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Bacterial etiology, antibiotic susceptibility pattern, and treatment modality of surgical site infections among post-caesarean delivery women: A 2019 cross-sectional study conducted in Iringa, Tanzania

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Abstract

Background: Surgical site infection (SSI) is a common complication after cesarean section in Tanzania, with high rates of infection and multidrug-resistant isolates reported. Understanding bacterial etiology and antibiotic susceptibility patterns is crucial for effective treatment and prevention. Therefore, this study aimed to determine the bacterial etiology, antibiotic susceptibility patterns, and treatment modalities of SSI among post-cesarean delivery women in the Iringa region.

Methods: A cross-sectional study involving 162 women with SSI was conducted across five hospitals in Iringa. Data on demographics were collected using a structured questionnaire, and wound discharge samples were taken for culture and sensitivity testing. Definitive treatment modalities were identified from patients' files. Data analysis was performed using SPSS version 20, with chi-square tests used to identify associations, and a p-value < 0.05 considered significant.

Results: Among 162 participants, 59.7% had superficial SSIs and 35.2% had deep SSIs. Culture positivity was 96.3%, with 53.2% being gram-positive and 37.2% gram-negative. *Staphylococcus aureus* was the most commonly isolated pathogen (40.1%), with 64.6% of cases being methicillin-resistant (MRSA). Resistance to vancomycin and chloramphenicol among gram-positive isolates was 3.1% and 13.8%, respectively. Non-surgical management was provided to 58% of the participants, while *Staphylococcus aureus* infections were significantly associated with surgical intervention (OR = 1.38, p = 0.001).

Conclusion: Staphylococcus aureus, particularly MRSA, was the most prevalent pathogen in post-cesarean SSIs. Antibiotic resistance was common, and surgical intervention was significantly associated with *Staphylococcus aureus* infections.

Keywords: Surgical site infection; Caesarean section; Wound Infections; Resistance

1. Introduction

Cesarean section is a surgery for delivering a baby through incisions in the abdomen and uterus. Cesarean section rates have progressively climbed internationally throughout the years, reaching roughly 26.4% to 31.2% (1). Nowadays, it has become a preferred form of delivery in all developed and developing nations for a variety of reasons, including its ability to reduce maternal and newborn mortality (1–4). Despite being seen as a lifesaving procedure, cesarean birth is connected with a number of maternal and fetal problems. Maternal complications include surgical site infection (SSI),

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iatrogenic visceral injuries, thromboembolism, anesthesia problems, hysterectomy, and blood transfusions owing to bleeding (5), and fetal complications are asphyxia, jaundice, anemia, palsy, internal organ damage and increased intracranial hemorrhage (6).

SSI has great impact to causing morbidity and mortality among women after cesarean delivery. Rwabizi et al reported more than 50% near mis women due to SSI after cesarean delivery had severe forms of morbidity that includes peritonitis, necrotizing fasciitis, Endometritis, wound infection, uterine dehiscence, turbo ovarian mass etc. the study also reported 5% mortality rate among these women attributed by SSI (7). Also, increased resistant pattern has been observed in several studies (8–15). Methicillin resistant strains (MRSA) have been observed in Dodoma, Muhimbili and Mulago hospital, 79%, 44% and 37.5% respectively (12,13,16). Hence, the treatments of these resistant strains prolong hospital stay and involve repeated interventions (17).

Center of Disease Control has defined and categorized SSI infection into Incisional and Organ/space SSI (18). The Incisional SSI is further divided into superficial and deep SSI where Superficial SSI arise on the site of surgical incision, not more than one month from the procedure day and includes only skin and hypodermic tissues and deep SSI involve fascia and muscles, which arise within one month following surgery though with implants considered up to 1 year. Organ/space SSI involve any organ or space other than the cut made during operation, also should arise within 30 days unless there are implants (19).

Moreover, there are multitudes of factors predispose women to SSI following cesarean section. Some of them are obstructed labor, prolonged labor, early rupture of membranes, emergency operation, sub umbilical midline incision, surgeries done by junior doctors, no use of pre-operative prophylactic antibiotics, ineffective use of post-operative antibiotics and maternal conditions like obesity, diabetes mellitus, and hypertensive disorders (4,9–12). The depth of the infection determines management of SSI post cesarean delivery (7,20). The common interventions of superficial SSI include suture removal and drainage of the infected area with or without antibiotic (21). Deep SSI requires repeated debridement and reconstructive surgeries in severe cases (7). Organ/space SSI are associated with prolonged hospitalization and multiple re-operations (22).

