geographic Distribution of Surgical Access

Spatial analysis confirmed that surgical services remain concentrated in urban hospitals, particularly in and around Kigali. These facilities benefit from higher surgical volumes, workforce density, and infrastructure redundancy, while rural district hospitals face substantial capacity and equity deficits.

To rectify these disparities, the Ministry should adopt a geographically targeted deployment and incentive strategy. Rural and underperforming hospitals should be prioritized for SAO placement, infrastructure upgrades, and procedural mentoring. A rural retention package, including housing, bonus structures, and professional development, might attract and retain surgical providers in underserved areas. These equity-driven investments will align with Rwanda's national decentralization goals and strengthen the surgical safety net for marginalized populations.

6.2.2 Future Research Directions to Address Evidence Gaps

While this study offers a nationally standardized, facility-level snapshot of essential surgical capacity across Rwanda's district hospitals, it also reveals several critical evidence gaps that must be addressed through future research. These gaps stem from both methodological limitations and systemic data constraints that limit the depth and generalizability of current insights.

Firstly, the cross-sectional design of this assessment, while appropriate for baseline mapping, does not allow for the evaluation of trends over time or the impact of specific NSOAP interventions. There remains an urgent need for longitudinal studies that track surgical system performance using repeated, standardized indicators ideally integrated into Rwanda's HMIS. Additionally, although the WHO SAT-EESC tool captures infrastructure, workforce, and procedural capacity, it does not measure clinical quality, such as postoperative mortality rates (POMR), surgical site infections (SSI), or patient-reported outcomes. Future studies should incorporate quality metrics and outcome measures to better align surgical planning with safe and effective care delivery.

Secondly, the current study did not disaggregate task-shifting patterns or clinical decision-making workflows, both of which are essential to understanding how non-specialist cadres contribute to surgical care in rural settings.

Third, out-patient referrals were not captured to improve planning fidelity, future studies should deploy standardized referral definitions, incorporate both surgical and obstetric service mapping, and utilize digital registries or work force registries from higher institutions such as the MoH to avoid workforce double-counting.

Considering these limitations, future research should prioritize: (1) the development and validation of integrated surgical dashboards within DHIS2 to support real-time monitoring, (2) spatial mapping of patient access and delays to care, and (3) in-depth studies on the implementation and clinical impact of task-shifting models. These efforts will be vital not only to refine Rwanda's surgical planning processes but also to contribute to the broader global surgery evidence base particularly in low-resource and decentralized health systems.

Chapter 7 References

Adde, H. A., van Duinen, A. J., Andrews, B. C., Bakker, J., Goyah, K. S., Salvesen, Ø., Sheriff, S., Utam, T., Yaskey, C., & Weiser, T. G. (2023). Mapping population access to essential surgical care in Liberia using equipment, personnel, and bellwether capability standards. *British Journal of Surgery*, *110*(2), 169–176.

Albert, V., Goddia, C., O'Sullivan, E., Fitzgerald, E., & Walker, I. (2015). EMERGENCY AND ESSENTIAL SURGERY AND ANAESTHESIA (EESA) AS A COMPONENT OF UNIVERSAL HEALTHCARE COVERAGE; WHAT IS NEEDED TO ACHIEVE THIS IN MALAWI?: 0268. *International Journal of Surgery*, *23*, S71.

Albutt, K., Punchak, M., Kayima, P., Namanya, D. B., Anderson, G. A., & Shrime, M. G. (2018). Access to Safe, Timely, and Affordable Surgical Care in Uganda: A Stratified Randomized Evaluation of Nationwide Public Sector Surgical Capacity and Core Surgical Indicators. *World Journal of Surgery*, *42*(8), 2303–2313. https://doi.org/10.1007/s00268-018-4485-1

Alemayehu, T. Y., Taye, M. G., Kibret, S., & Habtie, M. F. (n.d.). *Assessment of emergency and essential surgery service in primary hospitals of South Gondar zone, Amhara region, 2019.* Retrieved June 21, 2025, from https://www.academia.edu/download/83368660/main.pdf

Anderson, J. E., Ndajiwo, A. B., Nuhu, S. A., Lawal, O. A., Amedu, J. O., & Ameh, E. A. (2019). Assessment of Capacity to Meet Lancet Commission on Global Surgery Indicators in the Federal Capital Territory, Abuja, Nigeria. *World Journal of Surgery*, *43*(3), 704–714. https://doi.org/10.1007/s00268-018-4835-z

Beard, J. H., Ajiko, M., & Löfgren, J. (2019). From Measuring Disease Burden to Designing and Evaluating Solutions—Global Surgery Research in Evolution. *Jama Network Open*. https://doi.org/10.1001/jamanetworkopen.2018.6840

Bickler, S. W., Weiser, T. G., Kassebaum, N. J., Higashi, H., Chang, D. C., Barendregt, J. J., Noormahomed, E. V., & Vos, T. (2015). *Global Burden of Surgical Conditions*. https://doi.org/10.1596/978-1-4648-0346-8_ch2

Bruno, E., White, M. C., Baxter, L. S., Ravelojaona, V. A., Rakotoarison, H. N., Andriamanjato, H. H., Close, K. L., Herbert, A., Raykar, N., Saluja, S., & Shrime, M. G. (2017). An Evaluation of Preparedness, Delivery and Impact of Surgical and Anesthesia Care in Madagascar: A Framework for a National Surgical Plan. *World Journal of Surgery*, *41*(5), 1218–1224. https://doi.org/10.1007/s00268-016-3847-9

Butler, E. K., Gyedu, A., Stewart, B. T., Quansah, R., Donkor, P., & Mock, C. N. (2021). Nationwide enumeration of emergency operations performed in Ghana. *European Journal of Trauma and Emergency Surgery*, *47*(4), 1031–1039. https://doi.org/10.1007/s00068-019-01276-1

Chaker, S., Henry, J. A., Hung, Y.-C., Saad, M., Slater, E., Madiraju, S. K., Waiguru, E., Mwai, P., Jani, P., & Lan, K. (2025). The Kenya Surgical Capacity Study: An audit of surgical equipment/infrastructure in level 4 public hospitals. *Ann Afr Surg*, *22*(1), 4–12.

Cheelo, M., Brugha, R., Bijlmakers, L., Kachimba, J., McCauley, T., & Gajewski, J. (2018). Surgical Capacity at District Hospitals in Zambia: From 2012 to 2016. *World Journal of Surgery*, *42*(11), 3508–3513. https://doi.org/10.1007/s00268-018-4678-7

Chichom-Mefire, A., Mbome Njie, V., Verla, V., & Atashili, J. (2017). A Retrospective One-Year Estimation of the Volume and Nature of Surgical and Anaesthetic Services Delivered to the Populations of the Fako Division of the South-West Region of

Cameroon: An Urgent Call for Action. *World Journal of Surgery*, *41*(3), 660–671. https://doi.org/10.1007/s00268-016-3775-8

Chu, K. M., Dell, A. J., Moultrie, H., Day, C., Naidoo, M., Van Straten, S., & Rayne, S. (2020). A geospatial analysis of two-hour surgical access to district hospitals in South Africa. *BMC Health Services Research*, *20*(1), 744. https://doi.org/10.1186/s12913-020-05637-0

Chu, K., Maine, R., & Duvenage, R. (2021). We Asked the Experts: The Role of Rural Hospitals in Achieving Equitable Surgical Access in Low-Resourced Settings. *World Journal of Surgery*. https://doi.org/10.1007/s00268-021-06271-5

Concepcion, T., Smith, E. R., Mohamed, M., Dahir, S., Ismail, E. A., Leather, A., Poenaru, D., & Rice, H. E. (2019). Provision of Surgical Care for Children Across Somaliland: Challenges and Policy Guidance. *World Journal of Surgery*. https://doi.org/10.1007/s00268-019-05079-8

DiMeo, A., Lama, T. N., Sydlowski, M., Barash, D., Maina, E., Menon, G., Gruendl, M. A., Cainer, M., Kapologwe, N., & Maongezi, S. (2021). A mixed-methods assessment of surgical capacity in Tanzania's Lake Zone. *East and Central African Journal of Surgery*, *26*(1), 6–14.

