SCHOOL OF MEDICINE

DEPARTMENT OF OBSTETRICS AND GYNECOLOGY

PREDICTORS BACTERIAL ISOLATES, AND ANTIBIOTIC SUSCEPTIBILITY AMONG WOMEN WITH SURGICAL SITE INFECTION FOLLOWING CAESAREAN SECTION AT AMANA REGIONAL REFERRAL HOSPITAL.

BY

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DECLARATION AND COPYRIGHT

I, Titus Benedict Kullaya declare that this dissertation is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance for examination by the KU dissertation entitled "Predictors of surgical site infection, Bacterial pattern and antibiotics susceptibility among women giving birth by cesarean section at Amana regional Referral Hospital in partial fulfillment of the requirements for the degree of masters of medicine in obstetrics and gynecology of the KU.

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DEDICATION

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ABSTRACT

Background:

Surgical site infection following cesarean section remain a common problem contributing to significant morbidity and mortality, attributed partly to the emergency nature of the surgical intervention and an increase in antimicrobial resistance among the etiological agents. This study was done to explore the predictors, bacterial pattern and antibiotics susceptibility among women giving birth by cesarean section at Amana Regional Referral Hospital.

Methodology:

This was a prospective cohort study which included 151 women who underwent cesarean section within 48 hours at Amana Regional Referral Hospital from March to May 2025 who were then followed up for 30 days to see if they develop SSI. Preoperative, intraoperative and postoperative data were collected by using a structured questionnaire. Wound swab was collected and sent to the laboratory for culture and sensitivity by following the standard operating procedures. Susceptibility testing was carried out by using Kirby-Bauer disc diffusion technique. Data obtained were analyzed using the SPSS version 26. Mean and standard deviation were used to summarize continuous variables while categorical variables were summarized as proportions. Both univariate and multivariate analyses were done and a p-value of less than 0.001 was considered statistically significant.

Results:

This study found that 19.9% (30 patients) developed surgical site infections, with superficial infections accounting for the majority—63.3% (19 cases) of all SSIs.

The study identified key risk factors for surgical site infections (SSI), including age above 35 years (82.6%), BMI> (37.5%), and cesarean sections lasting more than one hour (63.3%). Staphylococcus aureus (46.7%) was the most commonly isolated pathogen, followed by coagulase-negative staphylococcus (23.3%). Among antibiotics tested, Meropenem (71.4%) and Vancomycin (57.1%) were the most effective against the isolates, while Ceftriaxone (85.7%), Amoxicillin (64.3%), and Ampicillin and Cloxacillin (42.8%) showed poor effectiveness.

Conclusion:

The study identified several significant risk factors for surgical site infections (SSI), including age above 35 years, multigravidity, and prolonged cesarean sections (lasting more than one hour). The most frequently isolated pathogens were Staphylococcus aureus and coagulase-negative staphylococci. Antibiotic susceptibility testing revealed that Meropenem and Vancomycin were the most effective against the bacterial isolates, whereas Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin demonstrated poor efficacy.

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LIST OF ABREVIATIONS

AIDS	-	acquired immunodeficiency syndrome
C/S	-	Cesarean section
CDC	-	Centre for disease control
DM	-	diabetic mellitus
ARRH	-	Amana Regional referral hospital
HIV	-	Human immune virus
HTN	-	Hypertension
MA	-	MacConkey Agar
MOI	-	Medical officer in charge
SBA	-	Sheep Blood Agar
SPP	-	species
SPSS	-	Statistical package for social sciences
SSI	-	Surgical site infection
KU	-	Kariuki University
WHO	-	World Health Organization

DEFINITION OF TERMS

Surgical site infection is defined as an infection that occurs within thirty days after surgical intervention or after one year if an implant has been left in place after surgical intervention

Definition of surgical site infection in this study was based on the classification by center for disease control and prevention (CDC)

Superficial incisional surgical site infection

Infection occurs within thirty days after the operation and involves only skin and subcutaneous tissue of the incision and at least one of the following:

Purulent drainage with or without laboratory confirmation from the superficial incision

Organisms isolated from an aseptically obtained culture of fluid or tissue from superficial incision.

At least one of the following signs or symptoms of infection:

Pain or tenderness: Localized swelling, redness or heat Superficial incision is deliberately opened by surgeon, unless incision is culture negative

Diagnosis of Superficial incision SSI made by the surgeon or attending physician

Deep incisional surgical site infection

Infection occurs within thirty days after the operation or within one year if an implant has been left in place and the infection appears to be related to the operation and infection involves deep soft tissue for example fascia, muscle of the incision and at least one of the following:

Purulent drainage from the deep incision but not from the organ/space component of the surgical site.

A deep incision spontaneously dehisces or is deliberately opened by a surgeon when a patient has at least one of the following: fever, localized pain, tenderness, unless incision is culture negative.

An abscess or other evidence of infection involving the deep incision is found on direct examination, during operation or by histologic or radiologic examination

Diagnosis of SSI made by a surgeon or attending physician.

Organ/space surgical site infection

Infection occurs within 30 days after the operation or within one year if an plant is left in place and the infection is found to be related to the operation, and infection involves any part of the anatomy (e.g. organ and space) other than the incision that was opened or manipulated during an operation and at least one of the following:

Purulent drainage from the drain that is place through a stab wound into organ or space

Organisms isolated from aseptically obtained culture of fluid or tissue in the space or organ

An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation or by histopathologic or radiologic examination

Diagnosis of organ/space SSI made by a surgeon or attending physician.

Lost to follow up: in this study were those participants who were not reachable on cell phone after an attempt to call them for three consecutive weeks or whose phone

calls were responded by other people and upon asking them if they have any relative who gave birth on a specified date at Amana regional referral Hospital the response was no. Also, those who did not come for their hospital visit on day seven and day twenty-eight after surgical intervention apart from not being reachable on cell phone.

Culture negative: These were all patients whose sample from their wounds showed no growth of any bacteria after being processed in the laboratory.

C**ulture positive:** These were all patients whose samples from their wounds showed growth of bacteria after being processed in the laboratory.

Multiple drug resistance: In this study was defined as Bacteria found to be resistant to more than one group of antibiotics.

Sepsis: Sepsis (maternal) is severe bacterial infection of the uterus and/or surrounding structures which can occur in pregnant women or more commonly in the postpartum period

Health care associated infections: Are infections acquired by patients during their stay in the Hospital or another health care setting

High sensitivity: In this study high sensitivity is applied when sensitivity of the bacteria towards a drug is more than 50%

Low sensitivity: In this study low sensitivity is applied when sensitivity of bacteria towards an antibiotic is below 50%

Resistant: In this study the term resistant is applied when a bacteria does not show any sensitivity to an antibiotic, i.e. 0.0%

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

According to the United States Centers for Disease Control and Prevention (CDC), site within 30 days following a surgical site infection (SSI) is an infection related to a surgical procedure that occurs near the surgical site (or up to 90 days following surgery, where an implant is involved (1). These infections can be categorized based on their anatomical location and time of onset. Superficial incisional SSIs involve the skin and subcutaneous tissue, while deep incisional SSIs involve deeper tissues like muscles or fascia. Organ/space SSIs involve any part of the anatomy that was opened or manipulated during surgery. SSIs can develop within 30 days of surgery, with the risk window extending to 90 days for implanted prosthetics (2)

While often lifesaving, Caesarean section are major surgeries and carry inherent risks for complications, including post-cesarean SSIs, which are a specific type of surgical site infection and can significantly impact maternal health(3)These infections can lead to increased hospital stays, additional healthcare costs, and long-term morbidity (4)Factors contributing to SSIs after C-sections include breaks in sterile technique, pre-existing maternal infections, and prolonged surgical duration (5)

Globally, recent systematic review and meta-analysis have shown that the estimated global prevalence of post-caesarean surgical site infections is 5.63%, with the highest prevalence in sub-Saharan Africa (11.91%) and the lowest prevalence in North America (3.87%). Most surgical wound infections are acquired from the patient's microbial flora in the operating room, while the rest are obtained from operating room staff during

surgery, with the most prevalent pathogens being Staphylococcus aureus and Escherichia coli. Additionally, post-cesarean surgical site infections have a 3% maximum rate of maternal morbidity and mortality linked to it (6).

On the other hand, some primary studies reported a higher prevalence of caesarean SSI compared with the current meta-analysis including 10.9% prevalence in Tanzania according to a 2014 study at Bugando Medical Centre in Mwanza, 8% in Ethiopia, 16.01% in Nigeria and 8.02% in India while relatively low in Rwanda 6.85%, which was comparable to the 6.7% prevalence in Sierra Leone, 7.3% prevalence in Sub-Saharan multi-country study by Medecins Sans Frontieres, 5.34% prevalence in Egypt and 2.1% prevalence in Kenya(6). Targeting Tanzania specifically, other studies have reported SSI rates ranging from 21.3% to 48.0% among patients undergoing surgery, including cesarean sections (7)with the most common causative organism being Staphylococcus aureus (27.3%), followed by Klebsiella pneumoniae (22.7%) . Also, it is noticed that post-cesarean section patients with SSI have a longer average hospital stay compared to those without (12.7 ± 6.9 days vs. 4 ± 1.7 days), with a case mortality rate among these patients like Amana can help improve preventative measures and treatment strategies.

1.2 Problem Statement

Surgical site infections (SSIs) remain a significant cause of maternal morbidity following caesarean section deliveries, particularly in low-resource settings. Despite advances in surgical techniques and infection control protocols, the incidence of SSIs continues to

challenge healthcare systems, leading to prolonged hospital stays, increased healthcare costs, and adverse maternal outcomes(9).

In women undergoing caesarean sections, the development of SSIs is influenced by multiple predictors, including patient-related factors (e.g., anemia, obesity, diabetes), procedural variables (e.g., duration of surgery, emergency vs. elective procedure), and hospital practices. However, limited data exists on the specific bacterial isolates responsible for these infections and their patterns of antibiotic susceptibility in the local context.

This gap in knowledge hampers the ability of clinicians to implement targeted prophylactic and therapeutic strategies. Without localized data on microbial profiles and resistance patterns, empirical antibiotic use may be ineffective, contributing to antimicrobial resistance and poor clinical outcomes.