Furthermore, SSI is associated with major economic burden and prolonged morbidity (22–24). Several studies have demonstrated significant association between SSI and amount of medical interventions and associated health care cost (25). In England reported a loss of 6.4 bed days per day due to SSI of which 142 days being attributed by post cesarean delivery SSI. This was associated with aggregative cost of more than £2 million (24). Additional hospital costs are attributed to development of resistant strains followed prolonged use of antibiotics (17,26).

Although there was no study on SSI treatment or antibiotic susceptibility in Iringa, the observations at Iringa Regional Referral Hospital revealed a high number of post-cesarean women with prolonged hospital stays due to SSI, requiring repeated interventions and experiencing persistent wound discharge despite various antibiotics. Many patients struggled to afford hospital and social costs. This study therefore aimed to investigate the etiology, antimicrobial susceptibility pattern and definitive treatment modality of post cesarean delivery women presenting with SSI at Iringa region, Tanzania.

2. Material and methods

2.1. Study design

We conducted a cross-sectional analytical study design to investigate to explore the etiology, antimicrobial susceptibility pattern and definitive treatment modality of post cesarean delivery women presenting with SSI at Iringa region. The design was considered relevant as it provides the investigator measures the outcome and the exposures in the study participants at the same time.

2.2. Study setting

This study was conducted in Iringa Regional Referral Hospital and district hospitals in Iringa region. The district hospitals were Frelimo, Tosamaganga, Ilula and Mafinga were also received referrals from health centers located in the respective district. Iringa Region has a total area of 35743 square kilometers, with four administrative districts which are Iringa municipality, Iringa district, Kilolo and Mufindi. At the time of data collection, we referred to the national census of 2012. The region had a population of 941,238, of which 452,052 were males and 489,186 were females (27). At that time, Iringa Regional Referral Hospital had a capacity of 377 beds. There are about 5,132 deliveries which are conducted per year, of which 2,516 is by cesarean section with average of 210 cesarean section per month. Frelimo hospital has an average of 1800 cesarean deliveries per year, Tosamaganga hospital has 960 cesarean deliveries per year, Mafinga hospital is a Mufindi district hospital that has 45 beds in obstetrics ward, had a capacity of conducting 1000 cesarean deliveries per year, and Ilula hospital has 20 beds in obstetrics ward with almost 900 cesarean deliveries per year.

2.3. Study Population

The study involved all women with SSI after cesarean delivery in Iringa region during a period of the study and attended to Iringa Regional Referral Hospital or its district hospitals. The study's inclusion criteria were firstly, women with surgical site infection that developed within 30 days after surgery. Secondly, Referral patients with SSI from other health facilities within Iringa region. Those who women with SSI who were not ready to be enrolled, already initiated antibiotics after diagnosis of SSI and those who had repeat surgeries elsewhere were excluded.

2.4. Sampling methods

Hospital selection was a purposeful; Participants' selection was by convenient sampling. The eligible participants in the field during data collection time were recruited throughout the study until when sample size reached. Any woman who was diagnosed with any class of SSI by the attending physician or a researcher based on CDC classification during that time was enrolled for the study.

2.5. Sample size

Was calculated the sample size of the present study using Taro Yamane's formula (28)

$$n=N/1+N(e)2$$

Where:

n = sample size required, N = number of people in the study population, in this case is the number of new women with SSI who were expected to attend in IRRH and Iringa district hospitals, who were estimated to be 271 for the period of four months using the last year hospitals statistics. (Source: hospitals statistics 2018 IRRH=98, Frelimo= 66, Tosamaganga= 36, Mafinga= 37, Ilula= 34) where e = allowable error (5%) =0.05. Substituting in the formula:

$$n = 271/1+271(0.05)\ 2 = 162.$$

Therefore, the minimum sample size was 162.

2.6. Tools and data collection and methods.

2.6.1. Interview

Data was collected for a period of 4 months, from January to April 2019 where by a pre-tested structured questionnaire was used to collect the demographic data of patients who met inclusion criteria and signed informed consent. The demographic data was obtained through interview, extraction from the antenatal card, and the previous admission files.

