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The Prevalence and The Association of Antibiotic Practices with Surgical Site Infections Following Cesarean Section

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ABSTRACT

Background: The global Cesarean section (CS) rate is currently at 21%, higher than the recommended 15%, leading to an increased risk of surgical site infection (SSIs). In Uganda, the burden of SSIs stands at 15.5%. A burden to the economy and patients, despite being preventable through proper antibiotic use. This study aims to establish the prevalence of SSIs and evaluate the antibiotic practices following CS at Mbale Regional Referral Hospital (MRRH).
Methods: The design was retrospective cross-sectional. Randomly selected without replacement an equal numbers of patient files that developed SSIs (104) and an equal number of patient files that did not develop SSIs (104) making a sample size of 208 files out of the 2432 files reviewed at MRRH from 1st –January -2020 to 31st -December-2022.
Result: The prevalence of SSIs was 4.3%. Of the 208 operated women 71.2% received antibiotic prophylaxis, with intravenous (IV) ceftriaxone being the most prescribed (47.1%). Only 14.9% received prophylaxis within the recommended 30-60 minutes before incision. Factors significantly associated with reduced SSIs risk were the timing of antibiotic prophylaxis, 3days of hospital stay, and the cadre of the surgeon.
Conclusion : The Prevalence of SSIs at MRRH was 4.3%. Antibiotic prophylaxis administration within 30-60 minutes before skin incision, use of IV ceftriaxone and metronidazole post-CS, at least 3 days. The study emphasizes the importance of following guidelines and acquiring knowledge on appropriate antibiotic use to combat SSIs following CS and antibiotic resistance.

Keywords: Antibiotics ; surgical site infections (SSIs); cesarean section.

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Introduction

Cesarean section (CS) is a surgical procedure performed to deliver a baby and other uterine products to prevent or address life-threatening complications.[1,2] The global CS rate increased to 21% in 2015, surpassing the recommended rate of 15%. CS is considered a clean-contaminated surgery with a higher risk of sepsis compared to vaginal delivery.[3,4] Surgical site infections (SSIs) can occur within one month after cesarean without the use of an implant or within one year with implant use.[5] Maternal mortality rates and post-CS complications are particularly high in Sub-Saharan Africa, with African women being 50 times more likely to die after CS compared to those in high-income continents.[6]

SSIs are primarily caused by bacteria that enter the operation site during or after the surgery, leading to an immune response within 5 to 7 days.[7] Strict infection control protocols and appropriate antibiotic use can prevent and treat SSIs. [8,9]

Certain factors increase the risk of SSIs following CS, including emergency CS, antibiotic prophylaxis, the expertise of surgeons, and blood loss exceeding 1000 ml. [12-14] However, there is limited research on SSIs following CS in Uganda, with an unknown rate of occurrence. Antibiotic resistance is a global concern, with resistant bacteria causing significant mortality and increased treatment costs. Inappropriate antibiotic practices contribute to the development of resistance.[15,16]

The study aims to investigate the association between pre and postoperative antibiotic practices and other factors with the development of SSIs following CS at Mbale Regional Referral Hospital in Eastern Uganda. The research will contribute to understanding the effectiveness of antibiotic usage in preventing SSIs and improving patient outcomes in this setting.

Mbale Regional Referral Hospital (MRRH) in Eastern Uganda serves multiple districts and provides specialized obstetrics and gynecology services. Despite efforts to address challenges such as delayed supplies and a high patient-to-healthcare worker ratio, the hospital continues to face re-admissions of women due to surgical site infections (SSIs) following Cesarean sections (CS). In response, this study assessed pre- and post-cesarean antibiotic practices and their association with SSIs at MRRH, aiming to identify strategies to improve surgical outcomes and enhance maternal care in the region.

Methods

It was a retrospective cross-sectional study conducted on women who were delivered by CS between 1st-January-2020 and 31st-December-2022 at MRRH.Mbale Regional Referral Hospital (MRRH). It is an approximately 650-bed serving more than six districts of Uganda. Using Kish and Leslie, and adjusting for 10% for the incompleteness of Data; N=208 files of patients who met the inclusion were reviewed.