Therefore, this study seeks to identify key predictors of SSIs, characterize the bacterial isolates involved, and assess their antibiotic susceptibility among women who have undergone caesarean sections. The findings will inform evidence-based interventions to reduce SSI rates and improve maternal health outcomes.

1.3 Rationale of a Study

This research aims to bridge the knowledge gap by identifying the specific factors that contribute to SSIs after Caesarian sections in. It will benefit mothers undergoing Caesarian sections, healthcare providers treating post-cesarean SSIs, and policymakers developing public health guidelines. By understanding the unique risk factors, prevalent bacterial strains, and their antibiotic susceptibility patterns, the study, through its

findings, will contribute to guiding the development of targeted prevention strategies and optimizing antibiotic treatment regimens at Amana Hospital, leading to better patient outcomes.

The study has also the potential to contribute to a more comprehensive understanding of SSIs in sub-Saharan Africa, informing future research and potentially revealing regional variations in bacterial profiles and antibiotic resistance while its data can be used to advocate for improved hygiene practices, resource allocation, and potentially influence national guidelines for C-section protocols and post-operative care in Tanzania.

1.3. Research Questions

1. What maternal and surgical risk factors are associated with an increased risk of developing cesarean surgical site infections (SSIs)?
2. What are the most common bacterial pathogens isolated from cesarean surgical site infections (SSIs)?
3. How susceptible are bacterial isolates from cesarean surgical site infections (SSIs) to commonly used antibiotics at Amana Hospital?

1.4 Objectives.

1.4.1 Broad Objectives.

This study aims to evaluate the predictors, bacterial patterns, and antibiotic susceptibility in cesarean surgical site infections at Amana Hospital.

1.4.2 Specific Objectives.

i. To identify maternal and surgical risk factors associated with the development of caesarean surgical site infections.

ii. To describe the distribution of bacterial isolates from caesarean surgical site infections (SSIs).

iii. To determine the laboratory antibiotic susceptibility of bacterial isolates from caesarean surgical site infections to commonly used antibiotics.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The magnitude of surgical site infection after cesarean section.

The problem of surgical site infection is well established globally because of its high rate of morbidity, mortality and its significant effect on quality of life through increased extended hospital stay and financial burden to health care provider (10). The center for disease control and prevention (CDC) describe post cesarean section surgical site infection (SSI) as an infection that occurs within 30 days from cesarean section procedure. CDC divides post cesarean section surgical site infection into incisional SSI and organ/space SSI. Incisional SSI is furthermore categorized into superficial SSI involving skin and subcutaneous tissue and deep SSI involving fascia and muscle layers (11)

Despite an increase in skilled care during childbirth in sub-Saharan Africa maternal mortality rate in the region remains high at 104 per 100,000 live births in 2022, and among the leading causes is surgical site infection (12).

Surgical site infection is common complication following emergency cesarean section. It is the most prevalent among the health care associated infections which formally was named nosocomial infections, others being Central line associated bloodstream infection, Catheter associated urinary tract infection and ventilator associated pneumonia (13)

Though surgical site infection is a global problem, the magnitude of surgical site infection is high in lower income countries compared to higher income countries because the risk of acquiring surgical site infection in lower income countries increases

the risk of financial catastrophe. It is the second among health care associated infections in Europe and United States of America. In recent studies conducted in developed countries the magnitude of SSI was 20% in USA and 17% in Europe. In developing countries SSI is reported frequently among health care associated infections while in developed countries surgical site infection is not reported under health care associated infections because of dissimilarities in economic status and health policy(10).

In accord with World Health Organization 2017 annual report the prevalence of SSI in low- and middle-income countries was found 11.7%. In developed countries, the magnitude was 20% in the United States of America and 17% in Europe. In sub-Saharan African countries surgical site infection is the most common surgical complication and 20% of women who gave birth by cesarean delivery developed SSI. The magnitude of surgical site infection in Sub-Saharan Africa ranges from 2.78% in Egypt to 10.9% in Tanzania (10,14).

Though much has been established locally, regionally and internationally, our facility does not have recently published data on the magnitude which this study aims to address.

2.2 The rate of post cesarean section surgical site infection

The incidence of post cesarean section surgical site infection is increasing (15). The rate is high in low- and middle-income countries compared to higher income countries because of differences in economic status and health policies. Globally the rate of post cesarean section surgical site infection ranges from about 3% to 15%. Also, other studies show that it ranges from as small as 0.3% in turkey to as large as 24% in

Tanzania. Recent studies in Tanzania shows the rate ranging from 21% to 24%. In low- and middle-income countries the rate of post cesarean section surgical site infection can reach up to 30% (7,10,15,16)

A retrospective study was done at Al Ain Hospital in the United Arab Emirates in 2017 in which a total of 807 women delivered by cesarean section and out of them 11(1.4%) developed post cesarean section surgical site infection of these 11 (100%) women were diagnosed after discharge home, but within 30 days after cesarean section (17). In a prospective study which was done in Lahore hospital in Pakistan from 2010 to 2012 determining the frequency of surgical site infection following emergency cesarean section in which 150(25%) out of 600 women developed surgical site infection. This signifies that emergency cesarean section is the most common cause of surgical site infection (18). This shows that surgical site infection following emergency cesarean section is very high. In a study which was done in Nepal from 27th Dec 2019 to 19th Feb 2020, out of 186 women who underwent cesarean section the incidence rate of surgical site infection was 13 (19)

In Tanzania about 120,000 cesarean sections are performed annually. The overall cumulative incidence of post cesarean section surgical site infection is 10.9% with incidence rate of 37.5 per 10,000 per day. A prospective observational study which was done in central Tanzania Dodoma, at a regional referral hospital in 2013 reported an extremely high prevalence of Surgical site infection (48.2%) (12,20,21)

The prospective cohort study which was done in Ethiopia from March 2019 to August 2019 showed the overall cumulative surgical site infection to be 25.4% with incidence of 11.7 per 1000 person per day. This is consistent with World Health Organization

report in 2017 which showed prevalence of 11.7% in low and middle income countries (22)

Clinical presentation of post cesarean section surgical site infection is increased pain at the incision site, fever and general body weakness, and on examination the patient will present with erythema, edema, indurations, dehiscence, pus discharge from the superficial wound and purulent drainage from the deeper wound. The most three questions which are specific and sensitive for diagnosing surgical site infection being purulent drainage, pain and fever. Also Bacteria identified by culture, or an abscess or other evidence of infection diagnosed by pathology or imaging (16,23). Generally, there is scant published data on this matter in Tanzania and the study will shade light to what is happening in the clinical sites with regard to surgical site infection.

2.3 Predictors of surgical site infection following cesarean section.

There are various variables associated with post cesarean section surgical site infection; these are patient-related variables which include age, underlying medical condition like diabetes mellitus, immune compromised state like HIV, history of blood transfusion, longer preoperative hospitalization, history of use of alcohol, use of tobacco and corticosteroids. Factors relate to the management and care, which consist of preoperative preparation of the patient, type of procedure (emergency/elective), type of anesthesia (regional/general), type of skin incision (horizontal/vertical),method of skin closure, type of suture used, antibiotic prophylaxis, duration of labor before cesarean section, duration of operation, number of vaginal examination done before surgery, grade of operator (specialist/ resident/registrar/intern doctor), previous caesarean section, and surroundings of the operating room (20,24)

Many studies which have indicated these variables are not from Tanzania and this study will identify the factors and unpack them for public consumption and scientific dissemination

Emergency cesarean section is found to be an important risk factor for surgical site infection following cesarean section, several studies reveals that emergency cesarean section contributes about 80% of surgical site infection following cesarean section. This risk is even higher if cesarean section is done for a woman who was in the course of labor (22,25)

2.4 Bacterial isolates in post cesarean section surgical site infection

The most commonly isolated Bacteria from surgical site infection is staphylococcus aureus. Others are Gram negative bacilli, Coagulase negative staphylococci, Escherichia coli and Enterococcus species (26). Bacterial source of pathogens in relation to cesarean section is diverse, originating from both skin and vagina. It is usually polymicrobial infection consisting of both aerobic and anaerobic microorganisms. The study which was done at the University of kalabar Nigeria shows that out of 600 patients who had a cesarean section 51 patients had surgical site infection with an incidence of 8.5%. The common isolates were *Staphylococcus aureus* (37%), Klebsiella pneumonia (27.1%) and E. coli (22.0%). Imipenem and amikacin antibiotics were found to be sensitive to most Bacteria causing surgical site infection. Another study which was done in Tanzania at DRRH the common isolates were *Staphylococcus aureus* (64.9%),coagulase negative staphylococcus species(spp) (44.9%),Klebsiella spp (26.8%),Enterococcus spp (7.8),Pseudomonas aeruginosa (14.6%), Proteus mirabilis (9.8%) and Streptococcus aureus (2.4%). Many studies have dealt with microbial

pattern in post cesarean section surgical site infection in general;this study will focus on Bacterial pattern in surgical site infection following emergency cesarean section which will contribute to proper management of such cases (7,27).

2.5 Antibiotics susceptibility

The pathogens mostly isolated from surgical site infection differ according to the site of surgical site infection. In many studies Staphylococcus aureus is the mostly isolated bacteria in surgical site infection because it is normal flora to the skin. Infection by multiple drug resistant bacteria has been a problem in developing countries (7)

In a cross section descriptive study which was done in the department of gynecology, Dhaka Medical College Hospital in Bangladesh from January to December 2008, total of 3904 cesarean operations was done, among them 444(11.37%) cases developed surgical site infection. From these patients 100 patients were chosen for the study, of aerobic cultures 55% were culture positive and 6 had significant polymicrobial infection. Staphylococcus aureus was the most common organism (20%). Other isolates include Escherichiacoli (11%), Acinetobacter Spp (7%), pseudomonas's (6%), proteusspp (5%). *Staphylococcus aureus* was mostly sensitive to ceftriaxone (50%), Amikacin (30%), Azithromycin (27.9%) and gentamycin (14.3%). Most of E coli (80%) were sensitive to Amikacin. Both were resistant to Ampicillin (100%), Amoxicillin/ Clavulanate (50%) and sulphamethoxazole/trimethoprim (78.5%). They were 100%, 85.7% and 68% sensitive to meropenem, ceftazimidine and ciprofloxacin respectively (28). Most of the studies have researched antimicrobial susceptibility in general, this study will focus on antimicrobial susceptibility in surgical site infection following emergency cesarean section and this will give light to management of such cases.