2.6.2. Laboratory investigations

a) Specimen collection and transportation

Two research assistants from each facility trained on specimen collection were involved in the process of data collection. Pus aspirates and wound swabs from the surgical wounds were collected and transported on Stuart tube for laboratory processing. The specimens were collected aseptically. The area around the surgical wound was cleaned with 70% Ethyl alcohol. The wound was swabbed with normal saline in sterile gauze and the exudates was collected from the depth of the wound using two sterile cotton swabs, one for Gram stain and another for culture. Utmost care was taken not to touch the surrounding tissues to prevent contamination of the swab from endogenous resident flora. Then, the collected samples were placed in the Stuart transport media that was kept in refrigerator at 2 to 8 degrees centigrade at the study Centre and transported by ice packed container to the investigation laboratory immediately for processing to avoid drying and to prevent the growth of some species at room temperature that could obliterate the true pathogens.

b) Laboratory Sample processing

Before the sample were processed, we ensured that all collected sample met the inclusion criteria, sample with old wound swabs and pus aspirates, improperly labeled samples, and sample with improper filled form were rejected. Then, samples were processed as soon as they reached the laboratory by following the standard laboratory procedures. From the two collected samples, one was used for gram staining and other for isolation of bacteria by culture.

Macroscopic and Microscopic examination, the pus samples were examined for appearance, color, consistency and presence of granules. Microscopic examination, an evenly spread smear of the specimen was prepared on a clean grease free glass slide. The smear was allowed to air dry, heat fixed and Stained by Gram stain method. The smear was then examined for the presence of bacteria and cellular elements using microscope by using x 100 objective lens with oil immersion.

Culture, the second swab was inoculated onto plates of 5% Sheep Blood agar (BA), MacConkey agar (MA) and chocolate ager (CA) by rolling the swab over the agar and streaking from the primary inoculums, using a sterile bacteriological loop. These plates were incubated at 37°C for 24-48 hours. Chocolate and blood ager plates were incubated within the candle jar

c) Characterization and Identification

All types of colonies on the primary plates were examined macroscopically for hemolysis in BA, changes in physical appearance of differential media, and the colony characteristics were recorded. The colony present on these plates was gram stained, identified by biochemical testing and antibiotic susceptibility testing.

Gram staining, Colonies on MacConkey Agar and blood agar plates were stained by gram's staining method and the morphology, gram reaction and arrangement of the microorganisms were noted.

Biochemical tests, Catalase and coagulase testing was done for confirmation of Gram-Positive bacterial isolates. For Gram-negative bacterial isolates Indole, Citrate utilization test, hydrogen sulphide test, triple sugar iron test, Lysine iron agar and Urease was used for identification

d) Antibiotic susceptibility testing

Antibiotic sensitivity testing was performed using the standard disc Kirby-Bauer disc diffusion method using Mueller Hinton agar plate and interpreted according to the recommendations of the Clinical and Laboratory Standard Institute for the following antibiotics: Gentamicin 10µg, Meropenem 10µg, Ciprofloxacin 5µg, Ceftriaxone 30µg, Cotrimoxazole 1.25/23.75µg, tetracycline 30µg, and Amoxycillin 20µg for gram negative bacteria and Erythromycin 15µg, Oxacillin 1µg, Vancomycin 30µg chloramphenicol 30µg, clindamycin 2µg, Gentamycin 10µg, tetracycline 30µg and Cotrimoxazole1.25/23.75µg for gram positive bacteria. S. aures resistant to oxacillin was identified as MRSA and those susceptible as methicillin Sensitive S. aureus (MSSA).

Interpretation. Relied on the diameters of the inhibition zones of a particular drug to each organism according to clinical and laboratory standards institute recommendation of 2012, (ISO-15189). Multidrug resistance was based on the recommendations from experts and international organizations criteria of EFSA 2017 (29).

e) Quality control for tests

The quality control was performed in every required step. The samples were collected using sterile swab aseptically in order to avoid contamination. The sterility of each batch of the test medium were confirmed by incubating uninoculated plates and tubes overnight at 37°C and were not used if those plates and tubes showed the evidence of bacterial growth and other visual reactions after incubation. The positive and negative controls were incubated along with test for comparing the results. Control strains of E. coli (ATCC-25922), S. aureus (ATCC- 25923), Klebsiela (ATCC-700603) and P. aeruginosa (ATCC-27853) were used to check the quality of the medium in the same manner from each batch similarly.