Out of the 2432 women that underwent cesarean section reviewed, an equal number (104) of women who developed surgical site infection (SSIs) and those that did not develop SSIs (104) were selected by simple random sampling without replacement to make a total sample size of 208 participants). For this study SSIs was defined by a diagnostic code "infection of the surgical site, or sepsis or wound infection as stated in the patient file by the doctor.

All women's files that delivered by cesarean section and those that developed surgical site infections (SSIs) within 30 days post-cesarean between 1st-January-2020 to 31st-December-2022 at Mbale Regional Referral Hospital (MRRH).

Women's files who delivered by cesarean and were referred. Women's files operated elsewhere and were managed for SSIs at MRRH and women's files with missing operation notes and incomplete data about the study variables.

The dependent variable (primary outcome) was surgical site infection following cesarean section. The independent variables included the following:

1. Pre-cesarean antibiotic practice (Prophylaxis administration, the antibiotic type, and duration of administration).
2. Post-cesarean antibiotic practices (I.V antibiotic type administered, oral antibiotic, and duration of hospital stay).

3. Other factors (age, cadre of the surgeon, amount of blood loss, type of CS, parity of the woman, indication for CS.

An independent obstetrician, not part of the research team checked the empty and completed data collection sheets.

In this study, the chi-squared test was used to determine to analyze the association between the dependent variable and independent variables. Variables with a *p-value: ≤ 0.025* for the bivariate were analyzed for the independence of association with SSIs using the multivariate logistic regression at *p-value: ≤ 0.05* and a two-tailed test was reported.

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) Version 23.

Result

Prevalence of SSIs following CS at MRRH

Out of 2432 files of women that underwent cesarean section that were retrieved and reviewed, 104 of the women had developed surgical site infections.

$$\textbf{Prevalence} = \frac{\text{women who developed SSIs} \times 100}{\text{Total women who underwent CS}}$$

Prevalence = 104/2432 × 100= **4.3%.**

The prevalence of SSIs was **4.3%**

Pre-cesarean antibiotic practices

During the Bivariate logistic regression: only reception of antibiotic prophylaxis by the women before skin incision was not associated with the development of surgical site infection at *p-value: 0.878.*

During the multivariate logistic regression: Type of antibiotic prophylaxis; administration of I.V ceftriaxone antibiotic prophylaxis was protective against SSIs (AOR=0.645, 95% CI: 0.301-1.379). Women who received I.V ampicillin were 2.630 times more at risk for SSIs than those that received I.V metronidazole (AOR=2.073, 95% CI:0.469-9.172) who were also at risk. However, the association was not statistically significant (*p-value: 0.258*)

Women who received prophylactic antibiotics 30-60 minutes before skin incision were protected against SSIs (AOR=0.103, 95% CI: 0.022-0.474) as compared to those that received antibiotic prophylaxis within 1-14 minutes and 15-29 minutes. This relationship was statistically significant (*p-value: 0.004*).

Post-cesarean antibiotic practice

All the variables under this category were statistically significant for the Bivariate chi-square test. During the Multivariate logistic regression: Intravenous administration of ceftriaxone & metronidazole was protective against the development of SSIs (AOR=0.188, 95% CI: 0.037-0.966) amongst women as compared to administration of I.V ampicillin & metronidazole. This relationship was statistically significant (*p-value: 0.045*).

Women who received oral cefixime (AOR=0.188, 95% CI: 0.037-0.966), oral amoxicillin (AOR=0.183, 95% C.I: 0.064-0.528), and oral Gramocef (AOR=0.161, 95% CI: 0.042-0.615) were protected against surgical site infection as compared to those that received oral metronidazole and ampiclox. These associations were all statistically significant at *p-value: 0.009.*

Hospital stay for three or more days (≥ 3 days) was protective against SSIs (AOR=0.194, 95% CI: 0.090-0.420) as compared to staying less than three (< 3 days) and this relationship was significant at *p.value:0.000*

Other factors

During the bivariate chi-squared test, the type of cesarean section (CS), age of the women, parity, and indication for CS was not associated with SSIs with *p-values > 0.05.*

During the multivariate logistic regression analysis: Women who were operated on by medical officers were more protected against SSIs (AOR=0.040, 95% CI: 0.004-0.376) than those who were operated on by junior house officers (interns) (AOR=0.119, 95% CI: 0.049-0.289) and both associations were statistically significant at *p-values 0.005* and *0.000* respectively.