2.6 Conceptual Model.

The independent variables are social demographic factors, obstetric factors and surgical factors which are predictors of surgical site infection.

The dependent variable is common bacterial isolated and bacterial susceptibility.

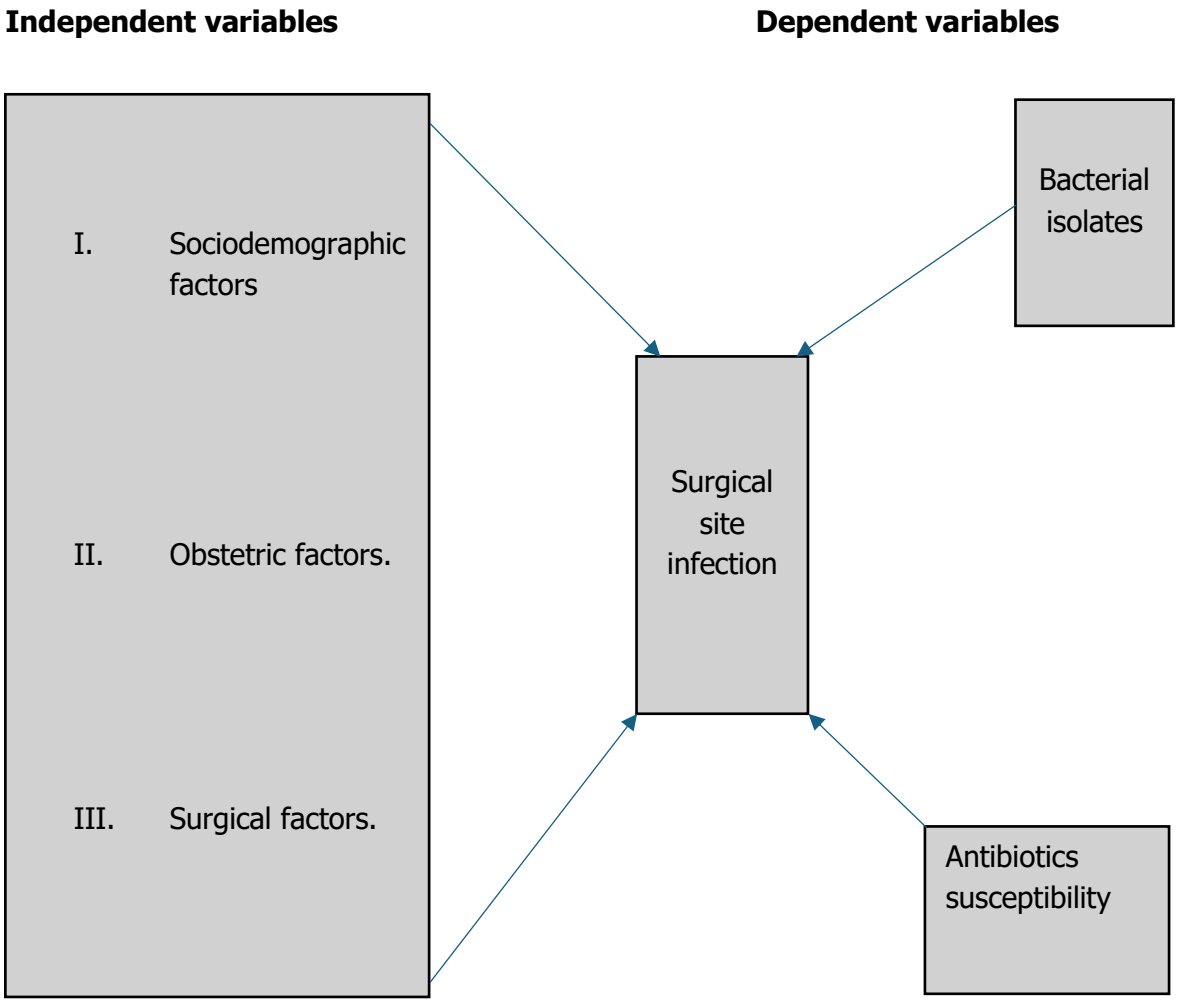

Figure 1 Conceptual Framework

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Study Design.

This study was employing a prospective cohort study design. This design allows for the identification of risk factors and their association with the development of cesarean SSIs over time. By following a group of women who undergo cesarean sections, researchers can collect detailed data on maternal and surgical factors, bacterial isolates, and antibiotic susceptibility.

3.2 Study Settings.

This study was conducted at Amana Regional Referral Hospital. The choice of this hospital as the study site is strategically sound for several reasons. As the oldest public hospital in Dar es Salaam, ARRH serves a substantial population from approximately 200 health centers in the Ilala district and the year 2018, was subjected to a 1.2 Tanzanian billion shilling expansion for its maternal facility to reduce number of pregnant women flocking to Muhimbili National Hospital i.e., making it capable of accommodating 200 pregnant women at a time. This large patient volume increases the likelihood of recruiting a sufficient sample size for the study. The hospital's role as a regional referral center implies a diverse patient population, potentially capturing a wide range of risk factors for cesarean SSIs.

Moreover, ARRH's dedicated obstetrics and gynecology department, with its distinct units for antenatal, delivery, postnatal, and gynecological care, provides an ideal setting to conduct this research. The availability of a well-equipped laboratory with expertise in culture and sensitivity testing is crucial for accurate bacterial identification

and antibiotic susceptibility profiling. This aligns perfectly with the study's objectives of characterizing bacterial isolates and determining their antibiotic susceptibility patterns

By conducting the study at ARRH, the proposed study can leverage the hospital's infrastructure, existing data, and experienced healthcare professionals to efficiently collect and analyze data.

3.3. Study Population.

The study population was consisting of women who undergo cesarean section at Amana Regional Referral Hospital (ARRH) within the study period.

3.4. Sample size

The sample size was calculated by using the Open-Epi software version 3 for proportions at a 95% confidence interval and an expected prevalence of 11% from a study in Ethiopia by Mezemir et al in 2023 (4)

i.e., Sample size $\mathbf{n = [DEFF*Np\ (1-p)]/\ [(d^2/Z^2_{1-\alpha/2}*(N-1) +p*(1-p)]}$

Whereby,

Population size (for finite population correction factor or fpc) (N):	1000000
Hypothesized % frequency of outcome factor in the population (p):	11%+/-5
Confidence limits as % of 100(absolute +/- %) (d):	5%
Design effect (for cluster surveys- DEFF):	1

n=151

Thus, the estimated sample size equals 151

3.5. Sampling procedures.

A systematic sampling technique was employed for recruiting 151 study participants. This method involves selecting participants at regular intervals from a complete sampling frame. In this case, the sampling frame was a list of all women undergoing cesarean sections at Amana Regional Referral Hospital within the specified study period. By calculating the sampling interval (total population of cesarean deliveries divided by the desired sample size of 151), the study will then systematically select every 5^{th} woman on the list. This approach was ensure a representative sample while minimizing bias.

3.5.1 Inclusion Criteria

i. Adult women aged 18 years and above.

ii. Pregnant women undergoing cesarean section at ARRH.

iii. Voluntary informed consent to participate in the study.

3.5.2 Exclusion criteria

i. Women with conditions of mental illness.

ii. Women who refuse to participate in the study or withdraw consent.

iii. Women with multiple pregnancies, as this could introduce additional complexities and confound the results.

3.6 Data collections

A structured questionnaire was administered to collect demographic, obstetric, and surgical information. Data collected was include:

i. Section A (Patient demographics) **-** Age, weight, height, BMI, gestational age, parity, gravidity, and underlying medical conditions.

ii. Section B (Surgical factors) **-** Type of anesthesia, antibiotic prophylaxis, type of cesarean section, duration of surgery, and estimated blood loss.

iii. Section C (Post-operative care) **-** Wound care procedures (PI), antibiotic therapy, and duration of hospital stay.

iv. Section D (Occurrence of SSI) **-** Presence or absence of SSI, onset, location, and clinical manifestations.

Clinical observations, including signs and symptoms of infection, was documented daily. Follow-up visits were conducted on postoperative days 5, 7, 10, 15, 20, 25, and 30 to assess wound healing, any signs of infection and to administer the questionnaire again for updated information.

3.6.1 Validity.

The study was ensured that the data collected truly reflects the prevalence and characteristics of cesarean SSIs at Amana Hospital. This can be achieved through the careful selection of study participants, the use of standardized data collection tools, and the employment of rigorous laboratory methods for bacterial identification and antibiotic susceptibility testing. Additionally, establishing clear operational definitions for variables and using validated diagnostic criteria for SSIs.

3.6.2 Reliability

The study was utilizing standardized protocols for data collection, sample processing, and laboratory procedures. Inter-rater reliability among research assistants was assessed to minimize variability in data collection. Additionally, using established and validated laboratory techniques was enhance the consistency of results. By

implementing these measures, the study aims to minimize random errors and increase confidence in the replicability of the findings.

3.6.3. Research Assistants

To effectively conduct this study, the involvement of a medical doctor and a laboratory technician was crucial. The medical doctor, with their clinical expertise, was play a pivotal role in patient recruitment, data collection, and swab collection from the patient and transport in sterile container with appropriate media to the laboratory, and ensuring adherence to ethical guidelines. Their medical knowledge will be invaluable in assessing patient eligibility, explaining the study to potential participants, and obtaining informed consent. Additionally, the medical doctor can contribute to the interpretation of clinical findings and provide valuable insights into the clinical context of the study. The laboratory technician, on the other hand, was responsible for the technical aspects of the study, including specimen collection, processing, and microbiological analysis. Their expertise in laboratory procedures will guarantee the accuracy and reliability of bacteriological data, which is essential for identifying causative organisms and determining antibiotic susceptibility patterns. The combined skills of the medical doctor and laboratory technician was ensuring the successful implementation and execution of the study.

3.7. Data Collection and Processing

STEP 1: All pregnant women coming for delivery services at ARRH were screened by trained personnel (an MD) for eligibility for this study, and only those who meet the inclusion criteria was recruited using the chosen systematic sampling technique and proceed to sign an informed consent.

STEP 2: The patient's primary information, including bio-data and other details included in Section A of the questionnaire, was appropriately filled in at this point.