Definitive treatment plan of SSI in the patient's file offered by the attending physician at the hospital was considered as treatment modality. The treatment modalities were categorized into surgical and non-surgical. The treatment was regarded as non-surgical if it involves use of antibiotics or dressing or both while surgical treatments were regarded when it involves debridement, laparotomy with abdominal washout and laparotomy with hysterectomy.

2.7. Data Analysis

Data were coded, entered, cleaned then analyzed using the Statistical Package for Social Science (SPSS) version 20 in accordance to specific objectives. Distribution statistics; frequency calculations were presented in tables and charts. The Chi-square test was used to test the associations between variables where, the p-value of <0.05 was taken as significant.

2.8. Validity and Reliability of the study

To ensure the validity and reliability of the present study, several measures were taken: The questionnaire was pre-tested at Iringa Regional Referral Hospital. Culture media were incubated at 37°C for 24 hours, and discarded if no bacterial growth occurred. Mueller-Hinton agar plates for Kirby-Bauer diffusion were incubated with microbial control discs at 37°C for 24 hours to assess effectiveness. Two wound swabs were collected from each client to compare results between gram stain and culture. All laboratory procedures were performed and interpreted by one laboratory scientist, and counterchecked by a senior laboratory scientist before the results were released.

3. Results

3.1. Demographic characteristics of the study participants.

This study was conducted between January and April 2019. A total of 162 women with clinical features of SSI were enrolled during the whole period of the study. The age range of participants was from 17 years to 42 years with mean of 27 years ± 5.5. Majorities were in age group between 21-34 years 78.4%. In terms of parity, majority 70.4% were multiparas with 71% of women resided in urban areas. (Table 1). The most common indication for cesarean section in this study was abnormal labour 46.5% followed by previous scar 33.3%.

3.2. Culture results and Bacterial isolates from wound swabs of women with SSI

Out of 162 enrolled participants with SSI 156 (96.3%) samples had positive bacteria growth. The common bacteria growth was gram positive (51.2%). The common bacteria isolate was *Staphylococcus aureus* (40.1%) followed by *Escherichia coli* (23.5%).

Table 1 Demographic characteristics N=162

Variables	Categories	Frequency (n)	Percentage (%)
Age	≤20	14	8.6
	21-34	127	78.4
	≥35	21	13
Parity	Prime Para	48	29.6
	Multipara	114	70.4
Marital status	Single	31	19.1
	Living with partner	131	80.9
Education	No formal	4	2.5
	Primary	72	44.4
	Secondary	45	27.8
	Collage	41	25.3
Occupation	Peasant	74	45.7
	Trader	26	16
	Self employed	17	10.5
	Employed	41	25.3
	Student	4	2.5

Residency	Urban	115	71
	Rural	47	29
BMI	Normal weight	51	31.5
	Overweight	70	43.5
	Obesity	41	25.3
Place of delivery	IRRH	103	63.6
	Peripheral	59	36.4

Key: BMI=Body mass index, IRRH=Iringa Regional Referral Hospital.

3.3. Antibiotics susceptibility pattern for both gram-positive and gram-negative isolated organisms from the wound swabs taken among women with SSI

For the gram-positive bacteria; Vancomycin had least resistance by 3.1% followed by chloramphenicol by 13.8% and MRSA by 64.6%. While, Meropenem was the only drug that had not shown resistance to any organism followed by Gentamycin. Ceftriaxone the commonly used drug had little resistance to klebsiela by 26.1% while it showed high resistance to others. (Table:02)

Table 2 The distribution of Gram-negative and Gram-positive organisms isolated from wound swabs and their antibiotics resistance pattern

