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Antibiotic Prescribing Patterns and Prevalence of Surgical Site Infections in Caesarean Section Deliveries at Two Tertiary Hospitals in Lusaka, Zambia

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Abstract

Introduction: A caesarean section (CS) is one of the most frequently performed obstetric surgeries in the world and its use has increased dramatically in recent years. The number of caesarean section cases worldwide has been increasing each year, and the World Health Organization (WHO) reported an excess of 10% - 15% of CS procedures for all births. However, some women experience surgical site infections (SSIs) after undergoing CS delivery. This study investigated the prescribing patterns of antibiotics in CS deliveries and the prevalence of SSIs at two tertiary hospitals in Lusaka, Zambia. **Materials and Methods:** A retrospective cross-sectional study was conducted from January 2020 to December 2020 at the Women and Newborn University Teaching Hospital (UTH) and the Levy Mwanawasa University Teaching Hospital, in Lusaka, Zambia. **Results:** Of a total of 838 women who delivered via CS, more than half were aged between 21 and 25 years (n = 461, 55.0%), 56.3% were

from low-cost residential areas, and 57% had emergency CS delivery. The prevalence of SSIs was 6.0%, with the level of education (OR 0.377, 95% CI 0.150 - 0.946), type of caesarean section (OR 6.253, 95% CI 2.833 - 13.803), and oral antibiotics post-caesarean (OR 0.218, 95% CI 0.049 - 0.963). The duration of IV antibiotic treatment significantly predicted SSI ($p < 0.001$), and 99.8% of the women received antibiotic(s). The antibiotic combination of benzylpenicillin, gentamicin, and metronidazole was the most commonly prescribed (n = 39, 146.7%), followed by ceftriaxone (n = 349, 41.6%). **Conclusion:** This study found that the third-generation cephalosporin (cefotaxime) and triple combination therapy (benzylpenicillin, gentamicin, and metronidazole) were the most frequently prescribed antibiotics before and after CS. The level of education, type of CS, oral antibiotics post-CS, facility, and duration of administering IV antibiotics were all predictors of SSIs.

Keywords

Antibiotic Prescribing Patterns, Caesarean Section, Post-Operative Antibiotics, Prophylactic Antibiotics, Surgical Site Infections

1. Introduction

A caesarean section (CS) is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby [1]. It may be necessary if vaginal delivery poses a risk to the mother or baby when there is prolonged labour, foetal distress, or the baby is presenting in an abnormal position [2]. As compared with vaginal delivery, women who have a caesarean section have a five- to ten-fold increased risk of complications associated with infection [3]. In addition, a CS can cause significant complications, disability, or death, particularly in settings that lack the facilities to conduct safe surgeries or treat potential complications [4] [5].

A CS delivery is one of the most common operative procedures performed in Sub-Saharan Africa (SSA), accounting for as much as 80% of the surgical workload [6]. In contrast to CS deliveries performed in high-income countries, those performed in SSA are primarily emergency operations and are accompanied by high morbidity and mortality rates [6]. This operation is the most important known variable associated with an increased probability of postpartum bacterial infection as compared with vaginal birth, with reported rates of infection ranging from 1% to 25%, about 5 to 20 times higher than that of vaginal delivery [6] [7].

Infectious complications following a caesarean section delivery include fever, wound infection, endometritis, and urinary tract infection. Serious complications include pelvic abscess, bacteraemia, septic shock, and septic pelvic vein thrombophlebitis that can sometimes lead to maternal mortality [8] [9] [10]. Preventive measures have been suggested to avoid post-caesarean infection including proper preparation of an incision site which can reduce the bacterial population

to a minimal level [9].

Antimicrobials are commonly prescribed in obstetrics and gynaecology prophylactically for pre- and postoperative procedures [11]. First-generation cephalosporins including ceftriaxone, cefotaxime, and cefazolin have been reported to be the most commonly used for prophylaxis [12] [13] [14]. Prophylactic antibiotics reduce the incidence of SSIs and evidence-based guidelines recommend the use of antibiotics before an incision [15]. In recent times, despite the importance of antibiotic use for post-caesarean infection prevention, the injudicious and prolonged administration of antibiotics has led to a surge in the emergence of resistant strains of microorganisms [16]. Without newer antibiotics being developed over the next few years, the optimum use of antibiotics remains to be a challenge for many countries and hospitals [17].