STEP 3: The participants will then undergo the cesarean section procedure, and the surgical factors was captured and filled in the respective section (section B) of the questionnaire immediately after surgery.

STEP 4: The study participants will then undergo post-operative care, and their daily details will be filled in section C of the questionnaire.

STEP 5: Participants were then be followed up for the specified period (30 days for this study), and those who develop an SSI within this period was have their details taken and filled in Section D of the study questionnaire. For these participants, wound swabs were collected for microbiological analysis.

PUS SAMPLE COLLECTION PROCEDURE:

Detailed information regarding the location and appearance of the wound was recorded, then a sterile cotton Swab was rotated gently over the infected wound to collect pus from the wound site using a sterile technique. The collected specimens were transported to the hospital laboratory under appropriate conditions for prompt processing.

I. Direct Gram's stain

A smear of the pus was prepared on a glass slide, heat-fixed, and stained using Gram's stain technique. Gram stain differentiates bacteria into two broad categories: gram-positive (blue) and gram-negative (pink). This initial step provides a rapid clue about the morphology of the causative organism(s).

Expected Results were such that gram-positive cocci in clusters will be suggestive of Staphylococcus aureus or coagulase-negative staphylococci. Gram-positive bacilli were suggestive of Bacillus species while gram-negative bacilli were suggestive of Enterobacteriaceae (e.g., E. coli, Klebsiella spp., Proteus spp.) or Pseudomonas aeruginosa

II. Culture/inoculation.

A standardized inoculum of the pus sample was plated onto different culture media to allow growth of a diverse range of bacteria. This typically includes Blood agar which supports the growth of most fastidious bacteria, Chocolate agar which is an enriched medium for fastidious organisms, particularly Neisseria spp., MacConkey agar which differentiates lactose fermenting (pink colonies) from non-lactose fermenting (yellow colonies) colonies, aiding in the identification of Enterobacteriaceae as well as Sabouraud dextrose agar used to identify fungal pathogens, if suspected. The inoculated plates were incubated at 37°C for 24-48 hours.

Expected results were such that no growth on any media indicates the absence of viable bacteria in the sample, while growth of colonies on specific media can provide preliminary clues about the organism based on colony size, color, morphology, and hemolytic properties (blood agar)

III. Colonies' appearance.

Following incubation, the culture plates were examined for bacterial growth. Colony characteristics such as size, color, shape, elevation, and edge morphology will be documented (Aryal, 2015b). These features can be used for presumptive identification of certain bacteria, i.e.

i. Staphylococcus aureus: Large, round, golden yellow colonies with entire margins.

ii. Coagulase-negative staphylococci: Small, white or grey colonies.

iii. Escherichia coli: Large, pink, lactose-fermenting colonies on MacConkey agar.

iv. Klebsiella pneumoniae: Mucoid, lactose-fermenting colonies on MacConkey agar.

v. Proteus spp: Swarming, irregular colonies on blood agar.

vi. Pseudomonas aeruginosa: Large, mucoid, green-pigmented colonies with a distinct odor.

IV. Biochemical Tests.

a. Catalase test.

This test determines the presence of the enzyme catalase, which breaks down hydrogen peroxide. Positive results are typically associated with Staphylococcus aureus, E. coli, K. pneumoniae, and P. aeruginosa

b. Triple Sugar Iron (TSI) agar.

This medium differentiates enteric bacteria based on their ability to ferment glucose, lactose, and sucrose, and produce hydrogen sulfide

c. Indole test.

This test detects the production of indole from tryptophan, which is characteristic of certain bacteria, including Escherichia coli

d. Citrate utilization test.

This test determines the ability to utilize citrate as a sole carbon source, which is characteristic of certain bacteria, including K. pneumoniae

e. Urease test.

This test detects the presence of the urease enzyme, which is characteristic of certain bacteria, including K. pneumoniae

f. Oxidase test.

This detects the presence of cytochrome c oxidase enzyme, which is characteristic of certain bacteria, including K. pneumoniae

V. Antibiotic susceptibility test (Kirby-Bauer disc diffusion).

Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method. Standardized discs containing various antibiotics will be placed on a Mueller-Hinton agar plate inoculated with the isolated bacteria. The plates will be incubated, and zones of inhibition around each disc was measured. The diameter of the inhibition zone indicates the susceptibility of the bacteria to the specific antibiotic.

Expected results was such that a large inhibition zone was indicate that the bacteria are susceptible to the antibiotic, while a small inhibition zone or no zone of inhibition indicates that the bacteria are resistant to the antibiotic.

3.8 Specimen collection and laboratory procedures

By using sterile cotton swabs, two pus swabs or wound swabs were aseptically collected from each patient with surgical site infection and sent to the laboratory immediately for culture and sensitivity test.

Gram stain was made from one swab to get provisional diagnosis

The other swab was put in 5% sheep blood agar (SBA) and MacConkey agar (MA) plate and incubated at 37 degrees Celsius for 48hours before being reported as sterile

Growth on culture plate was identified by its colony characters and the series of standard biochemical and physiological methods.

3.9 Data analysis plan

Microsoft excel was used for data entry and data cleaning

Statistical Package for Social Sciences (SPSS) program version 26 was used for data analysis in accord with specific objectives.

Descriptive analysis of categorical variables was run through frequency tables

Mean, Standard deviation and Range were computed for continuous variables

The Chi square test, univariate and multivariate logistic regression model were used to detect the association between the predictor variable and outcome variables.

Simple frequencies and percentages were used to find the rate of surgical site infection after cesarean section P-value less than 0.001 were considered statistically significant Odds ratios and confidence intervals were computed.

3.10 Ethical consideration

This study was adhered to the ethical principles of autonomy, beneficence, non-maleficence, and justice. Participants were fully informed about the study's objectives, procedures, potential risks, and benefits through a detailed information sheet. Written informed consent was obtained from all participants before enrollment. Participation in the study was entirely voluntary, and participants were having the right to withdraw at any time without consequence.

Confidentiality of participant data was strictly maintained throughout the study and beyond. Data will be anonymized, and only research team members with appropriate

clearance was have access to identifiable information. To minimize harm, standard precautions was followed during specimen collection and handling. Any adverse events related to study participation was be reported to the ethics committee.

The study team were undergoing ethical training to ensure understanding and adherence to ethical guidelines. Regular monitoring of study procedures were conducted to identify and address any ethical concerns. Findings from the study were disseminated through appropriate channels to benefit the healthcare community and contribute to improving maternal health outcomes.

Ethical clearance from Kariuki University's Research Ethics Committee were sought before initiating the study to ensure adherence to national and institutional ethical standards.

CHAPTER FOUR

4.0 RESULTS OF THE STUDY

4.1. Study participant's flow charts.

In the present, 151 eligible pregnant mothers were consecutively recruited till the required sample of study was reached.

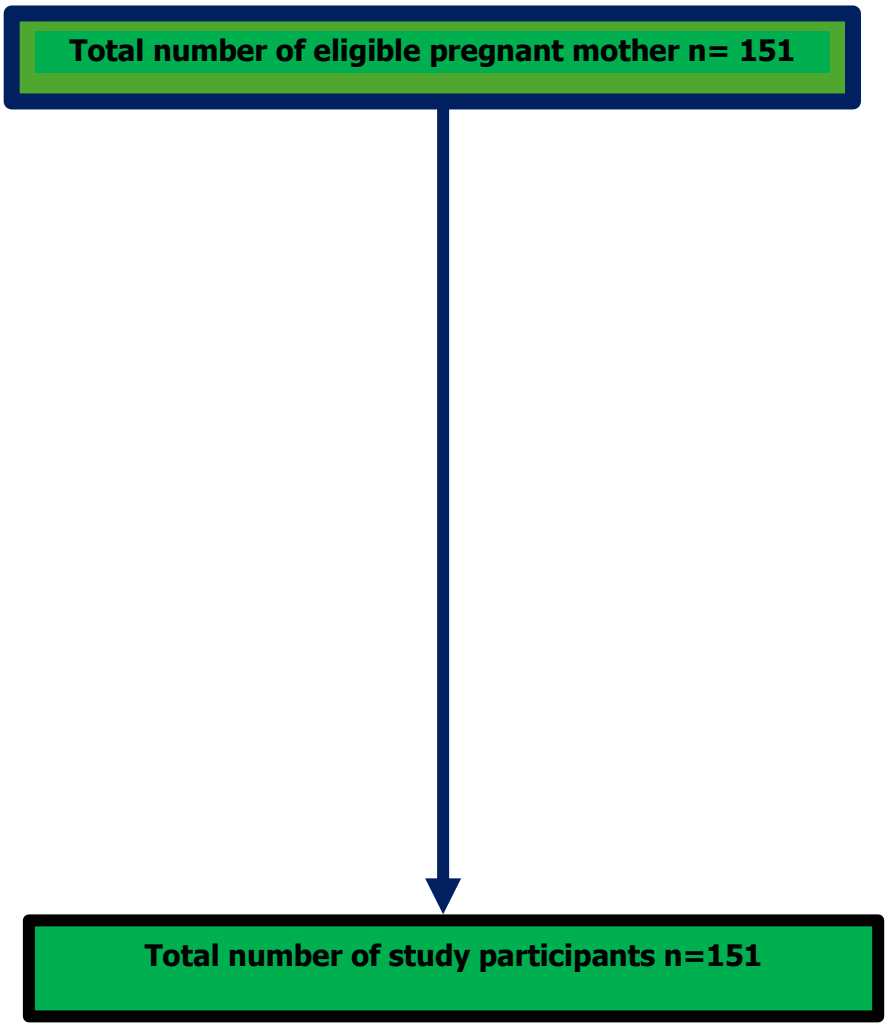

Figure 2: Study participant's flow charts.

4.2. Baseline sociodemographic factors of study participants.

Table 1: Baseline sociodemographic factors of study participants. N=151

Characteristics	**N= 151**	**%**
Age		
< 25	67	44.4
26-35	61	40.4
>35	23	15.2
Marital status		
Single	38	25.2
Married	101	66.9
Divorced	12	7.9
Religion		
Muslim	62	41.1
Christian	89	58.9
Education level		
No formal education	22	14.6
Primary	37	24.5
Secondary	61	40.4
High school/college	31	20.5
Occupation		
Unemployed/house wife	54	35.8
self-Employed	66	43.7
Formal employed	25	16.6
Student	6	4.0

In the present study, nearly half of the participants were below 25 years old (44.4%), and most of them were married (66.9%). The religious distribution was relatively

balanced, with 58.9% identifying as Christian and 41.1% as Muslim. Furthermore, a significant portion had completed secondary education (40.4%) and most participants were self-employed (43.7%).