Elkheir, N., Sharma, A., Cherian, M., Saleh, O. A., Everard, M., Popal, G. R., & Ibrahim, A. A. (2014). A cross-sectional survey of essential surgical capacity in Somalia. *BMJ Open*, *4*(5), e004360.

Esquivel, M. M., Uribe-Leitz, T., Makasa, E., Lishimpi, K., Mwaba, P., Bowman, K., & Weiser, T. G. (2016). Mapping disparities in access to safe, timely, and essential surgical care in Zambia. *JAMA Surgery*, *151*(11), 1064–1069.

Furre, M. E., Svengaard, M., Øvreås, E., van Duinen, A. J., Ashley, T., Grobusch, M. P., Bakker, J., Gunneweg, J., Roy, N., Kabba, M., & Bolkan, H. A. (2025). The Impact of Surgical

Task-Sharing in Sierra Leone: A Nationwide Longitudinal Observational Study on Surgical Workforce and Volume, 2012–2023. *BMJ Global Health*. https://doi.org/10.1136/bmjgh-2024-018423

Gajewski, J., Bijlmakers, L., & Brugha, R. (2018). Global Surgery – Informing National Strategies for Scaling Up Surgery in Sub-Saharan Africa. *International Journal of Health Policy and Management*. https://doi.org/10.15171/ijhpm.2018.27

Gajewski, J., Bijlmakers, L., Mwapasa, G., Borgstein, E., Pittalis, C., & Brugha, R. (2018). 'I Think We Are Going to Leave These Cases'. Obstacles to Surgery in Rural Malawi: A Qualitative Study of Provider Perspectives. *Tropical Medicine & International Health*. https://doi.org/10.1111/tmi.13135

Grimes, C., Law, R., Borgstein, E., Mkandawire, N. C., & Lavy, C. (2011). Systematic Review of Met and Unmet Need of Surgical Disease in Rural Sub-Saharan Africa. *World Journal of Surgery*. https://doi.org/10.1007/s00268-011-1330-1

I. B. M. Corp. (2020). *IBM SPSS Statistics for Windows (Version 27.0)*.

Iverson, K. R., Ahearn, O., Citron, I., Garringer, K., Mukhodpadhyay, S., Teshome, A., Bekele, A., Workneh, S., Workneh, R. S., & Zemenfeskudus, S. (2020). Development of a surgical assessment tool for national policy monitoring & evaluation in Ethiopia: A quality improvement study. *International Journal of Surgery*, *80*, 231–240.

Kushner, A. L. (2010). Addressing the Millennium Development Goals From a Surgical Perspective. *Archives of Surgery*. https://doi.org/10.1001/archsurg.2009.263

LeBrun, D. G., Chackungal, S., Chao, T. E., Knowlton, L. M., Linden, A. F., Notrica, M. R., Solis, C. V., & McQueen, K. K. (2014). Prioritizing essential surgery and safe anesthesia for the Post-2015 Development Agenda: Operative capacities of 78 district hospitals in 7 low-and middle-income countries. *Surgery*, *155*(3), 365–373.

Lindheim-Minde, B., Gjøra, A., Bakker, J. M., van Duinen, A. J., van Leerdam, D., Smalle, I. O., Bundu, I., & Bolkan, H. A. (2021). Changes in surgical volume, workforce, and productivity in Sierra Leone between 2012 and 2017. *Surgery*, *170*(1), 126–133.

Luboga, S., Macfarlane, S. B., Schreeb, J. von, Kruk, M. E., Cherian, M., Bergström, S., Bossyns, P., Denerville, E., Dovlo, D., Galukande, M., Hsia, R. Y., Jayaraman, S., Lubbock, L. A., Mock, C., Ozgediz, D., Sekimpi, P., Wladis, A., Zakariah, A., Dade, N. B., … Debas, H. T. (2009). Increasing Access to Surgical Services in Sub-Saharan Africa: Priorities for National and International Agencies Recommended by the Bellagio Essential Surgery Group. *Plos Medicine*. https://doi.org/10.1371/journal.pmed.1000200

Malemo, L. K., Yap, A., Mitume, B., Salmon, C., Karafuli, K., Poenaru, D., & Onyango, R. (2024). Essential surgery delivery in the Northern Kivu Province of the Democratic Republic of the Congo. *BMC Surgery*, *24*(1), 95. https://doi.org/10.1186/s12893-024-02386-3

Meara, J. G., & Greenberg, S. L. (2015). The Lancet Commission on Global Surgery Global surgery 2030: Evidence and solutions for achieving health, welfare and economic development. *Surgery*, *157*(5), 834–835.

Meshesha, B. R., Sibhatu, M. K., Beshir, H. M., Zewude, W. C., Taye, D. B., Getachew, E. M., Merga, K. H., Kumssa, T. H., Alemayue, E. A., Ashuro, A. A., Shagre, M. B., & Gebreegziabher, S. B. (2022). Access to surgical care in Ethiopia: A cross-sectional retrospective data review. *BMC Health Services Research*, *22*(1), 973. https://doi.org/10.1186/s12913-022-08357-9

Ministry of Health Rwanda. (2018). *National Surgical, Obstetric and Anesthesia Plan (NSOAP) 2018–2024*.

https://www.moh.gov.rw/fileadmin/user_upload/Moh/Publications/Strategic_Plan/NSOAP_Rwanda-_Approved1.pdf

Ministry of Health Rwanda. (2024). *NSOAP Four-Year Review: Progress and Way Forward (2018–2022)*. https://moh.prod.risa.rw/index.php?eID=dumpFile&t=f&f=117766&token=43679a0e5a0ed3446d41eab885a791397932c1fa

Mock, C., Cherian, M., Juillard, C., Donkor, P., Bickler, S. W., Jamison, D. T., & McQueen, K. (2009). Developing Priorities for Addressing Surgical Conditions Globally: Furthering the Link Between Surgery and Public Health Policy. *World Journal of Surgery*. https://doi.org/10.1007/s00268-009-0263-4

Mock, C., Donkor, P., Gawande, A. A., Jamison, D. T., Kruk, M. E., & Debas, H. T. (2015). Essential Surgery: Key Messages From Disease Control Priorities, 3rd Edition. *The Lancet*. https://doi.org/10.1016/s0140-6736(15)60091-5

Mpirimbanyi, C., Nyirimodoka, A., Lin, Y., Hedt-Gauthier, B. L., Odhiambo, J., Nkurunziza, T., Havens, J. M., Omondi, J., Rwamasirabo, E., Ntirenganya, F., Toma, G., Mubiligi, J., Bayitondere, S., & Riviello, R. (2017). Emergency general surgery in Rwandan district hospitals: A cross-sectional study of spectrum, management, and patient outcomes. *BMC Surgery*, *17*(1), 121. https://doi.org/10.1186/s12893-017-0323-x

National Institure of Statistics of Rwanda. (2022). *MAIN INDICATORS: 5th Rwanda Population and Housing Census (PHC) | National Institute of Statistics of Rwanda*. https://www.statistics.gov.rw/fifth-population-and-housing-census-2022/main-indicators-5th-rwanda-population-and-housing-census-phc

Ndong, A., Diallo, A. C., Togtoga, L., Faye, M., Faye, P. M., Bah, M. S., Ndoye, P. D., Cissé, M., Konaté, I., & Niang, K. (2024). Organization of abdominal emergency surgical care

across healthcare services in Senegal: A cross-sectional nationwide survey. *Discover Public Health*, *21*(1), 80. https://doi.org/10.1186/s12982-024-00202-0

Ng-Kamstra, J. S., Arya, S., Greenberg, S., Kotagal, M., Arsenault, C., Ljungman, D., Yorlets, R. R., Agarwal, A., Frankfurter, C., Nikouline, A., Xing Lai, F. Y., Palmqvist, C. L., Fu, T., Mahmood, T., Raju, S., Sharma, S., Marks, I. H., Bowder, A. N., Pi, L., … Shrime, M. G. (2018). Perioperative Mortality Rates in Low-Income and Middle-Income Countries: A Systematic Review and Meta-Analysis. *BMJ Global Health*. https://doi.org/10.1136/bmjgh-2018-000810