The antibiotic prescribing patterns in a maternity ward are influenced by several factors such as premature rupture of the membrane which predisposes a patient to chorioamnionitis, endometritis, and neonatal infections [18], the age of the patient, obesity, gestational diabetes mellitus, and a prolonged trial of labour before CS delivery [19].

Furthermore, irrational use of antibiotics has been identified as one of the factors contributing to the emergence of antimicrobial resistance and, as such, negatively impacting both treatment and prophylaxis [20] [21]. Therefore, it is important to assess the antibiotic prescribing patterns in labour/maternity wards and their prophylaxis effectiveness in preventing post-CS infection.

In this study, we investigated the prescribing patterns of antibiotics before and after CS deliveries and the occurrence of SSIs at two tertiary hospitals in Lusaka, Zambia.

2. Materials and Methods

2.1. Study Site

This study was a retrospective hospital-based cross-sectional study conducted using medical charts for 838 patients who underwent CS delivery from January 2020 to August 2020. The study was performed at the UTH and the LMUTH in Lusaka. The UTH and LMUTH are the leading institutions in maternal, reproductive health, and newborn care in Zambia. They act as referral hospitals for surrounding districts and are centres of excellence in research and training.

2.2. Data Collection

The data were collected retrospectively from labour room medical records using a predefined data collection checklist that was adapted from the World Health Organization (WHO) tools for investigating drug use in healthcare facilities (**Appendix**). The data included patient demographics (age, religion, marital status, level of education, occupation, and place of residence), date of admission, indication for caesarean section, date and type of caesarean section, medications prescribed, type of wound infection, and length of hospital stay. The wound infec-

tion results were collected from the microbiology laboratory system. The data were cleaned and examined for completeness during collection, and incomplete patient medical records were excluded.

2.3. Inclusion Criteria

This study included all medical charts that had complete information including age, indication for caesarean section, and demographic factors. The charts of all women who underwent CS delivery (elective or non-elective) during the study period and also had other complications that warranted the use of antibiotics apart from prophylaxis were included in the study.

2.4. Exclusion Criteria

The charts of all women who underwent CS delivery but with incomplete information such as age, indication for caesarean section, and other demographic factors were not included in the study. The charts of these women who underwent caesarean section and also had other complications that warranted the use of antibiotics apart from prophylaxis were not included in the study.

2.5. Data Analysis

The collected data were entered into Microsoft excel and were checked for completeness, inconsistencies, and missing values, and then coded. Data were analysed using SPSS version 21.0. Descriptive statistics were used to determine frequencies and percentages to describe the study population with sociodemographic and other relevant variables. A chi-square test of association was performed to determine the distribution of antibiotic prescribing patterns, by the facility. Backward stepwise binary logistic regression was performed to determine the factors that would independently predict SSI post caesarean section. A p-value ≤0.05, with a 95% confidence interval, was considered to be statistically significant.

3. Results

3.1. Demographic and Clinical Information of the Participants

We reviewed a total of 838 medical files of women who delivered through CS. More than half (55%) of the women who had CS deliveries were aged between 21 and 25 years, and slightly over one-third (38.9%) of these women had attained only a secondary education level. The distribution of respondents by site was similar, with 417 (49.8%) from the UTH and 421 (50.2%) from the LMUTH. In addition, most of the women, 478/838 (57.0%) had undergone an emergency CS and 50 (6.0%) experienced SSIs (Table 1).

3.2. Factors that Independently Predict Surgical Infection Post Caesarean Section Surgery

A backward stepwise binary logistic regression was performed to determine the factors that would independently predict the existence of SSI post-CS surgery.

Table 1. Sociodemographic and clinical information of the women who delivered through caesarean section.