4.3. Baseline obstetrical and medical factors of participants.

Table 2: Baseline obstetrical and medical factors of participants. N=151

Characteristics	**N=151**	**%**
BMI		
Underweight (<18.5)	0	0.0
Normal weight (18.5-24.9)	57	38.7
Overweight (25.0-29.9)	25	16.6
Obese (>30.0)	69	45.7
Comorbidities		
Absent	53	35.1
Anemia	46	30.5
Hypertension	32	21.2
DM	20	13.2
Parity		
Primiparous	59	39.1
Multiparous	71	47.0
Grand multiparous	21	13.9
Gravidity		
Primigravida	56	37.1
Multigravida	66	43.1
Grand multigravida	29	19.8
Types of surgery		
Elective	32	21.2
Emergency	119	78.8
Duration of surgery		

<1 hour	121	80.1
>1 hour	30	19.9
Level of surgeon		
Intern	20	13.2
Resident	62	41.1
Mo	52	34.4
Specialist	17	11.3
Duration of hospital stay		
< 7 days	119	78.8
7-14	25	16.6
>14 days	7	4.6
Local signs		
Absence	121	80.1
Pain + serous discharge	11	7.3
Pain + pus discharge	19	12.6

In this study, a significant proportion of participants were obese (45.7%). The majority were multiparous (47.0%) and had experienced multiple pregnancies (43.1%). Elective procedures constituted only 21.2% of surgeries, while the remaining 78.8% were emergency cases. Most surgical procedures (80.1%) were completed in under one hour. Residents (41.1%) and medical officers (34.4%) performed the majority of the operations. A large portion of patients (78.8%) were discharged within a week, whereas 4.6% had hospital stays exceeding 14 days. Regarding postoperative outcomes, 80.1% exhibited no local signs of infection, while 12.6% presented with pain accompanied by purulent discharge, and 7.3% reported pain with serous discharge.

4.4. Magnitude and patterns of SSI among study participants.

Table 3: Magnitude and patterns of SSI. N=151

Characteristics	**n=151**	**%**
SSI		
Absent	121	80.1
Present	30	19.9
Types of SSI	**N=30**	**%**
Superficial	19	63.3
Deep	11	36.7

This study found that 19.9% (30 patients) developed surgical site infections, with superficial infections accounting for the majority—63.3% (19 cases) of all SSIs.

4.5. Maternal and surgical risk factors associated with an increased risk of developing cesarean surgical site infections (SSIs).

Table 4: Sociodemographic factors associated with increased risk of developing caesarian SSI. N=30

Characteristics	**SSI**		**Bivariate**		**Multivariate**	
	Absence (n=121)	**Present (n=30)**	**0R(95%IC)**	**P value**	**OR (95%CI)**	**Value**
Age (years)						
< 25	61(91.0)	6(9.0)	**Reff**			
26-35	56(91.8)	5(8.2)	0.9(0.2-3.1)	0.9		
>35	4(17.4)	19(82.6)	18(12.3-189)	0.001	15.3(7-154)	0.001

Marital status						
Married	70(78.7)	19(21.3)	Reff			
Single	32(84.2)	6(15.8)	0.69(0.25-1.8)	0.47		
Divorced	19(79.2)	5(20.8)	0.9(0.3-2.9)	0.95		
Religion						
Muslim	50(80.6)	12(19.4)	1.0(0.4-2.3)	0.8		
Christian	71(79.8)	18(20.2)	Reff			
Education level						
No formal education	29(78.4)	8(21.6)	1.2(0.3-4.7)	0.7		
Primary	49(80.3)	12(19.7)	1.1(0.3-3.8)	0.8		
Secondary	25(80.6)	6(19.4)	1(0.2-4.3)	0.9		
High school/college	18(81.8)	4(18.2)	Reff			
Occupation						
Unemployed/house wife	43(79.6)	11(20.4)	1.2(0.3-4.7)	0.7		
self-Employed	53(80.3)	13(19.7)	1.1(0.3-3.8)	0.8		
Formal employed	20(80.0)	5(20.0)	Reff			
Student	5(83.3)	1(16.7)	1(0.2-4.3)	0.9		

In the present study, Participants aged over 35 years had a significantly increased risk—15 times higher—of developing surgical site infections (p = 0.001)

Table 5: Obstetrical and medical factors associated with increased risk of SSI among study participants. n=30

Characteristics	SSI		Bivariate		Multivariate	
	Absent (n=121)	Present (n=30)	0R(95%IC)	P value	OR (95%CI)	P Value
BMI						
Normal weight (18.5-24.9)	45(93.8)	3(6.2)	Reff			
Overweight (25.0-29.9)	46(83.6)	9(16.4)	2.9(0.7-11.5)			
Obese (>30.0)	30(62.5)	18(37.5)	9(2.4-33)	0.001	1.2(0.1-8.1)	0.08
Comorbidities						
Absent	42(79.2)	11(20.8)	Reff			
Anemia	37(80.4)	9(19.6)	0.9(0.3-2.4)	0.8		
Hypertension	26(81.2)	6(18.8)	0.8(0.2-2.6)	0.8		
DM	16(80.0)	4(20.0)	0.9(0.2-3.4)	0.9		
Parity						
Primiparous	47(79.7)	12(20.3)	0.6(0.2-1.9)	0.4		
Multiparous	59(83.1)	12(16.9)	Reff			
Grand multiparous	15(71.4)	6(28.6)	0.5(0.1-1.5)	0.2		
Gravidity						

Primigravida	47(83.9)	9(16.1)	3(0.1-1.1)	0.4		
Multigravida	58(87.9)	8(12.10)	Reff			
Grand multigravida	16(55.1)	13(44.8)	2(1.1-4.1)	0.006	11(1.1-116)	0.03
Duration of surgery						
<1 hour	110(90.9)	11(9.1)	Reff			
>1 hour	11(36.7)	19(63.3)	7(3.6-17)	0.001	8(1.9-34)	0.005
Level of surgeon						
Intern	16(80.0)	4(20.0)	1.1(0.2-6.1)	0.8		
Resident	50(80.6)	12(19.4)	1.1(0.2-4.2)	0.8		
Mo	41(78.8)	11(21.2)	1.2(0.3-5.1)	0.7		
Specialist	14(82.4)	3(17.6)	Reff			

The current findings indicate that BMI>30 and prolonged cesarean section duration (over 1 hour) were significantly associated with an 11-fold and 8-fold higher likelihood of surgical site infection.

4.6. Distribution of bacterial isolates from caesarean surgical site infections (SSIs).

Table 6: Distribution of bacterial isolates from caesarean surgical site infections. N=30

Bacteria isolated	n = 30	%
Staphylococcus aureus	14	46.7
Coagulase negative staphylococcus	7	23.3
Enterobacteria	4	13.3
Escherichia coli	5	16.7

In this study, Staphylococcus aureus followed by coagulase negative staphylococcus accounted for the highest proportion of isolated bacteria, representing respectively 46.7% and 23.3 % of all isolates.

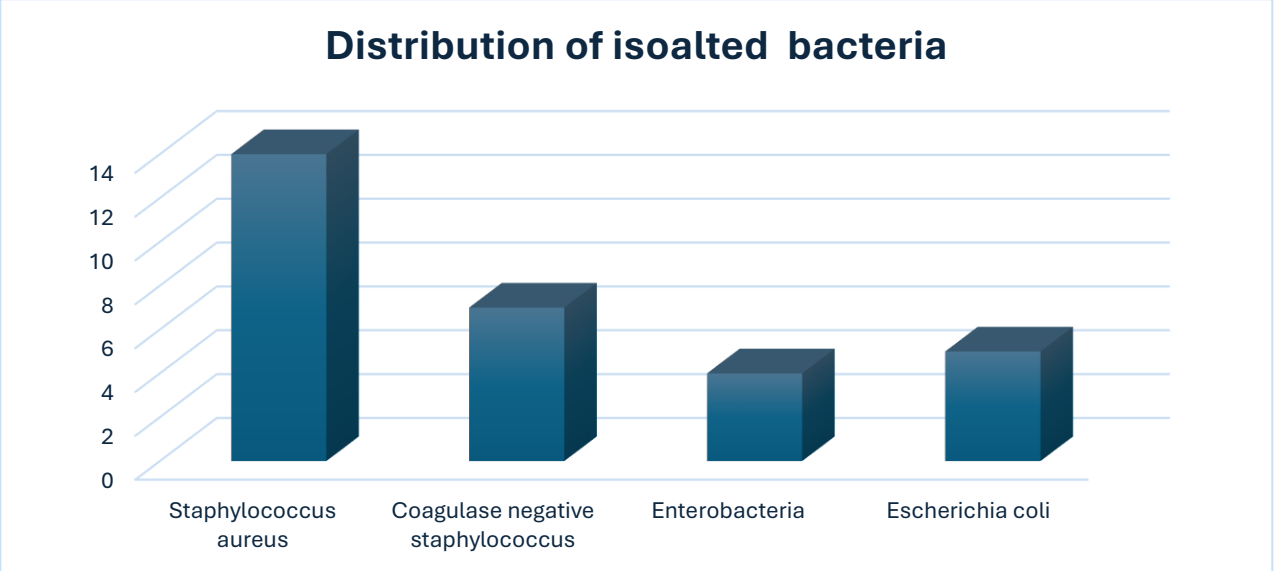

Figure 3: Histogram showing distribution of isolated bacteria

4.7. Antibiotic susceptibility of bacterial isolated from caesarean surgical site infections to commonly used antibiotics.