Ologunde, R., Maruthappu, M., Shanmugarajah, K., & Shalhoub, J. (2014). Surgical Care in Low and Middle-Income Countries: Burden and Barriers. *International Journal of Surgery*. https://doi.org/10.1016/j.ijsu.2014.07.009

Omar, M. A., Osman, M. M., Mohamud, A. M., Hashi, A. S., Mohamed, S. A., Kifle, F., Corlew, S., & Maswime, S. (2024). Assessment of surgical, anesthesia, and obstetric workforce in Somalia. *World Journal of Surgery*, *48*(9), 2199–2206. https://doi.org/10.1002/wjs.12283

Oosting, R. M., Dankelman, J., Wauben, L., Madete, J., & Groen, R. S. (2018). *Roadmap for Design of Surgical Equipment for Safe Surgery Worldwide*. https://doi.org/10.1109/ghtc.2018.8601913

Osen, H., Chang, D. C., Choo, S., Perry, H. B., J. Hesse, A. A., Abantanga, F., McCord, C., Chrouser, K., & Abdullah, F. (2010). Validation of the World Health Organization Tool for Situational Analysis to Assess Emergency and Essential Surgical Care at District Hospitals in Ghana. *World Journal of Surgery*. https://doi.org/10.1007/s00268-010-0918-1

Peters, A. W., Roa, L., Rwamasirabo, E., Ameh, E. A., Ulisubisya, M., Samad, L., Makasa, E., & Meara, J. G. (2020). National Surgical, Obstetric, and Anesthesia Plans Supporting the

Vision of Universal Health Coverage. *Global Health Science and Practice*. https://doi.org/10.9745/ghsp-d-19-00314

Petroze, R. T., Nzayisenga, A., Rusanganwa, V., Ntakiyiruta, G., & Calland, J. F. (2012). Comprehensive national analysis of emergency and essential surgical capacity in Rwanda. *Journal of British Surgery*, *99*(3), 436–443.

Price, R. R., Makasa, E., & Hollands, M. (2015). World Health Assembly Resolution WHA68.15: "Strengthening Emergency and Essential Surgical Care and Anesthesia as a Component of Universal Health Coverage"—Addressing the Public Health Gaps Arising From Lack of Safe, Affordable and Accessible Surgical and Anesthetic Services. *World Journal of Surgery*. https://doi.org/10.1007/s00268-015-3153-y

Rios-Diaz, A. J., Lam, J., Ramos, M., Moscoso, A. V., Vaughn, P., Zogg, C. K., & Caterson, E. J. (2016). Global Patterns of QALY and DALY Use in Surgical Cost-Utility Analyses: A Systematic Review. *Plos One*. https://doi.org/10.1371/journal.pone.0148304

Rwanda medical & Dental Council. (n.d.). *List of hospitals in Rwanda*. Retrieved July 10, 2025, from https://rmdc.rw/spip.php?article11

Shrime, M. G., Dare, A., Alkire, B. C., O'Neill, K., & Meara, J. G. (2015). Catastrophic Expenditure to Pay for Surgery Worldwide: A Modelling Study. *The Lancet Global Health*. https://doi.org/10.1016/s2214-109x(15)70085-9

Shrime, M. G., Sleemi, A., & Ravilla, T. (2014). Charitable Platforms in Global Surgery: A Systematic Review of Their Effectiveness, Cost-Effectiveness, Sustainability, and Role Training. *World Journal of Surgery*. https://doi.org/10.1007/s00268-014-2516-0

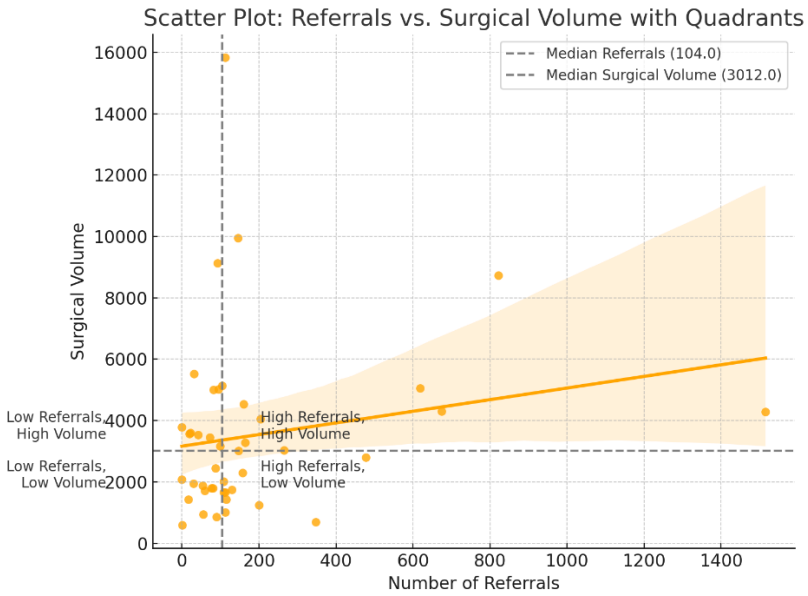
Tefera, A., Lutge, E., & Clarke, D. L. (2020). Bellwether operations in KwaZulu-Natal Province, South Africa, are performed at regional and tertiary rather than district hospitals. *South African Medical Journal*, *110*(5), 374. https://doi.org/10.7196/SAMJ.2020.v110i5.14218

Universal health coverage (UHC). (2025, March 26). https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc)

World Health Organisation. (2010). *WHODAS 2.0 Translation Package*. https://terrance.who.int/mediacentre/data/WHODAS/Guidelines/WHODAS%202.0%20Translation%20guidelines.pdf

Appendix

Appendix 1: Figure. illustrates the scatterplot of referrals versus surgical volume with a fitted regression line and 95% confidence interval.



Appendix 2: District Hospitals list coordinate locations

Facility Name	Province name	District Name	Latitude	Longitude	Type
Nyamata L2TH	East	BUGESERA	-2.138231	30.079871	Level Two Teaching Hospital
Kiziguro DH	East	GATSIBO	-1.765732	30.384790	District Hospital
Ngarama DH	East	GATSIBO	-1.546963	30.243541	District Hospital
Gahini DH	East	KAYONZA	-1.841450	30.483232	District Hospital
Rwinkwavu DH	East	KAYONZA	-1.964148	30.615480	District Hospital
Kirehe DH	East	KIREHE	-2.267239	30.653199	District Hospital
Kibungo L2TH	East	NGOMA	-2.166245	30.539429	Level Two Teaching Hospital
Gatunda DH	East	NYAGATARE	-1.395619	30.207859	District Hospital
Nyagatare DH	East	NYAGATARE	-1.296945	30.326478	District Hospital
Rwamagana L2TH	East	RWAMAGANA	-1.950907	30.433423	Level Two Teaching Hospital
Kacyiru DH	Kigali City	GASABO	-1.932818	30.074603	District Hospital

Kibagabaga L2TH	Kigali City	GASABO	-1.931055	30.114038	Level Two Teaching Hospital
Masaka DH	Kigali City	KICUKIRO	-1.992197	30.211905	District Hospital
Muhima DH	Kigali City	NYARUGENGE	-1.936797	30.058609	District Hospital
Nyarugenge DH	Kigali City	NYARUGENGE	-1.981125	30.043475	District Hospital
Butaro L2TH	North	BURERA	-1.408255	29.837441	Level Two Teaching Hospital
Gatonde DH	North	GAKENKE	-1.670848	29.661107	District Hospital
Nemba DH	North	GAKENKE	-1.638277	29.786550	District Hospital
Ruli DH	North	GAKENKE	-1.828955	29.848933	District Hospital
Byumba L2TH	North	GICUMBI	-1.589284	30.055534	Level Two Teaching Hospital
RUHENGERI L2TH	North	MUSANZE	-1.513627	29.633195	Level Two Teaching Hospital
Rutongo DH	North	RULINDO	-1.786617	30.002304	District Hospital
Kibilizi DH	South	GISAGARA	-2.649151	29.783390	District Hospital

