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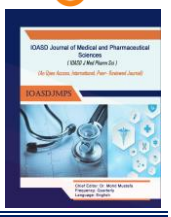

Reduce Maternal Mortality: Prevent Surgical Site Infections

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ABSTRACT

Cesarean delivery is defined as a surgical procedure in which a baby is delivered through incisions made in the mother's abdominal wall and uterus. When medically indicated, cesarean section plays a significant role in preventing severe complications, including obstetric fistula and birth asphyxia, thereby safeguarding the lives of both mother and child. Surgical site infections (SSIs) significantly contribute to increased healthcare costs, morbidity, and mortality associated with surgical procedures and remain a persistent global public health challenge. A study conducted in three hospitals in Cameroon reported a surgical site infection (SSI) prevalence of 9.2% among postoperative patients, with superficial infections being the most common type. A study conducted by Korol et al. (2013) identified several factors linked to an increased risk of surgical site infections (SSIs), including the presence of comorbid conditions, older age, higher surgical risk scores, patient frailty, complex surgical procedures, and diabetes. In addition, prolonged duration of surgery was shown to significantly elevate the likelihood of developing an SSI. In a bid to prevent surgical site infection in delivered mothers, a study was conducted to investigate factors influencing the incidence of SSI. The study revealed that personal hygiene of patient, duration of surgical procedure, frequent movement of visitor, poor hygiene of ward (irregularity of general cleaning), delayed detection of infections and inconsistencies in routine cleaning practices contributed to the occurrence of surgical site infections.

Key words: Surgical site infection, delivery, mothers, cesarean.

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1. INTRODUCTION

Cesarean delivery, also referred to as cesarean section, is a surgical procedure in which a baby is delivered through incisions made in the mother's abdominal wall and uterus [1]. This procedure is recommended in situations such as antepartum hemorrhage or fetal distress, where continuing with vaginal delivery may pose serious risks to the mother or fetus. In such cases, cesarean delivery becomes essential to reduce maternal and neonatal morbidity and mortality [2]. When medically indicated, cesarean section plays a significant role in preventing severe complications, including obstetric fistula and birth asphyxia, thereby safeguarding the lives of both mother and child [3].

However, despite its life-saving benefits, cesarean delivery carries potential risks. These may include postoperative infections, excessive bleeding, uterine rupture, and complications related to abnormal placental attachment in both current and subsequent pregnancies [3,4].

Surgical site infection (SSI) is one of the common complications following surgical procedures. It is defined as an infection occurring within 30 days after an operation [5]. SSIs can negatively impact patient recovery, prolong hospital stay, and increase healthcare costs [6]. These infections usually develop at or near the surgical incision and may present with signs such as warmth, redness, pain, and swelling. The Centers for

Disease Control and Prevention (CDC) classifies SSIs into three categories: superficial incisional infections, which involve only the skin and subcutaneous tissue; deep incisional infections, which affect deeper soft tissues; and organ/space infections, which involve any internal part of the body that was opened or manipulated during surgery, excluding the incision layers [5].

Surgical site infections (SSIs) significantly contribute to increased healthcare costs, morbidity, and mortality associated with surgical procedures and remain a persistent global public health challenge [7]. Even with advances in surgical practices and the routine use of prophylactic antibiotics, SSIs continue to be among the most frequently reported postoperative complications [8]. The clinical and socioeconomic impact of SSIs is considerable, as they often lead to hospital readmissions, repeated surgical interventions, prolonged treatment, long-term disability, and substantial patient suffering. Individuals who develop SSIs have a higher likelihood of requiring intensive care unit (ICU) admission and face an increased risk of mortality compared to patients without such infections. Additionally, SSIs are commonly associated with factors such as advanced age, extended hospital stays, blood transfusions, and emergency surgical procedures [9,10].

A study conducted in three hospitals in Cameroon reported a surgical site infection (SSI) prevalence of 9.2% among postoperative patients, with superficial infections being the most common type [11]. Similarly, research conducted at Nnamdi University Teaching Hospital, Nigeria, found an SSI prevalence of fifteen percent among surgical patients [12]. In Rwanda, findings from a 2015 study in teaching hospital among women who underwent cesarean section showed an SSI prevalence of 4.9%; [13]. however, when infections occurring after discharge were considered, the prevalence increased to nearly 11% [14].

Across Sub-Saharan Africa, hospital-based studies indicate that SSI prevalence varies widely, ranging from 6.8% to 26%. Considerable variation has been observed by surgical specialty, with higher infection rates reported in general and visceral surgery (19.1%), followed by orthopedics (14.8%) and obstetrics, and gynecology (8.6%) [15].

