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Predictors Bacterial Isolates, and Antibiotic Susceptibility Among Women With Surgical Site Infection Following Caesarean Section at Amana Regional Referral Hospital from March to May 2025.

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Abstract

Background: Surgical site infections (SSIs) after caesarean section are a major contributor to maternal morbidity, especially in resource-limited settings. The rise in antibiotic resistance further complicates their management.

Objective: To determine the predictors, bacterial isolates, and antibiotic susceptibility patterns among women with surgical site infections (SSI) following caesarean section at Amana Regional Referral Hospital.

Methodology: A prospective cohort study was conducted to women who underwent caesarean section. Data were collected using structured questionnaires and patient records. Wound swabs were taken from patients with suspected SSIs and analyzed using standard microbiological methods. Antibiotic susceptibility testing was performed using the Kirby–Bauer disk diffusion method. Statistical analysis was used to identify predictors of SSIs, with significance set at $p < 0.001$.

Results: The study identified key risk factors for surgical site infections (SSI), including age above 35 years (82.6%), BMI>30 (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.

Conclusion: Surgical site infections following caesarean section at Amana Regional Referral Hospital are influenced by identifiable risk factors and are caused by a range of bacterial isolates. The study shows notable variability in antibiotic susceptibility, including resistance to commonly used drugs. These findings highlight the need for improved infection prevention practices and rational antibiotic use to reduce infection rates and improve patient outcomes.

Keyword: Surgical site infection (SSI); Predictors; Bacterial isolates; Antibiotic susceptibility

1. Introduction

According to the United States Centers for Disease Control and Prevention (CDC), have defined SSIs as happening within 30 days of surgery and or up to 90 days following surgery, where an implant was involved. (1).

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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. (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%.

In conclusion, cesarean sections are major surgeries with a risk of post-surgical infections. These infections can significantly impact a mother's health and increase hospital stays. While the global prevalence of post-cesarean SSIs is estimated at 5.63%, studies in sub-Saharan Africa, including Tanzania, show a higher prevalence. Understanding the risk factors, bacteria involved, and antibiotic resistance in a specific hospital like Amana can help improve preventative measures and treatment strategies.

2. Materials and Method

2.1. 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 underwent cesarean sections, researchers can collect detailed data on maternal and surgical factors, bacterial isolates, and antibiotic susceptibility.

2.2. Study Settings

This study was conducted at Amana Regional Referral Hospital. The choice of this hospital as the study site ws 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 [7]. 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 was 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 [8].

2.3. Study Population

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

2.4. 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., (2023).

i.e., Sample size n = [DEFF*Np (1-p)]/ [(d2/Z2 *(N-1) +p*(1-p)]

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 with expected prevalence of 11% sample size was 151.

2.5. Sampling procedures

A systematic sampling technique was employed for recruiting 151study participants. This method involves selecting participants at regular intervals from a complete sampling frame. In this case, the sampling frame was list of all women who underwent 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 was then systematically select every 5th woman on the list. This approach was ensuring a representative sample while minimizing bias.

2.6. Data collections

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

- Section A (Patient demographics) - Age, weight, height, BMI, gestational age, parity, gravidity, and underlying medical conditions.
- Section B (Surgical factors) - Type of anesthesia, antibiotic prophylaxis, type of cesarean section, duration of surgery, and estimated blood loss.
- Section C (Post-operative care) - Wound care procedures (PI), antibiotic therapy, and duration of hospital stay.
- 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.

2.7. 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.

2.8. 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.

2.9. 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 was 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 was guaranteeing 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 were ensuring the successful implementation and execution of the study.

2.10. Data Collection Procedures

- STEP 1: All pregnant women coming for delivery services at ARRH was screened by trained personnel (an MD) for eligibility for this study, and only those who meet the inclusion criteria were 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 were then undergoing the cesarean section procedure, and the surgical factors were captured and filled in the respective section (section B) of the questionnaire immediately after surgery.
- STEP 4: The study participants were then undergoing post-operative care, and their daily details was 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 had have their details taken and filled in Section D of the study questionnaire. For these participants, wound swabs were collected for microbiological analysis.