Gakoma DH	South	GISAGARA	-2.482394	29.918299	District Hospital
Kabutare DH	South	HUYE	-2.607433	29.746975	District Hospital
Remera Rukoma DH	South	KAMONYI	-1.912080	29.954247	District Hospital
Nyabikenke DH	South	MUHANGA	-1.882617	29.770083	District Hospital
Kabgayi L2TH	South	MUHANGA	-2.103885	29.750594	Level Two Teaching Hospital
Kigeme DH	South	NYAMAGABE	-2.479303	29.525742	District Hospital
Kaduha DH	South	NYAMAGABE	-2.332692	29.525093	District Hospital
Nyanza DH	South	NYANZA	-2.352313	29.748937	District Hospital
Munini DH	South	NYARUGURU	-2.713222	29.534149	District Hospital
Gitwe DH	South	RUHANGO	-2.247806	29.689375	District Hospital
Mugonero DH	West	KARONGI	-2.180934	29.292435	District Hospital
Kirinda DH	West	KARONGI	-2.185484	29.577859	District Hospital

Murunda DH	West	RUTSIRO	-1.907413	29.377002	District Hospital
Gisenyi DH	West	RUBAVU	-1.700660	29.262725	District Hospital
Shyira DH	West	NYABIHU	-1.700347	29.632349	District Hospital
Muhororo DH	West	NGORORERO	-1.935921	29.625287	District Hospital
Kabaya DH	West	NGORORERO	-1.747411	29.537286	District Hospital
MIBILIZI DH	West	RUSIZI	-2.568588	28.954648	District Hospital
GIHUNDWE DH	West	RUSIZI	-2.483384	28.914639	District Hospital
Kibogora L2TH	West	NYAMASHEKE	-2.326525	29.131468	Level Two Teaching Hospital

Appendix 3: Adapted WHO EESC Tool

EESC Surgical Assessment Tool

WHO Situational Analysis Tool- Essential Emergency Surgical care	_____
Data Collector's Name	◯ Alexander Habtemariam ◯ Marie-Merci Cyuzuzo ◯ Patience Nzaramba ◯ Samuel Habimana ◯ Dushimimana Clarisse ◯ Twizerimana Charlotte
Facility Information	
Province	◯ East ◯ West ◯ North ◯ South ◯ Kigali city (Province where the hospital is located)
District (East Province)	◯ BUGESERA ◯ GATSIBO ◯ KAYONZA ◯ KIREHE ◯ NGOMA ◯ NYAGATARE ◯ RWAMAGANA (Province where the hospital is located)
District (West Province)	◯ KARONGI ◯ RUTSIRO ◯ RUBAVU ◯ NYABIHU ◯ NGORORERO ◯ RUSIZI ◯ NYAMASHEKE (Province where the hospital is located)
District (Northern province)	◯ BURERA ◯ GAKENKE ◯ GICUMBI ◯ MUSANZE ◯ RULINDO (Province where the hospital is located)
District (Southern province)	◯ GISAGARA ◯ HUYE ◯ KAMONYI ◯ MUHANGA ◯ NYAMAGABE ◯ NYANZA ◯ NYARUGURU ◯ RUHANGO (Province where the hospital is located)

District (Kigali city)	◯ GASABO ◯ KICUKIRO ◯ NYARUGENGE (Province where the hospital is located)
Facility ID	_____ (Name of the Health Facility)

Data Manager Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders. Our focus is to better understand the availability of critical infrastructure, trained personnel, surgical procedures, anesthesia services, and essential equipment across Rwanda's district-level facilities. By doing so, we aim to highlight both the strengths and the gaps in surgical systems - not to evaluate individual hospitals or staff - but to inform future investments and improvements in equitable surgical care delivery. We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.	_____
Name of the Data Manager interviewed	_____
Umubare w'ibitanda muri department ya surgery ? Number of beds in surgical department?	_____ (e.g. 100)
Umubare w'abarwayi bajya mu bitaro babazwe ku mwaka? (harimo n ababyeyi) Number of surgical admissions (including gyn/obs) in one year	_____
Umubare w'ibyumba babagiramo(ibito n ibinini) Number of total functioning ORs (major and minor)	_____ (The number of all ORs major and Minor)
Umubare w'abarwayi babagiwe muri ibi bitaro (kubagwa gukomeye cg koroheje, harimo no kubaga indwara z abagore) ku mwaka? Number of total procedures (Major and Minor) (including gyn/obs) per year?	_____ (insert numbers e.g. 1100)

Umubare w'abana bari munsi yi imyaka 15 babagiwe kuri ibitaro ku mwaka? Number of pediatric procedures (under 15 years)	_____ (Make sure the age is under 15)
Kubyaza umubyeyi abazwe Number of Caesarean Sections in the last 12 months	_____ (Cesarean section performed from May 2024- April 2025)
Umubare w'abarwayi babazwe bagakurwamo nyababyeyi mu mwaka ushize? Number of Hysterectomies in a year?	_____
Kuvura no gusana umwenge uterwa n'ibikomere by'ibyara (fistule) Number of obstetric fistula repairs	_____ (fistula repair procedures performed from May 2024 - April 2025)
Kubaga mu nda? Number of Laparotomies?	_____ (Laparatomies performed from May 2024 - April 2025)
Gusana ikibyimba cy umuyoboro w'inyama zo munda Number of Hernia Repairs	_____ (Hernia repair done from May 2024 - April 2025)
Kuvura imvune itabazwe Number of closed Fracture Reductions	_____ (Surgical fracture reductions from May 2024 - April 2025)
Koza no gutunganya ibisebe byaturutse ku mvune n ibisebe bifungune Number of irrigation & debridement of open fractures	_____
Kuvura imvune ibazwe Number of External Fixator Placements	_____
Gukosora kubyimba kw'inkovu y' ubushye/ kongera uruhu mu gukosora igikomere Number of Escharotomy/Fasciotomies	_____
Guca urugingo rwangiritse Number of Amputations	_____ (Amputations performed from May 2024 - April 2025)
Gusana ibirenge by'umwana yavutse bihengamye Number of Clubfoot Repairs	_____ (Club foot repairs done from May 2024 - April 2025)
Gusana ibibari Number of Cleft Lip and Palate Repairs	_____ (Cleft lip/palate repairs done from May 2024 - A)

Gukosora kubyimba kw'imitsi cg kongera uruhu mu gukosora igikomere Number of Skin Graftings	_____ (Skin Grafting done from May 2024 - April 2025)
Gukamura uburwayi bw'umusokoro cg ububabare mu ngingo Number of Drainage of Septic Arthritis/Osteomyelitis	_____ (Surgical drainage of Osteomyelitis from May 2024 - April 2025)
Umubare w abarwayi boherezwa kubitaro byisumbuye kugirango babagwe ku mwaka? Number of patients referred for surgical intervention	_____ (referrals from the surgical and ob/gyne department from May 2024 - April 2025)
Ikigereranyo cy'urugendo mu km umurwayi akora agera kuri ibi bitaro ngo abagwe? Average distance patients travel for surgical services	_____ (The distance patients travel to this hospital)
Ikigereranyo cy urugendo umurwayi akora km kugirango ajye aho yahabwa servisi zo kubagwa mutabasha gutanga Distance patients travel if no services are offered	_____ (Distance from this hospital to the next referral)

Anesthesiologist/ Anesthesist Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders. Our focus is to better understand the availability of critical infrastructure, trained personnel, surgical procedures, anesthesia services, and essential equipment across Rwanda's district-level facilities. By doing so, we aim to highlight both the strengths and the gaps in surgical systems - not to evaluate individual hospitals or staff - but to inform future investments and improvements in equitable surgical care delivery. We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.	_____
Name of the Clinical Director or Anesthesiologist interviewed	_____
Mufite ububiko bw' umuka? Do you have oxygen cylinder supply?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)

District (Kigali city)	○ GASABO ○ KICUKIRO ○ NYARUGENGE (Province where the hospital is located)
Facility ID	_____ (Name of the Health Facility)