Factors		Frequency	Percent
Age	15 - 20 Years	145	17.3
	21 - 25 Years	461	55.0
	26 - 30 Years	208	24.8
	31 - 40 Years	24	2.9
	Total	838	100
Level of education	Primary	210	25.1
	Secondary	326	38.9
	Tertiary	302	36.0
	Total	838	100
Residential area	Low cost	472	56.3
	Medium	266	31.7
	High cost	100	11.9
	Total	838	100
Marital status	Single	511	61.0
	Married	323	38.5
	Divorced	4	0.5
	Total	838	100
Facility	UTH	417	49.8
	LMUTH	421	50.25
	Total	838	100
Type of caesarean section	Elective	360	43.0
	Emergency	478	57.0
	Total	838	100
Prevalence of SSIs	Yes	50	6
	No	788	94

Key: SSIs = surgical site infections.

The factors that were found to significantly contribute to the model, and hence included in the analysis, were level of education, type of caesarean section, post-CS oral antibiotics being prescribed, facility at which the CS was performed, and duration of IV antibiotics treatment. Women who had attended secondary school were 2.653 times more likely not to have surgical site infection as compared with those who only attended up to primary school (OR = 2.653, 95% CI 1.057 - 6.667, p = 0.038). Women who had elective CS delivery were 6.253 likely of having no surgical site infection as compared with emergency CS delivery (OR = 6.253, 955% CI 2.833 - 13.803, p < 0. 001). In addition, women who had CS delivery at the UTH were 0.059 times less likely to have no surgical site infection as compared with those who had CS delivery at the LMUTH (OR = 0.059, 95% CI 0.020 - 0.173,

p < 0.001). Having a longer duration of post-CS IV antibiotic treatment resulted in a greater chance of having no surgical site infection as compared with antibiotic treatment for a duration of fewer than 7 days; OR = 18.044, 95% CI 6.607 - 49.279, p < 0.001 and OR = 6.868, 95% CI 2.823 - 16.710, p < 0.001, concerning 8 - 15 days and 16 - 22 days of IV antibiotic treatment, respectively, as shown in Table 2.

3.3. Pre-Caesarean Section Antibiotic Prescribing Patterns by Facility

Almost every woman (n = 836, 99.8%) who had CS delivery received an antibiotic before the CS operation. Overall, the triple therapy of X-pen, gentamicin, and metronidazole was the most commonly prescribed antibiotic combination (n = 391, 46.7%), followed by ceftriaxone (n = 349, 41.6%). The other antibiotics and their prescription patterns are shown in Table 3. The most commonly prescribed pre-CS antibiotic prescribed at the UTH was ceftriaxone (n = 290, 34.6%), while at the LMUTH, it was a combination of X-pen, gentamicin, and metronidazole (n = 339, 40.5%), as shown in Table 3.

Table 2. Factors independently associated with surgical site infection post-CS delivery.

	Odds Ratio	95% Confidence Interval	(p-Value)
Level of education			
Primary	-	-	
Secondary	0.377	0.150 - 0.946	0.038
Tertiary	0.677	0.249 - 1.610	0.338
Type of caesarean section			
Emergency	-	-	
Elective	6.253	2.833 - 13.803	<0.001*
Post CS oral antibiotics prescribed			
No	-	-	
Yes	0.218	0.049 - 0.963	0.045*
The facility at which CS was performed			
LMUTH	-	-	
UTH	0.059	0.020 - 0.173	<0.001*
Duration of IV antibiotics			
<7 days	-	-	
8 - 15 days	18.044	6.607 - 49.279	<0.001*
16 - 22 days	6.868	2.823 - 16.710	

OR, odds ratio; UTH, University Teaching Hospital; LMUTH, Levy Mwanawasa University Teaching Hospital; CS, caesarean section.

Table 3. Pre-caesarean section antibiotic prescribing patterns in study sites.