According to findings reported by the World Health Organization (WHO), surgical site infections (SSIs) are more prevalent in low- and middle-income countries, particularly in sub-Saharan Africa, compared to high-income nations. Evidence from studies conducted in Algeria and Tanzania in 2011 showed that the incidence of SSIs among surgical patients was 11.9% and 19.4%, respectively. Additionally, another study carried out in Tanzania revealed that 35.6% of 118 patients who underwent surgical procedures developed postoperative surgical site infections [11]. In Nigeria, the incidence of SSIs was 13% in 2012 at a tertiary hospital [16,12]. The prevalence of SSI was 2.5% among patients who underwent orthopedic surgery at King Fahd Hospital of a University in Saudi Arabia [17].

A study conducted by Korol et al. (2013) identified several factors linked to an increased risk of surgical site infections (SSIs), including the presence of comorbid conditions, older age, higher surgical risk scores, patient frailty, complex surgical procedures, and diabetes. In addition, prolonged duration of surgery was shown to significantly elevate the likelihood of developing an SSI [18].

Most determinants contributing to SSIs are preventable or can be addressed through appropriate interventions. For instance, inadequate waste management and poor environmental hygiene practices may compromise adherence to standard precautions. Strengthening infection prevention measures and developing context-specific clinical guidelines for various procedures are feasible strategies that health facilities can implement to reduce infection rates [19].

Furthermore, patient-related factors such as advanced maternal age, elevated body mass index (BMI), and the presence of underlying maternal medical conditions may also increase the risk of SSIs [20].

The best prevention measures of SSI include the use of prophylactic antibiotics, which are typically given 30 to 60 minutes before a surgery to allow the medication to reach therapeutic levels in the tissue by the time of the first incision. [21] Prophylactic antibiotics should be selected based on the expected pathogens associated with the specific surgical procedure and should generally be narrow in spectrum. For clean and clean-contaminated surgeries, coverage against *Staphylococcus* species is essential. Commonly used agents include cefazolin, or vancomycin in combination with metronidazole, as well as alternatives such as cefoxitin or ertapenem. In contrast, patients undergoing contaminated or dirty-infected procedures typically do not require prophylactic antibiotics because they are usually already receiving therapeutic antimicrobial treatment [22].

Prior to surgery, the incision site is routinely prepared using antiseptic agents, a process that is considered more effective when alcohol is included [23]. Alcohol has rapid bactericidal properties and, when combined with other antiseptic solutions, provides both immediate and sustained antimicrobial activity [24]. Commonly used preparations include chlorhexidine-alcohol and iodine-alcohol formulations, although ongoing studies continue to evaluate their relative effectiveness. While preoperative antiseptic bathing or showering may be advised in some cases, current evidence supporting its role in reducing surgical site infections (SSIs) remains limited [23]. In addition to skin preparation, members of the surgical team perform antiseptic hand and forearm scrubs before procedures.

This process typically lasts between two and five minutes, depending on the type of surgery and institutional protocols [24].

Throughout the surgical procedure, strict adherence to aseptic and sterile techniques is essential to minimize the risk of SSIs. Operating rooms are maintained under controlled conditions, including regulated air quality and temperature, routine surface disinfection, and the use of sterilized instruments and drapes. The practice of double-gloving has been shown to further reduce the likelihood of contamination. Maintaining sterility is critical, and in the event of glove perforation or contamination, surgical staff must promptly change gloves and, if necessary, repeat hand antisepsis [24].

Patient education plays a central role in preventing surgical site infections. Healthcare providers should assess patients for risk factors associated with SSIs, particularly those that can be modified prior to surgery. Factors such as obesity, smoking, and poor glycemic control significantly increase infection risk. Patients with elevated body mass index may be encouraged to pursue weight reduction, smokers may be advised to stop smoking, and individuals with diabetes should aim to optimize glycemic control, including achieving appropriate hemoglobin A1c levels, before elective surgery. Implementing these preventive strategies can substantially reduce postoperative infection rates [22].

Education should also extend to postoperative wound care for both patients and caregivers. Surgical dressings are generally recommended to remain in place for at least 48 hours following surgery, during which time the wound should be kept dry. If a dressing becomes loose or saturated, it should be replaced using clean or aseptic techniques while avoiding direct contact with the incision site [25]. Patients and caregivers should be instructed to seek medical attention promptly if signs or symptoms of infection develop. Because patients may have difficulty retaining discharge instructions due to sedative medications, it is essential to involve caregivers during the discharge process to ensure proper wound care and early recognition of potential complications [25].

As surgical site infections (SSIs) remain a significant challenge in healthcare management, it is essential to conduct a thorough and precise assessment of the factors that may increase an individual patient's susceptibility to infection, and identification of the gaps in currently-available prevention options could help to minimize morbidity, mortality and healthcare costs associated with SSI. Regular surveillance of surgical site infections (SSIs) is essential for identifying contributing risk factors and strengthening national prevention strategies. According to the Muhororo Hospital annual report for 2022–2023, a total of 1,048 patients underwent surgical procedures, with an SSI prevalence of 1.14%. However, no previous study has specifically investigated SSIs at this facility. Therefore, this study aims to identify the risk factors associated with surgical site infections among patients who underwent surgery at Muhororo Hospital. The findings are expected to support efforts to reduce postoperative infections and improve the quality of surgical care.