Data Manager Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders. Our focus is to better understand the availability of critical infrastructure, trained personnel, surgical procedures, anesthesia services, and essential equipment across Rwanda's district-level facilities. By doing so, we aim to highlight both the strengths and the gaps in surgical systems - not to evaluate individual hospitals or staff - but to inform future investments and improvements in equitable surgical care delivery. We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.	_____
Name of the Data Manager interviewed	_____
Umubare w'ibitanda muri department ya surgery ? Number of beds in surgical department?	_____ (e.g. 100)
Umubare w'abarwayi bajya mu bitaro babazwe ku mwaka? (harimo n ababyeyi) Number of surgical admissions (including gyn/obs) in one year	_____
Umubare w'ibyumba babagiramo(ibido n ibindi) Number of total functioning ORs (major and minor)	_____ (The number of all ORs major and Minor)

Mufite imashini zikora umwuka? Do you have oxygen concentrator supply?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite amazi? Do you have running water?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite umuriro? Do you have electricity source?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite generateri ikora? Do you have operational power generator?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite imashini ikoreshwa mu gutera ikinya? Do you have functioning anesthesia machine?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mubika amakuru y'abarwayi? Do you keep medical records?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite aho mwakirira abakeneye ubutabazi bwihuse? Do you have designated emergency care area?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite aho mushyira abarwayi babazwe? Do you have designated postoperative care area?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite imfashanyigisho ku butabazi bwibanze? Management guidelines available for Emergency care?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite imfashanyigisho ku buvuzi bwo kubaga? Management guidelines available for Surgery?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite imfashanyigisho mu gutera ikinya? Management guidelines available for Anesthesia?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite ububiko bw'amaraso mu bitaro byanyu? Management guidelines available for Pain relief?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Mufite ububiko bw'amaraso mu bitaro byanyu? Is there a blood bank available?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)
Ibitaro byanyu isuzuma ingano y amaraso(hb), n inkari? Facility for hemoglobin and urine tests?	◯ All the time (Buri gihe) ◯ Sometimes (Rimwe na rimwe) ◯ Not available (ntabihari)

Ibitaro byanyu bifite imashini ifotora?

Functioning X-ray machine available?

- ◯ All the time (Buri gihe)
- ◯ Sometimes (Rimwe na rimwe)
- ◯ Not available (ntabihari)

Ibitaro byanyu bifite igikoresho gipima umwuka mu maraso?

Functioning pulse oximeter available?

- ◯ All the time (Buri gihe)
- ◯ Sometimes (Rimwe na rimwe)
- ◯ Not available (ntabihari)

OR Head Nurse Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders.

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We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.

_____

Name of the OR Head Nurse interviewed

_____

Umubare w'indwara zabazwe

Number of general surgery procedures

_____

Umubare w'indwara z'abagore zabazwe

Number of OB/GYN procedures

_____

umubare w'indwara zikomeye zabazwe

Number of major procedures

_____

Umubare w'indwara zabazwe zoroheje

Number of minor procedures

_____

Umubare w'indwara zabazwe byihutirwa

Number of emergency surgeries

Umubare w'indwara zabazwe byateguwe

Number of elective surgeries

_____

Surgeon Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders.

Our focus is to better understand the availability of critical infrastructure, trained personnel, surgical procedures, anesthesia services, and essential equipment across Rwanda's district-level facilities. By doing so, we aim to highlight both the strengths and the gaps in surgical systems - not to evaluate individual hospitals or staff - but to inform future investments and improvements in equitable surgical care delivery.

We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.

_____

Name of the Surgeon interviewed

_____

Gususzuma igice cy'umubiri cyirwaye ufashe akanyama cg uduturugunyu

Do you provide: Biopsy?

- ◯ Yes (Yego)
- ◯ No (Oya)

Mwohereza abarwayi kwisumisha igice cy'umubiri cyirwaye ufashe akanyama cg uduturugunyu

Do you refer patients for: Biopsy?

- ◯ Yes (Yego)
- ◯ No (Oya)

Impamvu yo kohereza umurwayi gufatirwa ikizami cy akanyama cg uduturugunyu

What is the reason for referral for: Biopsy?

- ☐ Lack of skills (Mubohereza kubera ubumenyi buke)
- ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari)
- ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)

Mubaga ibibyimba byajemo amashyira

Do you provide: Incision and drainage of abscess?

- ◯ Yes (Yego)
- ◯ No (Oya)

Mwohereza abarwayi kubindi bitaro kubabgwa ibibyimba byajemo amashyira Do you refer patients for: Incision and drainage of abscess?	◯ Yes (Yego) ◯ No (Oya)
Impamvu mwohereza abarwayi kubindi bitaro kubabgwa ibibyimba byajemo amashyira? What is the reason for referral for: Incision and drainage of abscess?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mutanga serivise zo gukebwa kw'abagabo (gusiramura) Do you provide: Male circumcision?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza abagabo gusiramurwa kubindi bitaro? Do you refer patients for: Male circumcision?	◯ Yes (Yego) ◯ No (Oya)
Impamvu mwohereza abagabo gusiramurwa kubindi bitaro? What is the reason for referral for: Male circumcision?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gukuramo ikintu kidasanzwe kinjiye mu (muhogo, mu maso, mu gutwi cg mw' izuru) Do you provide: Removal of foreign body?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza kubindi bitaro gukuramo ikintu kidasanzwe kinjiye mu (muhogo, mu maso, mu gutwi cg mw' izuru) Do you refer patients for: Removal of foreign body?	◯ Yes (Yego) ◯ No (Oya)
Impamvu yo kohereza umurwayi gukuramo ikintu kidasanzwe kinjiye mu (muhogo, mu maso, mu gutwi cg mw' izuru) What is the reason for referral for: Removal of foreign body?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mudoda (ibisebe, uwongerewe abyara, gukomereka kw inkondo y'umura, no mu gitsina abyara)? Do you provide: Suturing?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza abarwayi bakeneye kudodwa (ibisebe, uwongerewe abyara, gukomereka kw inkondo y'umura, no mu gitsina abyara)? Do you refer patients for: Suturing?	◯ Yes (Yego) ◯ No (Oya)
Impamvu kwohereza abarwayi bakeneye kudodwa (ibisebe, uwongerewe abyara, gukomereka kw inkondo y'umura, no mu gitsina abyara)? What is the reason for referral for: Suturing?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)

Koza no gutunganya igisebe Do you provide Wound debridement?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza abarwayi bakeneye kozwa no gutunganyirizwa igisebe Do you refer patients for: Wound debridement?	◯ Yes (Yego) ◯ No (Oya)
Impamvu Mwohereza abarwayi bakeneye kozwa no gutunganyirizwa igisebe ? What is the reason for referral for: Wound debridement?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kwita ku bushye? Do you provide: Acute burn management?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza abarwayi bakeneye kuvurwa ubushye? Do you refer patients for: Acute burn management?	◯ Yes (Yego) ◯ No (Oya)
Impamvu Mwohereza abarwayi bakeneye kuvurwa ubushye What is the reason for referral for: Acute burn management?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gushyira umuyoboro mu gituza? Do you provide: Chest tube insertion?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza umurwayi gushyira umuyoboro mu gituza? Do you refer patients for: Chest tube insertion?	◯ Yes (Yego) ◯ No (Oya)
Impamvu yo kohereza umurwayi gushyira umuyoboro mu gituza? What is the reason for referral for: Chest tube insertion?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kugurura umwenge w'umuyoboro w'ubuhumekero utekanye ? Do you provide: Cricothyroidotomy/Tracheostomy?	◯ Yes (Yego) ◯ No (Oya)
Mwohereza umurwayi Kugurura umwenge w'umuyoboro w'ubuhumekero utekanye Do you refer patients for: Cricothyroidotomy/Tracheostomy?	◯ Yes (Yego) ◯ No (Oya)