2.11. 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 Laboratory within 2hours, for delayed samples refrigerated.

2.11.1. Data processing

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) [9]. This initial step provides a rapid clue about the morphology of the causative organism(s).

Expected Results was such that gram-positive cocci in clusters was suggestive of Staphylococcus aureus or coagulase-negative staphylococci. Gram-positive bacilli were suggestive of Bacillus species while gram-negative bacilli was suggestive of Enterobacteriaceae (e.g., E. coli, Klebsiella spp., Proteus spp.) or Pseudomonas aeruginosa [9].

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 [10]. The inoculated plates were incubated at 37°C for 24-48 hours.

Expected results was 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) [10].

Colonies' appearance

Following incubation, the culture plates were examined for bacterial growth. Colony characteristics such as size, color, shape, elevation, and edge morphology was documented [11]. These features can be used for presumptive identification of certain bacteria, i.e.

- Staphylococcus aureus: Large, round, golden yellow colonies with entire margins.
- Coagulase-negative staphylococci: Small, white or grey colonies.
- Escherichia coli: Large, pink, lactose-fermenting colonies on MacConkey agar.
- Klebsiella pneumoniae: Mucoid, lactose-fermenting colonies on MacConkey agar.
- Proteus spp: Swarming, irregular colonies on blood agar.
- Pseudomonas aeruginosa: Large, mucoid, green-pigmented colonies with a distinct odor.

2.11.2. Biochemical Tests

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 [12].

Triple Sugar Iron (TSI) agar

This medium differentiates enteric bacteria based on their ability to ferment glucose, lactose, and sucrose, and produce hydrogen sulfide [13].

Indole test

This test detects the production of indole from tryptophan, which is characteristic of certain bacteria, including Escherichia coli [14].

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 [15].

Urease test

This test detects the presence of the urease enzyme, which is characteristic of certain bacteria, including K. pneumoniae [16].

Oxidase test

This detects the presence of cytochrome c oxidase enzyme, which is characteristic of certain bacteria, including K. pneumoniae [17].

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

Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method. Standardized discs containing various antibiotics were placed on a Mueller-Hinton agar plate inoculated with the isolated bacteria [18]. The plates were 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 were 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 [18].

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.

2.12. 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.

2.13. Ethical consideration

Ethical approval for this study was obtained from Kairuki University Ethical Review Committee prior to data collection. Permission to conduct the study was also granted by the administration of Amana Regional Referral Hospital.

Informed consent was obtained from all participants before their inclusion in the study. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without any consequences to their care.

Confidentiality of participant's information was strictly maintained by using unique identification numbers instead of names, and all data were handled securely and used solely for research purposes.

All procedures performed in this study involving human participants were conducted in accordance with ethical standards and principles for medical research involving human subjects.

3. Results and Discussion.

In the present, 168 eligible pregnant mothers were consecutively recruited till the required sample of study was reached.

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

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

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

Table 4 Sociodemographic factors associated with increased risk of C/S SSI. N=30

Characteristics	**SSI**		**Bivariate**		**Multivariate**	
	Absence (n=121)	**Present (n=30)**	**OR(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		

Table 5 Obstetrical and surgical factors associated with increased risk of SSI. 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			