2. METHODS AND MATERIALS

2.1. Study setting and period

The study was caried out from July 2023 to December 2023 in Muhororo Hospital; a governmental hospital.

2.2. Study design

A six months hospital-based prospective cohort follow-up of women who gave birth by cesarean delivery in the six months of the data collection period was conducted.

2.3. Source population

The source population was drawn from women who delivered by cesarean delivery in Muhororo hospital.

2.4. Sample population

The sample population was drawn from women who delivered by cesarean delivery in the six months of data collection period in Muhororo hospital.

2.5. Inclusion criteria

All women who delivered by cesarean delivery and developed surgical site infection were included in the study.

2.6. Exclusion criteria

All women who delivered by cesarean delivery and did not developed surgical site infection were excluded in the study.

2.7. Sampling methods

All cesarean delivery that developed surgical site infection during data collection time were enrolled in the study (convenience sampling method).

2.8. Data collection

2.8.1. Data collection procedure

All mothers who delivered by cesarean delivery and developed surgical site infection during the study period were asked for their willingness to participate in the study. Medical record of those women was reviewed for the presence of surgical site infection risk factors. Each mother was interviewed face to face for the development of surgical site infection syndromes within 42 postoperative days.

2.8.2. Data collection tool

The data collection tool was adapted from a study done in Ethiopia and modified based on the contextual situation. It contains questions that assess

maternal characteristics such as the number of uterus scar; procedural characteristics such as duration of operation and surgical scrub, preoperative characteristics such as preoperative antisepsis, effective sterilization of materials, laundering and prophylactic antibiotics; postoperative characteristics such as delay of dressing and early detection of infection; and environmental characteristics such as personal hygiene of the mother, Total cleaning of rooms, hygiene in wards and frequent movement of visitors.

2.8.3. Data analysis

The collected data were coded, entered, checked, and cleaned by Epi-data and were exported to SPSS for data analysis. Descriptive statistics were used.

2.8.4. Data quality control

Data were collected by infection prevention control committee members in Muhororo hospital. The questionnaire was pretested on similar population; mothers who developed surgical site infection in the period before the study to assure the validity of it and modify accordingly.

2.9. Ethical considerations

Ethical clearance was obtained from the institutional ethic and research committee of Muhororo Hospital. A formal letter from the chairperson of ethic and research committee was written to infection prevention control committee of Muhororo Hospital granting permission to conduct the study. The study participants were assured confidentiality of information. The study participants were informed that they are free to withdraw from the study from any time. The study was conducted in accordance with Helsinki declaration.

3. RESULTS

Table 1: Characteristics of the respondents

Variables	Frequency	%
Period of onset SSI		
< Two weeks	3	60%
> Two weeks	2	40%
Number of uterus scar		
0 Time scar	4	80%
1 Time scar	1	20%
2 Times scar	0	0%
3 Times scar	0	0%
More than 3 times scar	0	0%
Did the patient discharged?		
Yes	5	100%
No	0	0%

The table 1 shows that 60% of the respondents presented onset symptoms of surgical site infection (SSI) before two weeks whereas 40% presented symptoms of infection in a period more than 14 days. Among the study participants, 80% were the first-time undergone cesarean section and 20% were the second time. All study participants (100%) get infected after being discharged from the hospital.

Table 2: Patient exposure

Variables	Frequency	%
Did the patient have communicable diseases?		
Yes	0	0%
No	5	100%
Unknown	0	0%
Immunosuppressive treatment		
Yes	0	0%
No	5	100%
Central Venous Catheter (CVC)		
Yes	1	20%
No	4	80%
Peripheral Venous Catheter (PVC)		
Yes	4	80%
No	1	20%
Mechanically Ventilated		
Yes	0	0%
No	5	100%
Tracheostomy		
Yes	0	0%

Variables	Frequency	%
No	5	100%
Type of surgical wound		
Clean wound	4	80%
Clean contaminated wound	0	0%
Dirty wound	1	20%
Urinary catheter		
Yes	5	100%
No	0	0%
If Yes, specify the type		
Supra public	0	0%
Urethral	5	100%
Condom	0	0%

The table 2 shows that 100% of the study participants were did not have communicable diseases, none of them (0%) were on immunosuppressive treatment. 20% of the studied clients were given intravenous fluids through central venous catheter tube, 80% of the study participants were given intravenous fluids through insertion of peripheral venous catheter tube. None of the study participants (0%) were given oxygen using tracheostomy or mechanical ventilated procedure. 80% of enrolled study participants were admitted with clean wound and 20% were admitted with dirty wound. The study revealed that 100% of enrolled study participants were catheterized by urethral urinary catheter.