Impamvu yo kohereza umurwayi Kugurura umwenge w'umuyoboro w'ubuhumekero utekanye What is the reason for referral for: Cricothyroidotomy/Tracheostomy?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mwohereza umurwayi guhabwa ubutabazi bwihuse (umwuka, amaraso,gufata umutsi)? Do you refer patients for: Resuscitation?	◯ Yes (Yego) ◯ No (Oya)
Mutanga ubutabazi bwihuse (umwuka, amaraso,gufata umutsi)? Do you provide: Resuscitation?	◯ Yes (Yego) ◯ No (Oya)
Impamvu yo kohereza umurwayi guhabwa ubutabazi bwihuse (umwuka, amaraso,gufata umutsi)? What is the reason for referral for: Resuscitation?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mubaga urwagashya? Do you provide: Appendectomy?	◯ Yes ◯ No
Mwohereza abarwayi bakenewe kubagwa urwagasya ? Do you refer patients for: Appendectomy?	◯ Yes ◯ No
Impamvu mwohereza abarwayi bakenewe kubagwa urwagashya? What is the reason for referral for: Appendectomy?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mukosora kubyimba kw'inkovu y' ubushye cg kongera uruhu mu gukosora igikomere? Do you provide: Contracture release/skin grafting?	◯ Yes ◯ No
Mwohereza abarwayi Gukosora kubyimba kw'inkovu y' ubushye cg kongera uruhu mu gukosora igikomere? Do you refer patients for: Contracture release/skin grafting?	◯ Yes ◯ No
impamvu mwohereza abarwayi Gukosora kubyimba kw'inkovu y' ubushye cg kongera uruhu mu gukosora igikomere? What is the reason for referral for: Contracture release/skin grafting?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kubaga no gusana umuyoboro ikibyimba cy' umuyoboro w'inyama zo munda Do you provide: Hernia Repair?	◯ Yes ◯ No

Mwohereza abarwayi Kubagwa no gusana umuyoboro ikibyimba cy' umuyoboro w'inyama zo munda Do you refer patients for: Hernia Repair?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi Gukosora kubyimba kw'inkovu y' ubushye cg kongera uruhu mu gukosora igikomere? What is the reason for referral for: Hernia Repair?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gusana umwenge w'amazi mw'ibya? Do you provide: Hydrocele?	◯ Yes ◯ No
Mwohereza umurwayi Gusana umwenge w'amazi mw'ibya? Do you refer patients for: Hydrocele?	◯ Yes ◯ No
Impamvu Mwohereza umurwayi Gusana umwenge w'amazi mw'ibya? What is the reason for referral for: Hydrocele?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kubaga mu nda(iturika rya nyababyeyi, inda iri hanze ya nyababyeyi,uburibwe bukabije mu nda, kwifunga kw'amara,gucika cg gukomereka) Do you provide: Laparotomy?	◯ Yes ◯ No
Mwohereza abarwayi Kubagwa mu nda(iturika rya nyababyeyi, inda iri hanze ya nyababyeyi,uburibwe bukabije mu nda, kwifunga kw'amara,gucika cg gukomereka) Do you refer patients for: Laparotomy?	◯ Yes ◯ No
Impamvu mwohereza abarwayi Kubagwa mu nda(iturika rya nyababyeyi, inda iri hanze ya nyababyeyi,uburibwe bukabije mu nda, kwifunga kw'amara,gucika cg gukomereka) What is the reason for referral for: Laparotomy?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kubyaza umubyeyi abazwe Do you provide: Caesarean delivery?	◯ Yes ◯ No
Mwohereza umubyeyi kubyara abazwe? Do you refer patients for: Caesarean delivery?	◯ Yes ◯ No
impamvu Mwohereza umubyeyi kubyara abazwe? What is the reason for referral for: Caesarean delivery?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)

Kwagura no gukora isuku mu mura? Do you provide: Dilatation and Curettage?	◯ Yes ◯ No
Mwohereza abarakeneye Kwagura no gukorerwa isuku mu mura? Do you refer patients for: Dilatation and Curettage?	◯ Yes ◯ No
Impamvu Mwohereza abarakeneye Kwagura no gukorerwa isuku mu mura? What is the reason for referral for: Dilatation and Curettage?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kuvura no gusana umwenge uterwa n'ibikomere by'ibyara? (Fistule) Do you provide: Obstetric fistula repair?	◯ Yes ◯ No
Mwohereza abakeneye Kuvurwa no gusana umwenge uterwa n'ibikomere by'ibyara? Do you refer patients for: Obstetric fistula repair?	◯ Yes ◯ No
Impamvu Mwohereza abakeneye Kuvurwa no gusana umwenge uterwa n'ibikomere by'ibyara? What is the reason for referral for: Obstetric fistula repair?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gufunga imiyoboro y'intanga(abagabo cg abagore)? Do you provide: Tubal ligation/vasectomy?	◯ Yes ◯ No
Mwohereza abarwayi Gufungirwa imiyoboro y'intanga(abagabo cg abagore)? Do you refer patients for: Tubal ligation/vasectomy?	◯ Yes ◯ No
impamvu Mwohereza abarwayi Gufungirwa imiyoboro y'intanga(abagabo cg abagore) ? What is the reason for referral for: Tubal ligation/vasectomy?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Guca urugingo rwangiritse Do you provide: Amputation?	◯ Yes ◯ No
Mwohereza abakeneye Guca urugingo rwangiritse? Do you refer patients for: Amputation?	◯ Yes ◯ No

Impamvu Mwohereza abakeneye Guca urugingo rwangiritse? What is the reason for referral for: Amputation?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kuvura imvune itabazwe? Do you provide: Closed treatment of fracture?	◯ Yes ◯ No
Mwohereza abarwayi Kuvurwa imvune itabazwe? Do you refer patients for: Closed treatment of fracture?	◯ Yes ◯ No
Impamvu mwohereza abarwayi Kuvurwa imvune itabazwe? What is the reason for referral for: Closed treatment of fracture?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Muvura Gusana ibirenge by'umwana yavutse bihengamye? Do you provide: Clubfoot repair?	◯ Yes ◯ No
Mwohereza abana kuvurwa ibirenge yavutse bihengamye? Do you refer patients for: Clubfoot repair?	◯ Yes ◯ No
Impamvu mwohereza abana kuvurwa ibirenge yavutse bihengamye? What is the reason for referral for: Clubfoot repair?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Muvura Gukamura uburwayi bw'umusokoro cg ububabare mu ngingo? Do you provide: Drainage of osteomyelitis/septic arthritis?	◯ Yes ◯ No
Mwohereza abarwayi kuvurwa gukamura uburwayi bw'umusokoro cg ububabare mu ngingo? Do you refer patients for: Drainage of osteomyelitis/septic arthritis?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi kuvurwa gukamura uburwayi bw'umusokoro cg ububabare mu ngingo? What is the reason for referral for: Drainage of osteomyelitis/septic arthritis?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kuvura gukuka kw'ingingo? Do you provide: Joint dislocation treatment?	◯ Yes ◯ No

Mwohereza Kuvurwa gukuka kw'ingingo? Do you refer patients for: Joint dislocation treatment?	◯ Yes ◯ No
Impamvu Mwohereza Kuvurwa gukuka kw'ingingo? What is the reason for referral for: Joint dislocation treatment?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kuvura imvune ibazwe? Do you provide: Open Treatment of fracture?	◯ Yes ◯ No
Mwohereza abarwayi Kuvurwa imvune ibazwe? Do you refer patients for: Open Treatment of fracture?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi Kuvurwa imvune ibazwe? What is the reason for referral for: Open Treatment of fracture?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Mubaga ishaza mu maso? Do you provide: Cataract surgery?	◯ Yes ◯ No
Mwohereza abarwayi bakeneye kubagwa ishaza mu maso? Do you refer patients for: Cataract surgery?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi bakeneye kubagwa ishaza mu maso? What is the reason for referral for: Cataract surgery?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Musana ibibari? Do you provide: Cleft lip repair?	◯ Yes ◯ No
Mwohereza abarwayi bakeneye gusana ibibari? Do you refer patients for: Cleft lip repair?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi bakeneye gusana ibibari? What is the reason for referral for: Cleft lip repair?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Kubaga abana b'impinja (gukosora inenge ku nda, gufungura umuyoboro w'igogora, gusana igitsina gifunze no gusubiza amara mu mwanya wayo)? Do you provide: Neonatal surgery?	◯ Yes ◯ No