Factor	Facility		Total percent	p-value
	UTH n (%)	LMUTH n (%)		
Pre-CS antibiotics given				
Yes	415 (49.5)	421 (50.2)	836 (99.8)	0.247
No	2 (0.2)	0 (0.0)	2 (0.2)	
Total			838 (100)	
Antibiotics prescribed				
Cefotaxime	11 (1.3)	3 (0.4)	14 (1.7)	
Ceftriaxone	290 (34.6)	59 (7.0)	349 (41.6)	
X-pen, gentamicin, and Metronidazole	52 (6.2)	339 (40.5)	391 (46.7)	
Metronidazole	14 (1.7)	0 (0.0)	14 (1.7)	
Ceftriaxone, and metronidazole	13 (1.6)	4 (0.5)	17 (2.0)	<0.001*
Metronidazole, and erythromycin	1 (0.1)	0 (0.0)	1 (0.1)	
Cefuroxime	23 (2.7)	10 (1.2)	33 (3.9)	
Sulfamethoxazole-trimethoprim	1 (0.1)	1 (0.1)	2 (0.2)	
Gentamicin and metronidazole	2 (0.2)	0 (0.0)	2 (0.2)	
Sulfamethoxazole-trimethoprim	2 (0.2)	0 (0.0)	2 (0.2)	
Amoxicillin and metronidazole	1 (0.1)	0 (0.0)	1 (0.1)	
Benzylpenicillin (X-pen)	0 (0.0)	1 (0.1)	1 (0.1)	
X-pen, gentamicin, and ceftriaxone	5 (0.6)	4 (0.5)	9 (1.1)	
N/A (antibiotics not prescribed)	2 (0.2)	0 (0.0)	2 (0.2)	
Total			**838 (100)**	

On the one hand, the timing of prophylaxis was reported to be adequate in 99.8% of the cases of pre-CS antibiotic treatment, but this did not seem to affect SSI prevalence. On the other hand, post-operative antibiotic administration was significantly lower in the post-CS treatment ($p < 0.005$).

3.4. Post-Caesarean Section IV Antibiotic Prescribing Patterns by Facility

Among the 838 women who underwent CS surgery, 812 women (812/838), representing 96.9% of all the women involved in this study, received post-caesarean section intravenous (IV) antibiotics and the majority of them received them for less than 7 days, 396/838 (47.3%). Overall, the X-pen, gentamicin, and metronidazole combination therapy was a highly prescribed antibiotic combination at both facilities, 555/838 (66.2%), followed by ceftriaxone, 166/838 (19.8%), the majority of which was prescribed at UTH, as indicated in Table 4.

3.5. Post-Caesarean Section Oral Antibiotic Prescribing Patterns by Facility

Among the 838 women who delivered through CS, 744/838 (88.7%) received post-CS oral antibiotics. Three-quarters of all the prescribed oral antibiotics were a combination of amoxicillin and metronidazole, 631/838 (75.3%), and by

Table 4. Post-caesarean section IV antibiotic prescribing patterns.

Factor	Facility		Total (%)	P-value
	UTH n(%)	LMUTH n (%)		
Post-CS IV antibiotics given				
Yes	397 (47.4)	415 (49.5)	812 (96.9)	0.005*
No	20 (2.4)	6 (0.7)	26 (3.1)	
Total			838 (100.0)	
Antibiotics prescribed				
Ceftriaxone	152 (18.1)	14 (1.7)	166 (19.8)	<0.001*
X-pen, gentamicin, and metronidazole	171 (20.4)	384 (45.8)	555 (66.2)	
Cefotaxime	9 (1.1)	0 (0.0)	9 (1.1)	
Ceftriaxone and metronidazole	44 (5.3)	17 (2.0)	61 (7.3)	
Metronidazole	8 (1.0)	0 (0.0)	8 (1.0)	
Cefuroxime	10 (1.2)	0 (0.0)	10 (1.2)	
Gentamicin	1 (0.1)	0 (0.0)	1 (0.1)	
Metronidazole and cefuroxime	1 (0.1)	0 (0.0)	1 (0.1)	
Gentamicin, metronidazole, and cefuroxime	1 (0.1)	0 (0.0)	1 (0.1)	
N/A (Antibiotics not prescribed)	20 (2.4)	6 (0.7)	26 (3.1)	
Total			838 (100.0)	
Duration of IV antibiotic treatment				
<7 days	187 (22.3)	209 (24.9)	396 (47.3)	<0.001*
8 - 15 days	179 (21.4)	199 (23.7)	378 (45.1)	
16 - 22 days	31 (3.7)	7 (0.8)	38 (4.5)	
None (never received IV Antibiotics)	20 (2.4)	6 (0.7)	26 (3.1)	
Total			838 (100.0)	

facility, they were the most prescribed oral antibiotic combination as shown in Table 5.