Women whose estimated blood loss was more than 1000mls (>1000) were 2.468 times more at risk for surgical site infection than those

whose estimated blood loss was less or equal to 1000mls (≤ 1000). However, this relationship was not significant at *p-value: 0.070*.

Discussion

Prevalence of surgical site infections

The prevalence of SSIs after CS was found to be 4.3% at the Mbale regional referral hospital, which was lower than rates reported in studies from West Africa and Tanzania (9-13%) but higher than rates reported in studies from Ethiopia and Uganda (8.9% and 15.5% respectively).[17,5,1] Similar prevalence rates of 4.9% were reported in a study conducted in Rwanda using a similar study design.[18] However, higher than a study in Kuwait and Peruvian hospitals reported prevalence rates of 2.1% and 2.4% respectively.[19,20] The variations in prevalence rates could be attributed to various factors such as study design, source population, demographic differences, geographical location, access to healthcare facilities, surveillance and reporting practices, healthcare interventions, and the presence or absence of other risk factors.

It is important to note that the study had limitations due to time constraints and limited resources, which may have affected the sample size and study design. Most studies with different prevalence rates had larger sample sizes and used prospective methods[21,3] whereas the current study relied on a retrospective cross-sectional design. Despite advancements in surgical care, the prevalence of SSIs after CS remains a concern, highlighting the need for further research and interventions to improve patient safety and surgical outcomes.

Pre-cesarean antibiotic practices

Antibiotic prophylaxis is a vital measure for preventing surgical site infections (SSIs) during surgeries, particularly cesarean sections (CS).[22] Studies have shown that administering prophylactic antibiotics in the recommended timing range of 30-60 minutes before the operation significantly reduces the risk of SSIs in women undergoing CS.[23] However, there are conflicting findings regarding the statistical significance of antibiotic prophylaxis timing and its relationship to SSIs.[24] Some studies have reported no significant correlation between timing and infection rates.[25]

International and national guidelines generally recommend the 30-60 minute timing for antibiotic prophylaxis before skin incision. The World Health Organization (WHO) and Uganda Clinical guidelines both recommend this timing range.[26-28] Canada suggests administering a single dose of intravenous cephalosporin, preferably first generation, within 15-60 minutes before the surgery. However, it is important to note that administering prophylactic antibiotics too far in advance, such as two hours before surgery, may increase the risk of SSIs.

Antibiotic prophylaxis aims to minimize the introduction of bacteria during or after the operation, allowing the body's immune system to effectively clear any potential invasion. Adequate whole-body concentrations of antibiotics are crucial for the prophylactic treatment to be effective.[19] Variations in the statistical significance of antibiotic prophylaxis timing and its impact on SSIs across studies may be attributed to differences in sample sizes. Further research is needed to better understand the relationship between timing and the effectiveness of prophylactic antibiotics in preventing SSIs during cesarean sections.

Post-cesarean antibiotic practices

Surgical site infections (SSIs) following cesarean section pose significant risks to maternal health and have economic implications. Among the known bacterial species causing SSIs, *S. aureus, P. aeruginosa*, and *E. coli* are the most common.[29] A study highlighted that post-cesarean intravenous administration of antibiotics was an independent factor contributing to the development of SSIs. However, the use of ceftriaxone and metronidazole as intravenous antibiotics showed a significant protective effect against SSIs (AOR=0.188, 95% CI: 0.037-0.966). Similar results were observed in an Indian study and a study conducted in Uganda, where the administration of ceftriaxone and metronidazole post-operatively reduced SSIs by 100%.