Mwohereza Kubaga abana b'impinja (gukosora inenge ku nda, gufungura umuyoboro w'igogora, gusana igitsina gifunze no gusubiza amara mu mwanya wayo)? Do you refer patients for: Neonatal surgery?	◯ Yes ◯ No
Impamvu mwohereza Kubaga abana b'impinja (gukosora inenge ku nda, gufungura umuyoboro w'igogora, gusana igitsina gifunze no gusubiza amara mu mwanya wayo)? What is the reason for referral for: Neonatal surgery?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gufungura umuyoboro w'inkari ku rukoba rw'inda Do you provide: Cystostomy?	◯ Yes ◯ No
Mwohereza abarwayi Gufungura umuyoboro w'inkari ku rukoba rw'inda? Do you refer patients for: Cystostomy?	◯ Yes ◯ No
Impamvu mwohereza abarwayi Gufungura umuyoboro w'inkari ku rukoba rw'inda? What is the reason for referral for: Cystostomy?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)
Gufungura umuyoboro w'inkari ufunganye? Do you provide: Urethral stricture dilatation?	◯ Yes ◯ No
Mwohereza abarwayi Gufungura umuyoboro w'inkari ufunganye? Do you refer patients for: Urethral stricture dilatation?	◯ Yes ◯ No
Impamvu Mwohereza abarwayi Gufungura umuyoboro w'inkari ufunganye? What is the reason for referral for: Urethral stricture dilatation?	☐ Lack of skills (Mubohereza kubera ubumenyi buke) ☐ Lack of supplies or drugs (Mubohereza kuko nta bikoresho cg imiti bihari) ☐ Non-functional equipment (Mubohereza kubera ibikoresho bidakora)

HR Section

Thank you for taking the time to speak with us today. We are conducting a nationwide assessment of the capacity and readiness of district hospitals in Rwanda to deliver Emergency and Essential Surgical Care (EESC). This study is part of an academic collaboration under the Master of Science in Global Health Delivery (Global Surgery Track) at the University of Global Health Equity (UGHE), and is supervised by the Ministry of Health and key national stakeholders.

Our focus is to better understand the availability of critical infrastructure, trained personnel, surgical procedures, anesthesia services, and essential equipment across Rwanda's district-level facilities. By doing so, we aim to highlight both the strengths and the gaps in surgical systems - not to evaluate individual hospitals or staff - but to inform future investments and improvements in equitable surgical care delivery.

We are using the WHO SAT-EESC tool and will ask a short set of questions based on your role. No personal or hospital identifiers will be collected, and your responses will remain confidential.

_____

Name of the HR Officer interviewed

_____

Abaganga babaga (babyize), Umubare w'abakozi bahahora?

Number of full-time surgeons

_____
(Licensed Surgeons)

Abaganga babaga (babyize), Umubare w'abanyakiraka?

Number of part-time surgeons

_____
(Licensed Surgeons)

Abatera ikinya (babyize), Umubare w'abakozi bahahora? (anesthesiologist)

Number of full-time anesthesiologists

_____
(Licensed anesthesiologist)

Abatera ikinya (babyize), Umubare w'abanyakiraka? (anesthesiologist)

Number of part-time anesthesiologists

_____
(Licensed anesthesiologist)

Abavura indwara z'abagore(babyize), Umubare w'abakozi bahahora?

Number of full-time Obstetetrician/Gyenecologist

_____

Abavura indwara z'abagore(babyize), Umubare w'abanyakiraka?

Number of part-time Obstetrician/Gyenecologists

_____

Abaganga basanzwe bashobora kubaga, Umubare w'abakozi bahahora? Number of full-time general doctors performing surgery	_____
Abaganga basanzwe bashobora kubaga, Umubare w'abanyakiraka? Number of part-time general doctors performing surgery	_____
Ababyaza, Umubare w'abakozi bahahora? Number of full-time midwives	_____
Ababyaza, Umubare w'abanyakiraka? Number of part-time midwives	_____
Abaforomo/abafasha abaganga kuvura no gutanga ikinya, Umubare w'abakozi bahahora? nurses+anesthetist in total Number of full-time nurses/assistants able to assist in surgery and anesthesia	_____
Abaforomo/abafasha abaganga kuvura no gutanga ikinya, Umubare w'abanyakiraka? (nurses+anesthetist) in total Number of part-time nurses/assistants able to assist in surgery and anesthesia	_____

Appendix 4: IRB Approval

University of Global Health Equity- Institutional Review Board

Notification of Approval

Ref: UGHE-IRB/2025/410

April 19, 2025

Protocol Title:	Assessment of the Essential Emergency Surgical Care in all District Hospitals across Rwanda using WHO-situational analysis tool for Essential Emergency Surgical care: A Cross-Sectional Survey
Principal Investigator(s):	Alexander Habte Habtemariam & Marie Merci Cyuzuzo
Protocol #:	410
Funding Source:	UGHE
Initial IRB Review Date:	25th March 2025
Initial Review Type:	Expedited review
Additional Review Dates:	17th April 2025
IRB Review Action:	**Approved**
Effective Date:	19th April 2025
Expiration Date:	18th April 2026

UNIVERSITY OF GLOBAL HEALTH EQUITY
P. O. BOX 6955, KIGALI, RWANDA
INSTITUTIONAL REVIEW BOARD
19 APR 2025
APPROVED
VALID UNTIL DATE SHOWN

Dear Alexander Habte Habtemariam and Marie Merci Cyuzuzo

On April 17th, 2025, the University of Global Health Equity Institutional Review Board (UGHE IRB) approved your submitted study. **Please note that the approval for this protocol will lapse after one (1) year and must be renewed according to the procedures of the UGHE IRB.**

The IRB reminds you that you are responsible for fulfilling the following requirements:

- Changes, amendments, and addenda to the protocol or consent form (if applicable) must be submitted to the committee for review and approval, prior to activation of the changes.
- Only approved consent forms are to be used for the enrollment of participants.
- All consent forms signed by subjects must be retained on file, and are submitted to inspection, along with other project materials, during routine onsite visits or audits.
- Upon expiry of the approval, failure to apply for renewal will result in the suspension or termination of the study.
- The UGHE IRB must be notified at the closure of the study with a summary report.

Please contact the UGHE IRB via email at irb@ughe.org with any questions.

Sincerely,

Dr. Anselme Shyaka,
IRB Chair

Appendix 5: Authorization from MoH to conduct research

REPUBLIC OF RWANDA

KIGALI, 09 MAY 2025
N°20/1315 /DPMEHF/2025

MINISTRY OF HEALTH
P. O. BOX: 84 KIGALI
www.moh.gov.rw

Vice Chancellor at the University of Global Health Equity (UGHE)
BUTARO

Re: Authorization to conduct research

Dear Vice Chancellor,

Reference is made to your letter dated March 7, 2025, requesting a support letter to allow your students to conduct research projects at various health facilities.

Based on the University of Global Health Equity (UGHE) - Institutional Review Board approval notifications provided to the remaining **(batch 2)** fourteen (14) research projects,

I am pleased to inform you that the Ministry of Health has granted you authorization to conduct the fourteen research projects mentioned in the attached list of students.

Kindly ensure that the results and the final report are shared with the Ministry of Health upon completion of the study. We trust that the data will be used in full compliance with national ethical and data protection standards.