4. Discussion

The rate of CS delivery is constantly growing due to both justifiable and non-justifiable medical and nonmedical reasons [22] [23]. Several notable advancements have been achieved in surgery including refinement of infection control measures such as improvement of surgical techniques, barrier nursing, and antimicrobial prophylaxis. Despite these positive scores, SSIs continue to be a major cause of maternal morbidity and prolonged hospital stay [24] [25]. Reports have shown that women who delivered via CS were 5 to 20 times more likely to get infected than women who have had a vaginal delivery, and regular use of antibiotics in women who deliver through CS reduces the risk of infection [26].

Caesarean section (CS) post-operative infections may be caused by bacteria such as *Staphylococcus epidermis*, *Staphylococcus aureus* Group B *streptococci*, or *Enterococcus* species. The WHO has also recommended routine prophylactic antibiotics for women undergoing elective and emergency CS delivery. In the current study, it was found that up to 99.6% of women who underwent CS

Table 5. Post-caesarean section oral antibiotic prescribing patterns.

Factor	Facility		Total percent	P-value
	UTH n (%)	LMUTH n (%)		
Post-CS Oral antibiotics given				
Yes	339 (40.4)	405 (48.3)	744 (88.7)	<0.001*
No	78 (9.3)	16 (1.9)	94 (11.2)	
Total			838 (100)	
Antibiotics prescribed				
Ceftriaxone	13 (1.6)	2 (0.2)	15 (1.8)	
Cefuroxime	10 (1.2)	1 (0.1)	11 (1.3)	
Amoxicillin and metronidazole	259 (30.9)	372 (44.4)	631 (75.3)	
Metronidazole	9 (1.1)	6 (0.7)	15 (1.8)	
Ceftriaxone and metronidazole	19 (2.3)	2 (0.2)	21 (2.5)	
Ciprofloxacin and doxycycline	1 (0.1)	0 (0.0)	1 (0.1)	
Benzylpenicillin (Xpen) & gentamicin	3 (0.4)	0 (0.0)	3 (0.4)	
Amoxicillin	4 (0.5)	1 (0.1)	5 (0.6)	
Xpen, gentamicin, and ceftriaxone	10 (1.2)	2 (0.2)	12 (1.4)	
Cefuroxime and clotrimazole	2 (0.2)	0 (0.0)	2 (0.2)	<0.001*
Metronidazole and gentamicin	2 (0.2)	0 (0.0)	2 (0.2)	
Erythromycin and metronidazole	1 (0.1)	0 (0.0)	1 (0.1)	
Xpen, gentamicin, and Amoxicillin	2 (0.2)	0 (0.0)	2 (0.2)	
Metronidazole & Cefuroxime	2 (0.2)	0 (0.0)	2 (0.2)	
Cefuroxime & Erythromycin	1 (0.1)	0 (0.0)	1 (0.1)	
Sulfamethoxazole-trimethoprim	1 (0.1)	11 (1.3)	12 (1.4)	
Cefuroxime and Amoxicillin	0 (0.0)	1 (0.1)	1 (0.1)	
Cephalexin and metronidazole	0 (0.0)	3 (0.4)	3 (0.4)	
Cefotaxime and metronidazole	0 (0.0)	4 (0.5)	4 (0.5)	
N/A (no antibiotics were given)	78 (9.3)	16 (1.9)	94 (11.2)	
Total			**838 (100.0)**	

On the one hand, the timing of prophylaxis was reported to be adequate in 96.9% of the cases in the post-CS treatment, but this did not seem to affect SSI prevalence. On the other hand, postoperative oral antibiotic administration was significantly lower in the post-CS treatment ($p < 0.001$).

delivery were prescribed antibiotics in line with the WHO recommendation. According to the WHO, cephalosporins are the first line of antibiotic treatment prescribed for CS patients, and then penicillins [27].

In the current study, it was noted that the majority of women who delivered through CS were in the age group between 21 and 25 years and above, which was in agreement with several similar studies [12] [28] [29] [30]. In our study, the most commonly prescribed antibiotics were the combination of benzylpenicillin, gentamicin and metronidazole or cefotaxime. This is in agreement with another study [29] and corroborates the WHO guidelines [27].