Table 7: Antibiotic susceptibility of bacterial isolated from caesarean surgical site infections to commonly used antibiotics. N=30

Antiobiotic		S.Aureus n=14(%)	CONS n=7(%)	Enterobac n=4(%)	E.coli n=5(%)
Gentamycine	R	0(0.0)	0(0.0)	0(0.0)	1(20.0)
	S	0(0.0)	3(42.9)	0(0.0)	1(20.0)
Meropenem	R	0(0.0)	0(0.0)	0(0.0)	0(0.0)
	S	10(71.4)	5(71.4)	3(75.5)	3(60.0)
Amoxclav	R	0(0.0)	0(0.0)	0(0.0)	0(0.0)
	S	5(35.7)	0(0.0)	0(0.0)	1(20.0)
Ceftriaxone	R	12(85.7)	6(85.7)	3(75.0)	80(80.0)
	S	2(14.3)	0(0.0)	0(0.0)	0(00.0)
Amikacine	R	0(0.0)	0(0.0)	0(0.0)	0(0.0)
	S	0(0.0)	1(14.3)	2(50.0)	0(0.0)
Vancomycine	R	1(7.14)	0(0.0)	0(0.0)	0(0.0)
	S	8(57.1)	4(57.1)	2(50.0)	2(40.0)
Ciprofloxcine	R	2(14.3)	0(0.0)	0(0.0)	0(0.0)
	S	1(7.14)	0(0.0)	0(0.0)	0(0.0)
Amoxiciline	R	9(64.3)	4(57.1)	2(50.0)	2(40.0)
	S	0(0.0)	0(0.0)	0(0.0)	0(0.0)

Azithromycine	R	5(35.7)	1(14.3)	0(0.00	1(20.0)
	S	2(14.3)	1(14.3)	0(0.0)	2(40.0)
Ampiciline cloxaciline	R	6(42.8)	2(28.6)	3(75.0)	1(20.0)
	S	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Tetracycline	R	1(7.1)	1(14.1)	0(0.0)	0(0.0)
	S	0(0.0)	0(0.0)	0.(0.0)	0(0.0)

This study found that Meropenem demonstrated the greatest antimicrobial activity against the isolated bacterial strains, with Vancomycin showing the next highest effectiveness. In contrast, Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin were among the least effective antibiotics,

CHAPTER FIVE

5.0 DISCUSSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1. Introductions.

5.2. Discussions.

The study identified key risk factors for surgical site infections (SSI), including age above 35 years, multigravidity, and Caesarean sections lasting more than one hour. Staphylococcus aureus was the most commonly isolated pathogen, followed by coagulase-negative staphylococcus. Among antibiotics tested, Meropenem and Vancomycin were the most effective against the isolates, while Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin showed poor effectiveness.

Advanced maternal age (>35 years) was associated with a 15-fold increased risk of SSI. This could be due to age-related physiological changes, slower wound healing, and potential comorbidities such as diabetes or hypertension, which impair immune response and tissue repair. Similarly, multigravida women showed an 11-fold higher likelihood of SSI. This may reflect cumulative obstetric interventions, uterine scarring, or prolonged labor in prior pregnancies, which can increase intraoperative contamination or postoperative wound complications. Additionally, CS procedures lasting over an hour were linked to an 8-fold increased risk, likely due to prolonged exposure of internal tissues, increased handling, and higher risk of contamination.

The findings of this study align with those observed in earlier research. For instance, Samuel and colleagues, in a study involving pregnant women attending public hospitals in the Dire Dawa Administration, Ethiopia, also found a significant association between maternal age above 35 and the risk of surgical site infections (17). Similarly, Filbert and

co-researchers reported comparable results among women who underwent Caesarean sections at Bugando Medical Centre (BMC) in Tanzania (29) In contrast, Wloch and colleagues found differing results, identifying younger maternal age, specifically below 19 years, as most strongly linked to SSI (10). This inconsistency may be attributed to variations in the study populations. On the other side, multigravidas showed an 11-fold higher likelihood of SSI. This may reflect cumulative obstetric interventions, uterine scarring, or prolonged labor in prior pregnancies, which can increase intraoperative contamination or postoperative wound complications. Similar findings have been documented by other researchers, corroborating our findings as in a study by Dayo-Dada in 2022 on post-cesarean mothers at a Teaching Hospital in Ekiti State, Nigeria. Their research demonstrated a higher incidence of surgical site infections (SSI) among multigravida women who underwent cesarean delivery, reinforcing the association between increased number of pregnancy and postoperative infection risk in obstetric patients(30). Consistent with previous findings from Mwandah et al, 2024 identified multigravidity as a significant risk factor for surgical site infections in their study of post-Caesarean patients at Mbarara Regional Referral Hospital, Uganda. Their research further substantiates the established association between higher gravidity and increased SSI risk following cesarean delivery (31)

On the other hand, this study found that CS procedures lasting over an hour were linked to an 8-fold increased risk, likely due to prolonged exposure of internal tissues, increased handling, and higher risk of contamination. Similar findings were reported by Daniel and colleagues in Uganda and Filbert and colleagues among mothers who underwent cesarean sections at Bugando Medical Centre (BMC) in Tanzania (29,31)

Furthermore, in this study, Staphylococcus aureus was the most predominant Pathogen. Staphylococcus aureus is a well-documented leading cause of SSIs, owing to its ability to colonize the skin and mucous membranes and its resistance to many antibiotics. The high prevalence reflects contamination from skin flora during surgery, inadequate aseptic technique, or poor wound care postoperatively. Coagulase-negative staphylococci (CoNS), although less virulent, are notorious for biofilm formation on surgical materials (e.g., sutures, prosthetics), contributing to persistent infections. Similar findings were reported by Rahel and colleague where staphylococcus aureus was found to be a leading cause of surgical site infection among post caesarian section mothers delivered at selected referral hospital in Addis Abeba (32). Bwana et al., in 2019 reported similar findings among mothers who underwent Caesarian Section at department of obstetrics & gynecology in GMERS medical college & hospital, in Tanzania (33). However, Velin and colleagues found that Coagulase negative staphylococcus as the most prevalent bacteria isolated among post caesarian SSI delivered at Kirehe District Hospital in Rwanda (34).

Meropenem (a carbapenem) and Vancomycin (a glycopeptide) demonstrated high efficacy against the pathogens isolated from surgical site infections (SSIs), likely due to their broad-spectrum activity and resistance to β-lactamase enzymes. Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin, commonly used β-lactam antibiotics, exhibited reduced effectiveness, possibly due to widespread resistance from overuse or inappropriate prescription. Similar conducted in India, among post-cesarean mothers who developed surgical site infections, where Meropenem demonstrated the highest efficacy against all bacterial isolated (35). In Tanzania, Moyo and colleagues reported

comparable results among post caesarian mother who delivered at Iringa Regional Referral Hospital and district hospitals in Iringa region, where meropenem followed by vancomycin showed high sensitivity for all isolated bacteria (21). In addition, they found also high resistance to and amoxicillin. The limited use of meropenem and vancomycin, caused by side effects, high costs, or policy restrictions, has reduced their role as alternative treatments, thereby lowering the risk of bacterial mutation. Similar patterns of susceptibility patterns were observed in other patients with SSI following any other type of surgery as seen in study conducted in Rwanda and Uganda(16,24). However, Rosenthal and colleagues reported contrasting results, noting a higher resistance to Vancomycin among the majority of bacterial isolates (36). This discrepancy might be attributed to differences in the study population.

5.3. Limitations of the study.

The following are the limitation of this study:

- This was a Single-Center Design: Conducted in a single hospital, the results may not reflect regional or national variations in bacterial resistance patterns and SSI risk factors.
- Lack of Molecular Characterization – The study identified *Staphylococcus aureus* and coagulase-negative staphylococci but did not perform genetic analysis (e.g., MRSA detection or resistance gene profiling), limiting insight into resistance mechanisms.
- Limited Antibiotic Testing – Only a select number of antibiotics were evaluated; broader testing (e.g., newer or combination therapies) might have revealed additional effective treatments.

5.4. Conclusions.

The study identified several significant risk factors for surgical site infections (SSI), including age above 35 years, multigravidity, and prolonged cesarean sections (lasting more than one hour). The most frequently isolated pathogens were Staphylococcus aureus and coagulase-negative staphylococci. Antibiotic susceptibility testing revealed that Meropenem and Vancomycin were the most effective against the bacterial isolates, whereas Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin demonstrated poor efficacy. These findings highlight the need for targeted antibiotic prophylaxis and strict infection control measures in high-risk obstetric patients to reduce SSI rates.

5.5. Recommendations.

- Minimizing Operative Time: Efforts should be made to reduce the duration of cesarean sections, particularly keeping procedures under one hour when clinically feasible, to lower the risk of SSI.
- Antibiotic Stewardship:

  The routine use of Ceftriaxone, Amoxicillin, and Ampicillin-Cloxacillin should be reconsidered due to their reduced effectiveness.
- Infection Prevention Protocols:

  Hospitals should strengthen infection control practices in operating theaters and post-operative wards, with particular focus on high-risk patients, to reduce SSI incidence.

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APPENDICES

Appendix 1: Consent form (English version)

Title: Consent to Participate in a Research Study on Cesarean Surgical Site Infections

You are being asked to participate in a research study to learn more about cesarean surgical site infections. The study is being conducted by Dr. Titus Benedict Kullaya as part of his Master of Medicine in Obstetrics and Gynecology program.

Purpose of the Study: The purpose of this study is to identify factors that contribute to cesarean surgical site infections and to determine the types of bacteria causing these infections. This information will help improve the prevention and treatment of these infections.

What will happen if you take part? If you agree to participate in this study, you will be asked to complete a questionnaire about your medical history and the cesarean section. You will also be asked to provide a wound swab for laboratory testing. There is no additional cost to you for participating in this study.

What are the risks of taking part? There are minimal risks associated with participating in this study. Providing a wound swab may cause slight discomfort. The results of the study will not be shared with your healthcare provider, but the information will be kept confidential.

What are the benefits of taking part? By participating in this study, you will contribute to the development of better ways to prevent and treat post-cesarean surgical site infections.

What if you decide not to take part? You have the right to refuse to participate in this study without any negative consequences.

Confidentiality: All information collected during this study will be kept confidential. Your name will not be used in any reports or publications. Only the research team will have access to your information.

Voluntary Participation: Your participation in this study is completely voluntary. You may withdraw from the study at any time without giving a reason.

Contact Information:

If you have any questions, concerns, or complaints about the study, don't hesitate to get in touch with the principal investigator: -

Dr. Titus Benedict Kullaya

P.o.Box 13443,

Dar-es-salaam

Tel no. +255784 624 934

Email. tkulaya@yahoo.com.

Main Committee Chair

Profesa Kaijage

0767 306 421.