For further information or clarification, please don't hesitate to contact Mr. Jerome H. BUSHUMBUSHO via his email at jerome.bushumbusho@moh.gov.rw or by Phone at **+250785420300.**

Sincerely,

MINISTRY OF HEALTH

"By Delegation of Authority"

Dr. Muhammad SEMAKULA
HoD of Planning, M&E, and Health Financing

Cc:

- **Hon. Minister of Health**
- **Hon. Minister of State/MoH**
- **Permanent Secretary/MoH**

SN	Students' Names	Project Title	Health Facilities
1	Marie Immaculee Dusingize Peace Ingabire	Exploring the Acceptability of Breast Milk Donation for Neonatal Feeding: Perspectives of Mothers and Healthcare Professionals in Two Rwandan Hospitals	Kirehe and Ruhengeri District Hospitals
2	Fred Nkurunziza Delphine Mizero	Exploring the barriers and facilitators in the management of diabetes among incarcerated individuals seeking care in the NCD clinic at Ruhengeri Level 2 Teaching Hospital in Rwanda.	Ruhengeri Hospital
3	Nathalie Uwamwezi	Fertility and family planning among oncology patients (IMB/PIH)	Butaro Hospital
4	Emmanuel Mugabo Byakagaba	Lab Test Turnaround Time Study in Butaro Level II Teaching Hospital	Butaro Hospital
5	Steve Ivan Rwema	Concept Note: Time Study Proposal in Butaro Level II Teaching Hospital Outpatient Department	Butaro Hospital
6	Alexandre Muhawenimana Alice Umutoni	Exploring Community Experience on First Aid Practices for Pre-hospital Injury Management in Northern Rwanda: A Case Study of Burera District.	Butaro Hospital
7	Alexander Habte Habtemariam, Marie Merci Cyuzuzo	Assessment of the Essential Emergency Surgical Care in all District Hospitals across Rwanda using WHO-situational analysis tool for Essential Emergency Surgical care: A Cross-Sectional Survey.	All Rwandan District Hospitals
8	Allison Ophélie Niragira Fanique Umuhoza	Fathers' Perspectives and Experiences on Parenting High-Risk Infants and Children with Developmental Disabilities.	Rwinkwavu Hospital
9	Aimable Ndayishimiye Feven Aregawi	The stage distribution among breast cancer patients consulted at Butaro Cancer Center of Excellence (BCCOE) from 2020 to 2024	Butaro Hospital
10	Bashir Garba, Marie Goreth Mukakayindo	Knowledge, Attitude, and Practice of Nurses and Midwives Regarding Maternity Triage in Rwanda: A Cross-sectional Study in Kibagabaga Level 2 Teaching Hospital and Muhima District Hospital	Muhima and Kibagabaga Hospitals
11	Sandra Shami Aimee Aline Kayiranga	Exploring Factors Associated with Inclusion and Child Care of under-five-year-old Children with Developmental Disabilities in Kirehe and Kayonza Districts.	Kirehe and Rwinkwavu Hospitals
12	Prince Rwema Ishimwe Wellars Mvuyekure	Assessing Quality of Life Variations Between Elderly Male and Female Living with Hypertension, Diabetes, Asthma and Heart Failure in Kayonza District, Rwanda.	Rwinkwavu Hospital
13	Belyse Mukayiranga Melina Uwamwezi	Assessing the Level of Readiness for Newborn Care in the Neonatal Department of JHPIEGO-Supported Hospitals in the Northern Province of Rwanda: A Cross-Sectional Study.	All JHPIEGO-supported hospitals
14	Clovis Gatete Nkeramihigo Sam Kamali	Assessing the Adherence of Practicing Physicians to the Rwandan Guidelines on the Diagnosis and Management of Pediatric Dehydration	Kirehe and Kibogora Hospitals

Appendix 6: Informed Consent Form

INFORMATION AND CONSENT FORM
Participant ID: _____
Project Title:
Assessment of Essential Emergency Surgical Care in All District Hospitals in Rwanda Using the WHO Situational Analysis Tool
Study Population:
Our study will evaluate the essential emergency surgical status of all 43 district hospitals in Rwanda.
Version Date:
Principal Investigators:
Alexander Habte Habtemariam, MGHD Candidate, University of Global Health Equity (UGHE)
Marie-Merci Cyuzuzo, MGHD Candidate, University of Global Health Equity (UGHE)
This study is being conducted as part of the MGHD program at the University of Global Health Equity (UGHE) and has received ethical approval from the UGHE Institutional Review Board (IRB). The research complies with international ethical standards for human participant research.

About This Consent Form
Dear Participant,
Before joining this study, please read this form carefully, as it contains important information to help you decide whether to participate or not. You may also take time to discuss your participation with family, colleagues, or other trusted individuals before making a decision.

Your participation in this study is completely voluntary. You have the right to ask any questions about the study before, during, or after your participation. If you decide to take part, you will be required to sign this form, and you will receive a copy of your records. Before making a decision, you may also take the time to discuss your participation with family, colleagues, or other trusted individuals.

Participation Is Voluntary
Your participation in this research is entirely voluntary. You may choose to withdraw at any time without giving a reason. Refusing to participate or withdrawing from the study will not result in any penalties or loss of benefits to which you are otherwise entitled.

What Should You Know About This Study?

What is the purpose of this project?
This study aims to assess the availability, capacity, and quality of emergency and essential surgical care in Rwanda's district hospitals using the WHO Situational Analysis Tool (WHO SAT-EESC). The findings will contribute to evidence-based policy recommendations to enhance surgical service delivery and improve health outcomes.

How Many People Will Participate?
A total of 43 key informants—one from each district hospital in Rwanda—will take part in this study.

What Will Participation Involve?
Participating in our research requires you to complete a structured survey based on the WHO Situational Analysis Tool for Essential and Emergency Surgical Care (SAT-EESC) tool, which consists of 140 items. The survey will assess various aspects of your hospital, including surgical infrastructure, workforce, equipment, and service delivery. The estimated time commitment for completing the survey is about 2 hours.

What Are the Potential Risks or Discomforts?
There are no anticipated risks associated with participation in this study.

What Are the Potential Benefits?
While there may be no direct benefits to you as a participant, your insights will play a crucial role in identifying gaps and strengths in Rwanda's district hospitals concerning emergency and essential surgical care. Your contributions will help inform national surgical policies aimed at improving service delivery and patient outcomes. Additionally, the data collected will provide evidence-based recommendations to enhance surgical capacity, workforce distribution, and infrastructure investments. Your participation will ultimately help shape future surgical healthcare strategies in Rwanda.

What are my alternatives to participating in this study?
The alternative is not to participate in the study

Will I Be Compensated for Participating?
No compensation or incentives will be provided for participating in this study.

Are There Any Costs to Participate?
There are no costs associated with participation.
What Happens If I Am Injured as a Result of This Study?
If physical injury resulting from participation in this research should occur, although UGHE's policy is not to provide compensation, medical treatment will be available, including first aid, emergency treatment, and follow-up care as needed, and your insurance carrier may be billed for the cost of such treatment. In making such medical treatment available or providing it, the persons conducting this research project are not admitting that your injury was their fault.

Can My Participation End Early?
Yes, you have the right to withdraw from study at any time without facing any consequences. Your participation is entirely voluntary, and you are under no obligation to continue if you decide otherwise. If you choose to withdraw, please inform the research team, and any data collected from you will be immediately deleted from the study records. Your decision to withdraw will not affect any current or future relationships with the research team or any affiliated institutions. If you have any concerns or questions about the withdrawal process, you are encouraged to reach out to the research team for clarification.

How Will My Privacy and Data Be Protected?
Your responses will remain strictly confidential throughout the study. To protect your privacy, no personal identifiers will be collected, and your data will be assigned a unique code instead of your name. This ensures that your identity remains anonymous and cannot be linked to your responses. All collected data will be securely stored and accessible only to the research team, which is committed to maintaining the highest standards of confidentiality and data protection. Additionally, in accordance with ethical research guidelines, all study data will be destroyed after five years to prevent any unauthorized access or misuse. We want to assure you that your personal information will not be shared with any third party under any circumstances. Your participation is valued, and we are dedicated to upholding the integrity and security of your information throughout the study. If you have any questions or concerns regarding data confidentiality, please feel free to reach out to the research team for further clarification.

Who Can I Contact If I Have Questions?
If you have any questions, concerns, or complaints about this study, you may contact:

Principal Investigators:

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Sponsors of the facility

This research has been reviewed by the University of Global Health Equity Institutional Review Board. If you wish to speak with someone from the IRB, please contact the IRB at irb@ughe.org, telephone: +250 788316894 or Office of Human Research Administration (OHRA) at Kigali Heights Building, 5th floor, Kacyiru, Kigali, P.O. Box 6955, Rwanda.

Statement of Consent

By signing below, you confirm that:

- ✔ You have read and understood the contents of this form.
- ✔ You have had the opportunity to ask questions and receive satisfactory answers.
- ✔ You voluntarily agree to participate in this study.
- ✔ You will receive a signed copy of this form.
- ☐ I consent to have my survey responses recorded and used for research purposes.

Signatures

Participant Name: _____
Signature: _____ Date: _____
Researcher Name: _____
Signature: _____ Date: _____