Antibiotics	**Gram-positive organisms**		**Antibiotics**	**Gram Negative Organism**				
	S. *aureus* N=65	**CoNS N=33**		**E.coli N=38**	**Klebsiela N=23**	**Coliform N=1**	**Proteus N=6**	**Pseudomonas N=5**
	n (%)	n (%)		n (%)	n (%)	n (%)	n (%)	n(%)
Vancomycin	2 (3.1)	1 (3.1)	Gentamycin	8(21.1)	2(8.7)	1(100)	0(0)	0(0)
Gentamycin	32(49.2)	7 (21.2)	Meropenem	0(0)	0(0)	0(0)	0(0)	0(0)
Chloramphenicol	9 (13.8)	10 (30.3)	Ciprofloxacin	17(44.7)	3(13)	0(0)	3(50)	3(60)
Tetracycline	27 (41.5)	20 (60.6)	Ceftriaxone	27(71.1)	6(26.1)	1(100)	3(50)	5(100)
Erythromycin	25 (38.5)	21 (63.6)	Cotrimoxazole	25(65.7)	3(13)	1(100)	4(66.7)	5(100)
Oxacillin	42 (64.6)	24 (72.7)	Tetracycline	10(26.3)	5(21.7)	1(100)	3(50)	5(100)
Cotrimoxazole	27 (41.5)	26 (78.8)	Amoxycillin	25(65.8)	17(73.9)	1(100)	4(66.7)	5(100)
Clindamycin	15 (23.1)	13 (39.4)	-	-	-	-	-	-

Key: E.coli=*Escherichia coli* S.aureus=Staphylococcus aureus, CoNS=Coagulase negative staphylococcus.

3.4. Treatment modality given to women with Surgical Site Infection

Table 03. Shows association between bacteria and treatment modality of SSI. The commonest treatment modality being non-surgical (58%), where S. aureus shows a statistically significant association with surgical treatment (P = 0.001). The other bacteria (Klebsiella, E. coli, CoNS, Coliform, Proteus, Pseudomonas) do not show statistically significant associations with the treatment modality (P > 0.05)

Table 3 Association between bacteria and treatment modality of SSI

	Treatment Modality			
Variable	**Surgical**	**Non-surgical**	**COR (CI=95%)**	**P value**
S.*aureus* n=65	N (%)	N (%)		
Yes	42(64.6)	23(35.4)	1.38(1.14-1.68)	0.001
No	26(26.8)	71(73.2)	1	
Klebsiela n=23				
Yes	5(21.5)	18(78.3)	1.15(0.97-1.35)	0.106
No	63(45.3)	76(54.7)	1	
E.coli n=38				
Yes	14(36.8)	24(63.2)	1.32(0.63-2.79)	0.464
No	54(43.5)	70(56.5)	1	
CoNS n=33				
Yes	10(30.3)	23(69)	1.88(0.83-4.26)	0.131
No	58(45)	71(55)	1	
Coliform n=1				
Yes	1(100)	0(0)		1.000*
No	67(41.6)	94(58.4)		
Proteus n=6				
Yes	1(16.7)	5(83.7)	1.48(0.36-6.13)	0.591
No	67(42.9	89(57.1)	1	
Pseudomonas n=5				
Yes	3(60)	2(40)	0.72(0.14-0.65)	0.686
No	65(41.6)	92(58.6)	1	

Key: CoNS =coagulase negative staphylococcus. S.aureus=Staphylococcus Aureus. *= Fishers exact, E.coli= Escherichia coli. COR= Crude Odds ratio

4. Discussion

This aimed to investigate the etiology, antimicrobial susceptibility pattern and definitive treatment modality of post cesarean delivery women presenting with SSI at Iringa region, Tanzania. Where the swabs were taken for culture and sensitivity taken from the participants revealed several organisms of which may explain surgeon's septic techniques during procedures, incorrect theatre equipment handling or inappropriate nursing care in the theatre and in the wards, also may be due to poor hygiene of the women or general poor self-wound care. From the above demographic characteristics of the cohort, conceivably the low education and financial constrain (low socio-economic status) were among the contributory major issues because majority of participants were standard seven leavers and peasants and therefore, they might have contributed to that contamination due to poor knowledge on hygiene and self-wound care as it was observed in a study from Australia that showed high positive association between low socio economic status and Staphylococcal aureus (30). Though pre-operative medication is recommended to prevent sepsis but perhaps was not consistent practice in Iringa and therefore it can be another theory behind that caused these hospital-based organisms. Aside from the observed high rate of bacterial growth, but majority of women presented with superficial SSI manifestation (59.9%) which now show that may be women adhere to some counseling given during discharge on early detection of danger signs and when to come back before the condition gets severe. The same situation also was observed from other studies reported elsewhere by Nardo et al, Mpogolo et al, and Manyahi et al etc (11,12,31).