Our study demonstrated that 56% of women who underwent CS delivery were from low-cost residential areas, similar to other studies [12] [28] [31]. It was also determined that all the patients who had CS delivery received perioperative anti-

biotic prophylaxis and anaesthetic. Antibiotics are very important both before and after skin incisions to prevent skin and SSIs. A similar study also showed that administering antibiotic prophylaxis before skin incision compared with after cord clamping significantly reduced the incidence of maternal infection [7] [32].

This study found a 6.0% prevalence of SSIs. This was in line with earlier findings from Egypt (5.3%) [33], Ankara (6.2%) [34], Pennsylvania (6.5%) [34], and SSA (7.3%) [35]. Conversely, the prevalence of SSIs found in our study was lower than what was found in similar studies with a prevalence of 10.9% in Tanzania [36], 11% in Ethiopia [37], 16.2% in Nigeria [38], 12.6% in Nepal [39] and 24.3% in Pakistan [40]. These results are not consistent with another study [41] which found that 7.5% of the CS deliveries had SSIs. This is presumably due to the long duration of prophylaxis [41].

Some other studies have indicated that emergency CS deliveries have been linked to SSIs, due to highly urgent operations with fewer concerns about sterility and the absence of prophylactic antibiotics administered on time [31] [42] [43] [44]. This is similar to what was found in our study, in which we demonstrated a greater association between elective CS delivery and no surgical site infections as compared with emergency CS deliveries. This was in agreement with what has been previously reported by other studies which indicate that elective CS delivery provides enough time for the initiation of prophylactic antibiotic therapy as well as ensures a sterile environment in which the operation is conducted and has shown to have a protective effect against developing SSIs [2] [29] [43]. Surgical site infections are the most frequent health-acquired infection (HAI) in Sub-Saharan Africa [45] [46]. Compared to elective cases, emergency CS is associated with a higher incidence of SSI (25.2%) versus (7.6%) [47].

Surgical site infections (SSIs) complicate up to 15% of all CS deliveries [48]. These infections are associated with significant morbidity and they also increase the financial burden of new mothers, their families, and the nation as a whole due to antibiotics that are prescribed for both prophylaxis and treatment, as well as prolonged hospital stays [30] [45]. Gentilotti and colleagues showed that SSI prevalence was 17% post-operation [42]. However, our study found a lower prevalence of SSIs, and this could be due to frequent use of prophylactic antibiotics before skin incision, as shown in our results in which almost every woman took an antibiotic before CS surgery.

This study shows a high level of antibiotic prescription for women among physicians and a lack of understanding, especially regarding the use of third-generation cephalosporins. High levels of antibiotics prescribed to women undergoing CS delivery indicate that antibiotics are prescribed for prophylactic purposes. The prophylactic use of antibiotics during vaginal deliveries in the study setting is not well understood by most physicians [28].

Furthermore, irrational use of antibiotics has been identified as one of the factors contributing to the emergence of antimicrobial resistance and, as such,

this would negatively impact both treatment and prophylaxis [20] [49]. The surgical site infection prevalence was found to be 6.0% among the women who underwent CS deliveries. Most of the women were given IV antibiotic treatment, which was similar to the reports of other studies noting that for operations lasting four hours or less, one antibiotic dose is usually sufficient. In a prolonged delivery of greater than four hours, a further antibiotic dose may be required to maintain the concentration, particularly if the antibiotic has a short half-life [29]. The prescribed antibiotic should be provided in an adequate dose based on a patient's body weight, adjusted dosing weight, or body mass index. The administration should be repeated intra-operatively if an operation is still in progress 2 half-lives after the first dose, to ensure adequate antimicrobial levels until wound closure. More studies should be conducted to identify the reasons for the differences. Therefore, it is recommended that physicians observe proper pre- and postoperative antibiotic prophylaxis and reduce the difference in antibiotic selection according to the guidelines.