I have read and understood the information provided above. I voluntarily agree to participate in this research study.

Participant's Signature: _____ Date: _____

Investigator's Signature: _____ Date: _____

Appendix 2: Fomu ya ridhaa (Swahili version).

Kichwa, Idhini ya kushiriki katika utafiti juu ya maambukizi ya vimelea vya wadudu wa baktaria baada ya kujifungua kwa upasuaji. Ninakuomba kushiriki katika utafiti huu ili kujifunza zaidi kuhusu maambukizi ya baktaria baada ya kujifungua kwa upasuaji. Utafiti huo unafanywa na Dk. Titus Benedict Kullaya, kama sehemu ya mafunzo yake Uzamili wa Tiba katika afya Uzazi kwa mama.

Madhumuni, Madhumuni ya utafiti huu ni kutambua mambo yanayochangia maambukizi ya baktaria baada ya kujifungua kwa upasuaji. Taarifa hii itasaidia kuboresha uzuiaji na matibabu ya maambukizi haya.

Nini kitatokea ikiwa utashiriki? Ukikubali kushiriki katika utafiti huu, utaombwa kukamilisha dodoso kuhusu historia yako ya matibabu na sehemu ya upasuaji. Pia utaulizwa kutoa swab ya jeraha kwa uchunguzi wa maabara. Hakuna madhara yeyote ya ziada kwako kwa kushiriki katika utafiti huu. Hatari za kushiriki ni zipi? Kuna hatari ndogo sana zinazohusiana na kushiriki katika utafiti huu. Kama vile kutoa usaha kwenye jeraha kunaweza kusababisha usumbufu kidogo.

Matokeo ya utafiti hayatashirikiwa na mtoa huduma wako wa afya kwa mtu mwingine, na maelezo yako yatawekwa siri.

Je, ni faida gani za kushiriki? Kwa kushiriki katika utafiti huu, utachangia katika maendeleo ya njia bora za kuzuia na kutibu maambukizi ya bakteria ya baada ya kujifungua kwa upasuaji.

Je, ukiamua kutoshiriki? Una haki ya kukataa kushiriki katika utafiti huu bila matokeo yoyote mabaya.

Usiri Taarifa zote zilizokusanywa wakati wa utafiti huu zitawekwa siri. jina lako halitatumika katika ripoti au machapisho yoyote. Timu ya utafiti pekee ndiyo itaweza kufikia maelezo yako.

Ushiriki wa Hiari.

Ushiriki wako katika utafiti huu ni wa hiari kabisa. Unaweza kujiondoa kwenye utafiti wakati wowote bila kutoa sababu.

Mawasiliano:-

Ikiwa una maswali, wasiwasi au malalamiko yoyote kuhusu utafiti, tafadhali wasiliana na kiongozi mtafiti.

Dkt. Titus Benedict Kullaya

S.L.P 13443,

Dar-es-salaam

Na ya Simu. +255784 624 934.

Mwenyekiti wa Kamati

Profesa Kaijage

0767 306 421.

Nimesoma na kuelewa habari iliyotolewa hapo juu. Ninakubali kwa hiari kushiriki katika utafiti huu.

Sahihi ya Mteja: _____ Tarehe: _____

Sahihi ya Mtafiti: _____ Tarehe: _____

Appendix 3: Questionnaire.

Instructions:

1. Circle on the number of options
2. Only one option is allowed

SECTION A: SOCIODEMOGRAPHIC CHARACTERISTICS

1. Age in years ……
2. Residence
    1. Urban
    2. Rural
3. Marital status
    1. Single
    2. Married
4. Parity…….
5. Religion
    1. Christian
    2. Muslim
    3. Non
    4. Others specify
6. Education level
    1. No formal education
    2. Formal educations
    3. Higher education
7. Occupation
    1. Peasant
    2. Employed
    3. Self employe

SECTION B: HOSPITAL INFORMATION

8. Date of admission……..
9. Date of operation……
10. Date discharged home……
11. Number of days in the Hospital after operation……
12. Referral status prior to delivery
    1. Self-referral
    2. Referral from lower facility
    3. From OPD
    4. From RCH

SECTION C: PRE-OPERATIVE INFORMATION

13. Blood transfusion done prior to delivery Yes/No
14. HIV Status
    1. Positive
    2. Negative
    3. Unknown

15. History of hypertension during last pregnancy
    1. Yes
    2. No
    3. Unknown
16. History of Diabetes mellitus during last pregnancy
    1. Yes
    2. No
    3. Unknown
17. Any history of long-term drug use
    1. Yes
    2. No
18. If yes in question 17 name, the drug(s) used……

19. Preoperative medication Yes/No
20. Number of vaginal examinations……
21. Duration of labor in hours……..
22. Duration of rupture of membranes……..

SECTION D: INTRAOPERATIVE INFORMATION

23 Duration of operation (in hours) ……..

24. Type of incision
    1. Sumi
    2. Pfannestrial
    3. Others (specify)

25. Suture material used for skin closure
    1. Chromic catgut
    2. Vicryl
    3. Silk
    4. Nylon
    5. Others (specify)

26. The level of the surgeon who performed surgery
    1. Specialist
    2. Resident
    3. Registrar
    4. Intern doctor

27. Type of skin suture technique
    1. Subcutaneous
    2. Interrupted
    3. Continuous
    4. Others(specify)

28. Type of anesthesia
    1. Spinal
    2. General

3. Others (specify)

29. Indication of emergency cesarean section……

SECTION E: POST OPERATIVE INFORMATION

30. History of fever. Yes/No

31. Post-operative antibiotics given Yes/No

32. Pain around the wound Yes/No if yes starting from day ……post-operative

34. Discharge from the wound

1. Serosanguinous
2. Thick creamy pus
3. Thin odorless pus
4. Bluish green pus
5. Yellow fishy odour pus

35. Duration of sepsis occurrence post cesarean delivery……days

36. Level of infection exposure

1. Superficial layer infection
2. Deep layer infection
3. Deep space/organ infection

37. Hospital stay since development of SSI……days

SECTION F: LABORATORY FINDINGS

38. Sample for culture taken

1. Yes
2. No

39. Bacteria isolated?

1. Yes
2. No

40. Mention the type of isolates

1……

2……..

3……..

4……

41. Drug susceptibility

Sensitive to

1. ……
2. ……..
3. ……..
4. ……..

42. Resistant to:

1. ……
2. ……..
3. ……
4. ……..

Appendix 4: Dodoso

Maelekezo:

1. Zungushia katika namba husika
2. Unaruhusiwa kuzungushia mara moja tu

Ukubwa wa tatizo, visababishi, vijimelea sababishi na dawa fasaha ya kutibia miongoni mwa wanawake wenye shida ya kidonda baada ya kujifungua kwa upasuaji wa dharura katika hospitali ya mkoa ya Amana.

Nambari ya dodoso……

Nambari ya faili…….

SEHEMU A; TAARIFA ZA MGONJWA

1. Umri
2. Makazi
    1. Mjini
    2. Kijijini
3. Hali ya mahusiano
    1. Sijaolewa
    2. Nimeolewa
    3. Tunaishi pamoja
    4. Tumetengana
    5. Nimefiwa
4. Uzazi wa ngapi?
    1. Wa kwanza

2. Wa pili
3. Wa tatu
4. Wa nne
5. Wa tano na zaidi

5. Dini yako
    1. Mkristo
    2. Muislamu
    3. Sina dini
    4. Nyingine elezea……

6. Kiwango chako cha elimu
    1. Sijasoma
    2. Shule ya msingi
    3. Shule ya sekondari
    4. Elimu ya chuo

7. Kazi yako
    1. Kulima
    2. Ajira binafsi
    3. Mfanya biashara
    4. Nimeajiriwa
    5. Nyingine(Taja)

SEHEMU B: TAARIFA ZA HOSPITALI

1. Tarehe ya kulazwa…….

2. Tarehe ya upasuaji……

3. Tarehe ya kuruhusiwa nyumbani……

4. Siku za kukaa hospitali baada ya kupasuliwa…….

5. Namna ya kulazwa kablaya kujifungua

    1. Nilikuja mwenyewe
    2. Nilikuja kwa rufaa

6. Namna ya kulazwa baada ya kupata maambukizi ya kidonda

    1. Nilikuja mwenyewe
    2. Nilikuja kwa rufaa
    3. Nilikuja kwa kupitia kitengo cha wagonjwa wa nje

SEHEMU C: TAARIFA ZA KABLAYAUPASUAJI

1. Uliwekewa damu kabla ya kupasuliwa? Ndiyo/Hapana
2. Hali ya maambukizi ya virusi vya ukimwi
    1. Nimeambukizwa
    2. Sijaambukizwa
    3. Haijulikani
3. Umewahi kupata shinikizo la damu kwenye ujauzito uliotangulia?
    1. Ndiyo
    2. Hapana
    3. Haijulikani
4. Umewahi kupata kisukari katika ujauzito uliotangulia?
    1. Ndiyo
    2. Hapana
    3. Haijulikani
5. Umewahi kutumia dawa ya aina yoyote kwa kipindi kirefu?
    1. Ndiyo
    2. Hapana
6. Kama jibu ni ndiyo kwa swali la hapo juu taja jina la dawa……
7. Ulipewa dawa kabla ya upasuaji? Ndiyo/Hapana
8. Ulipiwa njia ya uzazi mara ngapi?……
9. Uchungu ulidumu kwa mda wa takriban masaa mangapi?……..

10.Ni masaa mangapi yamepita tangia chupa ipasuke?.....