4.1. Bacterial etiology

Out of 162 discharge samples collected from the respondents' wounds, 156 (96.3%) had culture positive and 3.7% had no bacterial growth. This high rate of bacterial growth in our study is probably due to proper clinical diagnosis of SSI that was made during recruitment based on CDC criteria, also perhaps is due to quality of samples transportation technique, laboratory reagents, laboratory procedures and skills of personnel that was employed in the study was assured. It might also explain the high rate of contamination among women undergoing cesarean delivery. Failure of bacteria to grow probably was influenced by the prior use of antibiotics after surgery or perhaps could be the wound discharge was sterile. Compared to Nardo et al in Dodoma bacterial growth was observed in 102(53.8%) and several other reports from elsewhere in Mwanza by Mpogolo et al, Nepal by chhetry et al who contradict our results with their low rate of culture positive in their studies (11,12,32). This dissimilarity may be due to lack of some of the above-discussed factors in their methodology.

Most of the bacterial isolates in this study are the normal floras in human nasal pharyngeal, skin, rectum, and gastrointestinal, so it is very easy to contaminate the patient's wound during or after surgery (11–13). Probably the source of infection is either surgeon during surgery, hospital staffs in the wards, from other patients due to overcrowding in the postnatal wards or endogenous origin. It can also be due to lack of sustained pre-operative antibiotics prophylaxis.

The most commonly isolated organism was staphylococcal aureus by 40.1%. This high rate of S.aureus in Iringa region possibly is due to Iringa Regional Referral Hospital, Tosamaganga and Mafinga hospitals are all teaching hospitals, which accommodate students of different cadres in theatres and in the wards as well, therefore infection prevention and control is likely not taken care of and the strategies to monitor their practical works may be not effective. Also, may be due to overcrowding in the wards is another reason of contamination. Nardo et al also observed the same rate in their study in Dodoma 40.6% (12). However, it is lower compared to Negi et al in India who reported 50.7%(33), could be because their study was done in resource constrain areas where contamination is likely as low socio-economic status was associated with high rate of S.aureus by Tong et al in Australia (30).

However, the present study revealed variable pattern of other organisms like 3.1% Pseudomonas, 3.7% proteus, 0.1% coliform spp, 14.2% klebsiela, 23.5% E. coli and others among the isolated bacteria. Relatively the same distribution was seen in another study in Bugando where the distribution was somewhat the same with Pseudomonas spp 9.1%. Additionally in our study we observed the rate of coagulase negative staphylococcus was high 33(20.4%) and it was the third organism to be isolated frequently, this is another evidence that perhaps there is high contamination either during or after procedure because these are non-pathogenic normal floras in human body. This result is comparatively similar to that of Nardo et al in their study at Dodoma where they observed 44.5% (12), might be the study areas where the two studies were conducted there is lack of effective infection prevention and control strategies including skin preparation during surgery.

4.2. Antibiotics susceptibility

Antibiotics resistance in this study was high with MRSA of 64.6% that suggests the presence of S. aureus which are resistant to several antibiotics especially penicillin and cephalosporins. May be because post-cesarean delivery women are discharged with antibiotics therefore by the time of admission bacteria might have already mutated. Generally, antibiotics resistance development is associated with several concepts like empirical treatment of diseases, misdiagnosis, under dosage, irrational use of drugs without prescription or lack of drug resistance surveillance. Nardo et al reported higher rate of MRSA by 79% in their study compared to ours probably there is no routine resistance surveillance or empirical treatment is more practiced (34). Also study done in Dar es salaam, Tanzania among patients attending regional hospitals found 75.3% were methicillin susceptible S. aureus (MSSA) making the over- all prevalence of MRSA among all patients attending regional referral hospitals being 8.5% (35). The observed low rate may be because of time difference between the present study and the previous ones.

The present study also found Vancomycin and Chloramphenicol with least resistance to gram-positive organisms 3.5% and 13.8% respectively the same to gram-negative organisms had no any resistance to Meropenem. It is possibly due to the restricted use of those drugs due to side effects, high cost or policy. Moreover, their use as alternative drugs has therefore minimized the chance of developing bacterial mutation. Mpogolo et al found the same kind of results and several other studies elsewhere (11,13). Clindamycin, although it is not routinely used but it showed relative resistance to gram positive by 23.1%-39.4% which is lower compared to that observed by Seni et al 40.6%-62.5%, possibly there are other factors to be investigated. Amoxycillin and ceftriaxone had high pattern of resistance 65.8%-100% and 26.1-100% respectively, ciprofloxacin had 44.7%. Perhaps is because the drugs are used routinely as first line. This pattern was also found in studies at Mbarara, Mulago and Muhimbili where E.coli had resistance against ceftriaxone by 77.8%-100% and 50%-100% to ciprofloxacin (13,31,36) may be because of the same reason of frequently use.