The provision of peripheral prophylactic antibiotics for CS delivery is more effective in preventing infection in the surgical area. As explained in a study by Sway *et al*. (2019), a group taking antibiotics had a higher rate of postoperative infection (9.3%). They argued that the administration of immune antibiotics was the main reason for the decline in infection rates and that the data provided strong evidence that many infectious diseases found in the study population were treated with antibiotics before surgery (*i.e.* [6]). The use of antibiotic prophylaxis was reduced [6]. However, in this study, there were combinations of benzylpenicillin, gentamicin, and metronidazole, as well as ceftriaxone, or ceftriaxone, and metronidazole and more than one antibiotic class, including amoxicillin and metronidazole [7] [50], demonstrating the effectiveness of the combination of cephalexin and oral metronidazole after delivery in reducing the risk of infection in the surgical field, followed by the administration of standard preoperative prophylactic antibiotics. Subsequently, it is critical to be cautious and watchful when using antibiotics to prevent the development of antimicrobial resistance (AMR) [51] [52] [53] [54]. Additionally, prescribers should ensure that they adhere to the local, national, and international antibiotic prescribing guidelines that promote the rational use of antibiotics and antimicrobial stewardship [55] [56] [57] [58] [59] [60].

The limitation of this study was that it omitted some variables related to laboratory testing, body mass index (BMI), the main causes of surgical site infections, and service-related factors because the study was conducted using chart reviews. In addition, it did not evaluate the quality of health care, which can be useful for mothers with SSIs after CS delivery. Although we have taken appropriate measures to minimize misclassification, secondary data can lead to the misclassification of study participants. In addition, this study did not check the status of control groups who did not visit the respective hospitals for follow-up care. However, post-release surveillance is essential to address these groups. Rec-

ommended antibiotics in combination with cefotaxime, metronidazole, and gentamicin are effective in patients who are hospitalized and discharged within 3 days. Regular educational interventions are needed to improve physician prescribing practices at different levels, which may further promote the rational use of antibiotics.

5. Conclusion

In conclusion, our study revealed that third-generation cephalosporin (cefotaxime) and triple combination therapy (benzylpenicillin, gentamicin, and metronidazole) were the most frequently prescribed antibiotics for both pre-and post-operative treatments. There was a lower rate of surgical site infection found in our study which could have been attributed to the prescribed antibiotics before and after CS deliveries. There is a need for continued professional education on the rational prescribing of antibiotics among prescribers.

Author Contributions

Conceptualization, M.K. (Maisa Kasanga) and S.M.; methodology, M.K. (Maisa Kasanga)., S.M., M.C., and J.W.; analysis, M.K. (Maisa Kasanga)., R.M., and M.C. investigation, M.K. (Maisa Kasanga), J.W., and M.K. (Maika Kasanga); resources, M.K. (Maisa Kasanga) and M.K. (Maika Kasanga); writing—original draft preparation, M.K. (Maisa Kasanga); writing—review and editing M.K. (Maisa Kasanga), M.C., J.W., M.K. (Maika Kasanga) V.D., T.M., and S.M.; supervision, J.W., M.C., and S.M.; project administration, J.W. and M.K. (Maisa Kasanga). All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study was approved by the University of Zambia Biomedical Ethics Committee (UNZABREC), Federal Assurance #00000338, Protocol #975-2020.

Data Availability Statement

The datasets used during the current study are available from the corresponding

author on rational request.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendix

Data collection checklist

This checklist indicates the variables that will be collected from the medical files and charts of women who underwent C-sections.

No.	Variables
1.	Patients' age A. 15 - 20 years B. 21 - 25 years C. 26 - 30 years
2.	Level of Education A. Primary B. Secondary C. Tertiary D. Other
3.	Residential Area…… Marital status A. Single B. Married C. Divorced
4.	Were antibiotics prescribed? A. Yes B. No
5.	What antibiotics were prescribed?.....
6.	What peri-operative antibiotics were prescribed?.....
7.	What prophylactic antibiotics were given?.....
8.	What antibiotics were given on the operating table?.....
9.	What antibiotics were given in the anaesthetic room?.....
10.	What antibiotics were given before skin incision?.....
11.	Were post-operative IV antibiotics given? _____ which ones? A. Yes B. No
12.	What was the duration of postoperative IV? A. Yes B. No
13.	Were oral post-antibiotics given? If yes, which ones? A. Yes B. No
14.	Were Surgical site infections experienced? If yes, what type of infection? A. Yes B. No
15.	Length of hospital stay A. Less than 7 days B. 8 to 15 days C. 16 to 22 days D. More than 22 days
16.	What type of caesarean section was conducted? Elective or emergency? A. Elective B. Emergency