SEHEMU D: TAARIFA ZAWAKATI WA UPASUAJI

1. Mda uliotumika kufanya upasuaji (kwa masaa)…….
2. Aina ya mchano wa tumbo
    1. Wima
    2. Mlalo
    3. Nyingine(taja)
3. Aina ya nyuzi zilizotumika kufunga kidonda
    1. Chromic catgut
    2. Vicryl
    3. Silk
    4. Nylon
    5. Nyingine (taja)
4. Cheo cha Daktari aliyefanya upasuaji.
    1. Daktari bingwa
    2. Daktari bingwa tarajari
    3. Afisa tabibu
    4. Afisa tabibu mafunzo
5. Aina ya mshono wa ngozi
    1. Mshono mwendelezo wa ndani kwa ndani (Subcutaneous)
    2. Mshono mruko wa nje(Interrupted)
    3. Mshono mwendelezo wa nje(Continuous)
    4. Mwingine(taja)
6. Aina ya ganzi
    1. Ya mgongoni (nusu kaputi)
    2. Ya mwili mzima(kaputi)
    3. Nyingine(taja)
7. Kisababishi cha upasuaji wa dharura……

SEHEMU E: TAARIFA ZA BAADA YA UPASUAJI

1. Unapata homa? Ndiyo/Hapana
2. Ulipata dawa (antibiotics) baada ya upasuaji? Ndiyo/Hapana
3. Unapata maumivu kuzunguka kidonda? Ndiyo/Hapana.
   Kama ndiyo kuanzia siku ya ……baada ya upasuaji
4. Uchafu kutoka kwenye kidonda
   1. Majimaji mchanganyiko na damu
   2. Usaha mzito rangi ya maziwa
   3. Usaha mwepesi usionuka
   4. Usaha wa rangi ya kijani
   5. Usaha wa njano wenye harufu ya samaki aliyechina
5. Maambukizi yameanza siku ya…… baada ya upasuaji
6. Kiwango cha maambukizi
   1. Kipo juu bila kuzama ndani
   2. Kimezama ndani
   3. Kimezama ndani ya matumbo
7. Mda uliokaa Hospitali baada ya upasuaji ni siku ……

SEHEM F: TAARIFA ZA MAABARA

1. Kipimo kwa ajili ya uoteshaji kilichukuliwa?
   1. Ndiyo
   2. Hapana
2. Vijimelea (Bacteria)viliota?
   1. Ndiyo
   2. Hapana
3. Taja aina ya vijimelea vilivyoota
   1.……
   2.……
   3.……
   4.……

4. Ufanisi wa dawa

Dawa zilizoweza kuwatibu

1. ……
2. ……...
3. ……..
4. ……..

Dawa zilizoshindwa kuwatibu

1. ……
2. ……..
3. ……
4. ……..

Appendix 5: Permission Letter.

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF HEALTH

AMANA REGIONAL REFERRAL HOSPITAL

Telegram "HEALTH", DODOMA
Phone No.: +255 026 – 2323267
Email: ps@afya.go.tz

REF. NO. MoHCDGEC/ARRH/R.1/VOL V/48

P.O. Box 25411
DAR ES SALAAM
Phone: 022—2861903

Date: 19/06/2025

Director, Postgraduate Studies and
Research Institute.
Kairuki University,
P.O. Box 65300,
DAR ES SALAAM.

Re: PERMISSION FOR DATA COLLECTION

Refer to your letter which requested us to allow Dr. Titus B. Kullaya to conduct research and collect data in our institution.

We are here to acknowledge your request with the following conditions, that he must submit the results of his research after completion of analysis in order the hospital to make use of data s to solve hospital problems.

Regards.

For: MEDICAL OFFICER I/C
AMANA REGIONAL REFERRAL HOSPITAL

Dr. Rose Ntambute
FOR: MEDICAL OFFICER INCHARGE
AMANA REGIONAL REFERRAL HOSPITAL

Appendix 6: Introduction letter

KAIRUKI UNIVERSITY (KU)

70 Chwaku Street
Regent Estate – Mikocheni
P.O. Box 65300,
Dar es Salaam
Tanzania

Tel: +255-22-2700021/4
Email: secvc@ku.ac.tz
Website: www.ku.ac.tz

Ref. No. KU/PT/30.5/587 12th June 2025

Medical Officer Incharge,
Amana Regional Referral Hospital,
Dar es Salaam.

Re: LETTER OF INTRODUCTION FOR DR. TITUS B. KULLAYA (MMed Part II – OBSTE AND GYNECOLOGY).

The above named is a MMed postgraduate student specialising in Obstetrics and Gynaecology. As part of fulfilling his MMed programme, he plans to undertake a study titled, **"Predictors, Ba Profiles, and Antibiotic Susceptibility in Post-Caesarean Surgical Site Infection at Hospital".** This study was reviewed and has been granted with an ethics approv **KU/IREC/27.10/576** by the KU Institutional Research Ethics Committee that will be valid year with effect from 11th June 2025.

This letter serves to introduce **Dr. Titus B. Kullaya** who will be conducting his study in Dar es please accord him with the needed support.
Thank you for your support and cooperation in developing human resources for health in our

Regards,

DIRECTOR POSTGRADUATE STUDIES KAIRUKI UNIVERSITY P. O. Box 65300, DSM RESEARCH INSTITUTE

Professor Naboth Mushi,
Ag. Director Postgraduate Studies & Research Institute

c. c. Dr. Monica Chidua, Head, Department of Obstetrics and Gynaecology, KU
c. c. Head, Department of Obstetrics and Gynaecology, ARRH

eral Contact:
nfo@ku.ac.tz
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Academic:
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Admissior
Email: admissions@k
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+255 659

Appendix 7: Ethical clearance.

KAIRUKI UNIVERSITY (KU)

70 Chwaku Street,
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P.O BOX 65300,
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Tanzania.

Tel: +255-22-2700021/4
Fax: +255-22-2775591
Email: irec@ku.ac.tz
Website: www.ku.ac.tz

Ref. No. KU/IREC/27.10/576 **12 June, 2025**

Dr. Titus Benedict Kullaya,
Kairuki University,
70 Chwaku Street,
Mikocheni,
P. O. Box 65300.
Dar es Salaam, Tanzania.

RE: ETHICAL CLEARANCE CERTIFICATE FOR CONDUCTING HEALTH RESEARCH

I am pleased to inform you that the research titled: **Predictors, Bacterial Profiles, and Antibiotic Susceptibility in Post-Caesarean Surgical Site Infection at Amana Hospital (Kullaya, T. B., 2025)** has been granted ethical approval.

This approval is in effect for one year from the above date.

- Any changes in the procedures should be reported to the Institutional Research Ethics Committee.
- Significant changes will require the submission of a revised request for ethical approval.
- You will be required to submit **a study progress report** every six months.

Permission to publish your findings should be sought from the National Institute for Medical Research (NIMR) before submission to a publisher and not concurrently.

CHAIR PERSON

Name: Prof. Frederick Kaijage

Signature:

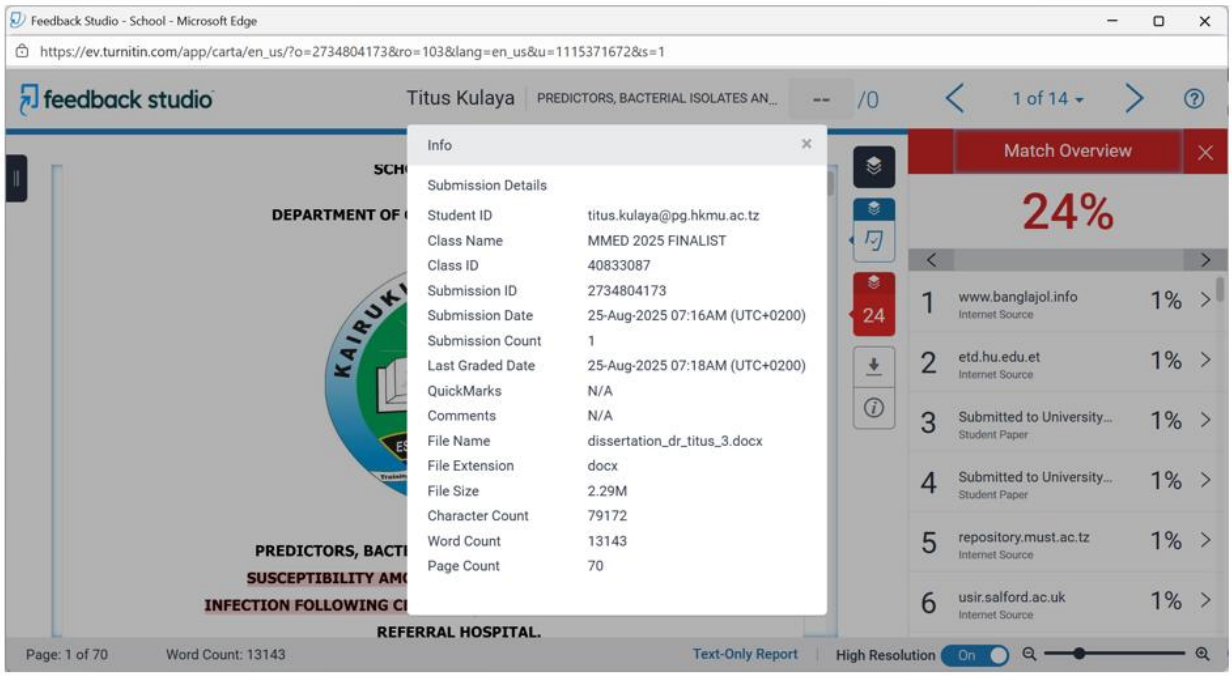
SECRETARY

Name: Prof. Columba Mbekenga

Signature:

DIRECTOR POSTGRADUATE STUDIES AND RESEARCH INSTITUTE
KAIRUKI UNIVERSITY
P. O. Box 65300, DSM

Appendix 8: Plagiarism report.



Appendix 9: Turnitin.

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Titus Kulaya
Assignment title:	Research Proposal
Submission title:	PREDICTORS, BACTERIAL ISOLATES AND ANTIBIOTIC SUSCEPTI...
File name:	dissertation_dr_titus_3.docx
File size:	2.29M
Page count:	70
Word count:	13,143
Character count:	79,172
Submission date:	25-Aug-2025 07:16AM (UTC+0200)
Submission ID:	2734804173

SCHOOL OF MEDICINE

DEPARTMENT OF OBSTETRICS AND GYNECOLOGY

PREDICTORS, BACTERIAL ISOLATES AND ANTIBIOTIC SUSCEPTIBILITY AMONG WOMEN WITH SURGICAL SITE INFECTION FOLLOWING CESAREAN SECTION AT KHAKA REGIONAL REFERRAL HOSPITAL.

BY

TITUS BENEDICT KULLAYA (KIE/PG/DG/22/10033)

SUPERVISOR: DR. MONICA CHEKUO

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF MEDICINE IN OBSTETRICS AND GYNAECOLOGY AT KAIRUKI UNIVERSITY (KU)

2025