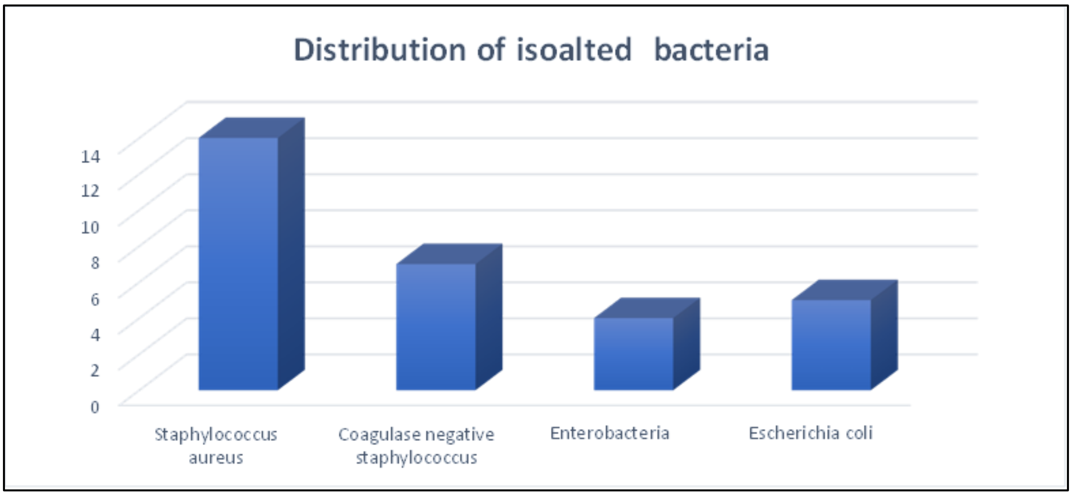

Figure 1 Histogram showing distribution of isolated bacteria

Table 6 Antibiotic susceptibility of bacterial isolated from c/s SSI 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)

4. Discussions

The study identified key risk factors for surgical site infections (SSI), including age above 35 years, BMI>30 and cesarean 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 (SSI) [20]. Similarly, Flibert and co-researchers reported comparable results among women who underwent cesarean sections at Bugando Medical Centre (BMC) in Tanzania [10]. In contrast, Wloch and colleagues found differing results, identifying younger maternal age, specifically below 19 years, as most strongly linked to SSI [12]. 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 [13] 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 [15].

Consistent with previous findings, [9] identified multigravidity as a significant risk factor for surgical site infections in their study of post- cesarean patients at Mbarara Regional Referral Hospital, Uganda. Their research further substantiates the established association between higher gravidity and increased SSI risk following cesarean delivery [15].

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 Flibert and colleagues among mothers who underwent cesarean sections at Bugando Medical Centre (BMC) in Tanzania [10],[15].

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 [11]. Vishall and colleague reported similar findings among mothers who underwent c section at department of obstetrics & gynecology in GMERS medical college & hospital, Sola, Ahmedabad in India [16]. How ever, Lotta and colleagues found that Coagulase negative staphylococcus as the most prevalent bacteria isolated among post caesarian SSI delivered at Kirehe District Hospital in Rwanda [14].

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 findings were observed by Pooja et al. in a study conducted at Jawaharlal Nehru Medical

College (JNMC), Belagavi, India, among post-cesarean mothers who developed surgical site infections, where Meropenem demonstrated the highest efficacy against all bacterial isolated [13]. In Tanzania, Alphonce 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 [15]. 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 [19]. However, Manisha and colleagues in India reported contrasting results, noting a higher resistance to Vancomycin among the majority of bacterial isolates [20]. This discrepancy might be attributed to differences in the study population.

5. Conclusions

The study identified several significant risk factors for surgical site infections (SSI), including age above 35 years, BMI>30 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 effectiveness. These findings highlight the need for targeted antibiotic prophylaxis and strict infection control measures in high-risk obstetric patients to reduce SSI rates.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no financial or non-financial conflicts of interest that could have influenced the design, conduct, analysis, or reporting of this study.

Statement of ethical approval

Ethical approval for this study was obtained from the Kairuki University Ethics Review Committee prior to data collection. Permission to conduct the study was also granted by the administration of Amana Regional Referral Hospital.

Statement of informed consent

Informed consent was obtained from all participants before their inclusion in the study. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without any consequences to their care.

Confidentiality of participant's information was strictly maintained by using unique identification numbers instead of names, and all data were handled securely and used solely for research purposes.

All procedures performed in this study involving human participants were conducted in accordance with ethical standards and principles for medical research involving human subjects.

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