4.3. Treatment modality of SSI

The level of exposure of surgical site infection usually determines the type of management of the patient (21). The commonly known treatments include antibiotics only, removal of suture and drainage with antibiotics and dressing, debridement, laparotomy with washout and laparotomy with hysterectomy. Our study found that majority of women with Surgical Site infection was managed by non-surgical 58%, this could be because in this current study majority presented with superficial SSI by 59.9%, Like various other studies reported elsewhere by Nardo et al, Mpogolo et al, Manyahi et al etc. Followed by debridement 35.2% and laparotomy was 6.8%. Similar results were observed by Cheu et al who reported high rate of non-surgical treatment 55.9% and debridement 30.1% (20). The severity of Surgical Site Infection is known to be determined by several factors like advanced age, prolonged duration of surgery, co-existence of other co morbidities, contaminated wounds, junior surgeons, late treatment etc, (37), therefore may be in our study, these factors were not significant to positively influence the severity of SSI and hence majority did not require surgery although these factors were not included under the study. However, in this study the rate of laparotomy was very low meaning that the women who came with high level of exposure of SSIs that needed vigilant intervention were few. One study from Rwanda reported high rate of laparotomy with washout 48%, and laparotomy with hysterectomy 22% among maternal near miss patients (7). This differing is perhaps due to the latter study recruited the near miss women only who most of them were obviously having high level of exposure as it was reported 56% of participants presented with peritonitis that is why majorities had laparotomy with or without hysterectomy but also the retrospective study design may have miss matched the results

4.4. Study limitations

Our study had certain limitations that are important to note, first the time gap between data collection in 2019 and its publication in 2024. During this period, medical guidelines, treatment protocols, and antimicrobial resistance patterns could have evolved, potentially making the findings less applicable to current clinical practices. Second, antimicrobial resistance trends may have shifted over time, meaning the susceptibility patterns identified in the study might not accurately reflect the current situation. Third, changes in hospital practices or infection control protocols introduced since 2019 could result in different clinical outcomes compared to those observed in the present study.

5. Conclusion

Therefore, this study found that SSI among post cesarean delivery women in Iringa was most commonly caused by staphylococcus aureus. The causative organisms variably showed a significant resistance to commonly prescribed antimicrobial drugs. Women with SSI, majority of them were successfully managed by antibiotics and dressing only and those who had been isolated with *staphylococcus aureus* were more likely to be managed by surgical intervention. We recommend both strengthening of infection prevention and control and establishment of strategies for routine assessment of antibiotics potency as resistance is gaining access rapidly (antibiotics resistance surveillance).

Compliance with ethical standards

Disclosure of conflict of interest

Authors of this study have no any conflict pf interest with any second or third part. The authors of this work are independent and have produced original work which under any case it does not interfere with any other individuals' rights or authorities at any capacity.

Statement of ethical approval

Ethical Clearance was obtained from University of Dodoma through UDOM Ethical committee (UDOM/DRP/134 VOL.VI/66-50). Permission to conduct the study was thought from Iringa Regional medical officer, Iringa Regional Referral Hospital authorities and Iringa districts medical officers. Informed consent was obtained from respondents and confidentiality was assured and maintained at all levels. During data collection, method employed did not cause harm to subjects and information obtained were used for research purpose only. Results were made available to the patients and were used to manage their conditions.

Statement of informed consent

All data used in this study observed the ethical principle of informed consent, where the respondents declared their willingness to participate in the research after clear information on what the research is all about was given to them. No respondent was forced at any capacity to give information without their consent.

Authors' contributions

AAM, AE, and AL participated in the study conception and study design. AAM, AE and AL were responsible for data collection and the coordination of laboratory testing. AAM and AE analyzed the data. AAM of research dissertation report and PDS & KIM wrote the initial draft of the manuscript, which was then reviewed by AAM and IKM. All the co-authors participated in revising the manuscript. All authors read and approved the final manuscript.

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