Ceftriaxone and metronidazole are broad-spectrum antibiotics effective against methicillin-resistant *S. aureus*, aerobes, and anaerobes, which are commonly associated with SSIs after cesarean section. [6] These drugs exhibit low resistance rates and be effective in preventing SSIs.[30,31] However, it should be noted that their common usage in Uganda may contribute to antibiotic resistance.[32] Another study in Uganda showed no association between ceftriaxone and metronidazole with SSIs, while metronidazole and ampicillin were found to be associated. [33]

The surgical bundle recommendation at Mbarara regional referral hospital supports the use of post-operative intravenous ceftriaxone and metronidazole for a minimum of three days to prevent SSIs following cesarean section.[5,30]

Despite some contradictory findings, existing evidence and practical experience support the use of intravenous ceftriaxone and metronidazole as preferred antibiotics for preventing SSIs after cesarean section. However, the World Health Organization (WHO) guidelines discourage the continued use of post-operative intravenous antibiotics beyond an appropriate single dose or 24 hours after fever resolution in susceptible women.[27] Nonetheless, the findings of the study align with the prevailing evidence, emphasizing the importance of ceftriaxone and metronidazole in preventing SSIs following cesarean section.

Duration of hospital stay

The duration of hospital stay for surgical patients varies depending on their post-operative condition. The length of stay is important for monitoring vital signs and identifying complications. However, both too short and too-long stays can be associated with postoperative complications.[34] In a study on cesarean-section patients, it was found that staying in the hospital for three or more days significantly reduced the risk of surgical site infections (SSIs) compared to stays of less than three days. This is likely due to the incomplete administration of intravenous antibiotics when the stay is shorter. Another study from Norway also supported these findings.[35]

However, a different study reported that staying in the hospital for four days or longer was associated with the development of SSIs. Prolonged hospital stays have been linked to financial burdens, increased risk of nosocomial infections, and poor post-surgical outcomes.[1,36]

On the other hand, a study found no relationship between pre- and post-cesarean hospital stays and SSIs.[37] There is a debate about whether the duration of hospitalization influences the development of SSIs or if SSIs affect the length of stay.[38]

Implementing evidence-based strategies, such as infection prevention and control measures, and appropriate antibiotic practices can prevent more than half of surgical site infections. A hospital stay of three days allows for the completion of recommended post-cesarean intravenous antibiotic medication. Stays shorter or longer than three days may pose risks to postoperative patients.

Others factors

The Ministry of Health of Uganda has a strict policy that only medical professionals with a Bachelor of Medicine and Bachelor of Surgery (MBChB) degree are allowed to perform surgeries on patients. These professionals are required to complete a one-year hands-on internship at a regional or district health centre to obtain a practicing license.[36] This group of surgeons constitutes the largest authorized body of surgeons in Uganda.

A study examined the relationship between the cadre of the surgeon and surgical site infections (SSIs) following cesarean sections. It found that being operated on by a medical officer had a more protective effect against SSIs compared to being operated on by a junior house officer (intern).[36] Another study from Tanzania reported that women operated on by interns were four times more at risk for SSIs compared to those operated on by medical officers. Similarly, a study from Nigeria also showed an association between the cadre of the surgeon and SSIs.

However, despite these findings, interns are preferred by patients due to their eagerness to learn and help. A study conducted in Uganda by Lubega contradicted these findings, as it found

no association between the cadre of the surgeon and the development of SSIs, although it compared surgeons and senior house officers. The difference in the protective effect of medical officers against SSIs could be attributed to their higher level of experience and better aseptic techniques in performing cesarean sections, which reduce the incidence of SSIs as compared to interns.

Conclusions

A study conducted at Mbale Regional Referral Hospital in Uganda found that the prevalence of surgical site infections (SSIs) after cesarean sections was 4.3%. The study identified several factors that were protectively associated with SSIs, including the timing of antibiotic prophylaxis within 30-60 minutes before skin incision, administration of post-cesarean I.V ceftriaxone and metronidazole, use of oral cefixime post-discharge, three days duration of hospital stay, and being operated on by medical officer surgeon.

SSIs can result in prolonged hospital stays, increased treatment costs, and higher rates of morbidity and mortality. Therefore, it is crucial to address these risk factors and implement preventive measures such as optimizing antibiotic usage and ensuring proper hygiene protocols to reduce the occurrence of SSIs after cesarean sections, ultimately improving patient outcomes and reducing healthcare burdens.

The study recommends emphasizing antibiotic prophylaxis within 30-60 minutes before surgery and a post-cesarean hospital stay of 3 days, use of I.V. ceftriaxone and metronidazole. Healthcare professionals should adhere to institutional surgical bundles and guidelines, receive training on infection prevention, control, and appropriate antibiotic use, and future research should explore this topic using a prospective design for better understanding and generalization

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