Table 3: Health care associated infection

Variables	Frequency	%
Type of SSI		
Superficial incisional	5	100%
Deep incisional	0	0%
Organ or space	0	0%
Catheter-associated urinary tract infection (CAUTI)		
Yes	0	0%
No	5	100%
Central line-associated bloodstream infection (CLABSI)		
Yes	0	0%
No	5	100%
Peripheral line-associated bloodstream infection (PLABSI)		
Yes	0	0%
No	5	100%
Clinical sepsis/Septicemia		
Yes	0	0%
No	5	100%
Other respiratory infection		
Yes	0	0%
No	5	100%
Infected Burns		
Yes	0	0%
No	5	100%
Infected bedsores		
Yes	0	0%
No	5	100%

The table 4 present that 100% of the study participants presented superficial incisional infection, none of them (0%) had deep incisional or organ infection. Except superficial incisional infection; none of the study participants (0%) presented catheter-associated urinary tract infection, central line-associated bloodstream infection, peripheral line-associated bloodstream infection, clinical sepsis/septicemia, infected burns, infected bedsores or any other respiratory infection.

Table 4: Possible source of infection

Variables	Frequency	%
Delay of dressing		
Yes	0	0%
No	5	100%
Poor personal hygiene		
Yes	2	40%
No	3	60%
Poor hand washing		
Yes	0	0%
No	5	100%
Frequent movement of visitors		
Yes	3	60%
No	2	40%
Poor hygiene of ward		
Yes	2	40%
No	3	60%
Poor early detection of infection		
Yes	3	60%
No	2	40%
Poor preoperative antisepsis		
Yes	0	0%
No	5	100%
Poor surgical scrub		
Yes	0	0%
No	5	100%
Poor sterilization technique		
Yes	0	0%
No	5	100%
Poor laundering		
Yes	0	0%
No	5	100%
Poor technique of surgical procedure		
Yes	0	0%
No	5	100%
Duration of surgical procedure		
Yes	1	20%
No	4	80%
Incompliance with prophylactic antibiotics before operation		
Yes	0	0%
No	5	0%
Irregularity of general cleaning		
Yes	2	40%
No	3	60%

The study found that 40% of infection occurred for the study participants were due to poor personal hygiene, 20% were due to abnormal duration of surgical procedure, 60% were due to the frequent movement of visitors, 40% were due to poor hygiene of ward, 60% were due to late detection of infection and 40% were due to irregularity of general cleaning (poor hygiene of the ward). The hypothesis of possible causes like delay of dressing, poor hand washing, poor preoperative antisepsis, poor surgical scrub, poor sterilization technique, poor technique of surgical procedure, poor laundering, incompliance with prophylactic antibiotics before operation were rejected or were found 0% each.

4. DISCUSSION

Four hundred eighty-six women who delivered by cesarean delivery in Muhororo Hospitals in the first semester of 6 months (July-December 2023) of the data collection. Among them 5 developed SSI and were interviewed face to face for the development of SSI syndromes.

In this study, the prevalence of surgical site infections (SSI) was 1.0%, a finding comparable to the 1.16% reported in a study conducted in Cameroon that examined SSI prevalence and associated risk factors following surgery [26]. However, a lower SSI rate of 0.5% was documented at King Abdulaziz Airbase

Hospital in Dhahran, Saudi Arabia, in a study focusing on orthopedic surgical procedures.[27] Unlike findings from a tertiary care hospital in western India, where prolonged preoperative hospital stay was linked to a higher risk of SSI [28]. No such association was observed in the present study. Notably, all SSI cases (100%) were detected after patient discharge, which aligns with findings reported elsewhere [29]. Regarding wound classification, the majority of surgical wounds in this study were categorized as clean (80%), while the remaining 20% were classified as dirty. This contrasts with results from a study on SSI risk factors following abdominal surgery, where different wound classifications predominated [30]. The discrepancy may be explained by differences in study focus, as the referenced study was limited to abdominal procedures and emphasized systematic antibiotic administration within 60 minutes prior to surgery. In the present study, all patients received prophylactic antibiotics within 60 minutes before surgery and underwent adequate preoperative preparation. These findings are consistent with a retrospective national review from Rwanda examining surgical volumes at district hospitals [29]. Nevertheless, no statistically significant association was found between the type of surgical procedure and SSI occurrence ($p > 0.05$). Furthermore, most surgical procedures (80%) were completed within 30 minutes, largely due to the high proportion of caesarean sections performed. This contrasts with evidence from studies on gastric surgery, where longer operative duration was identified as a significant risk factor for SSI [31].

5. CONCLUSION

Surgical site infections remain a significant public health concern in Rwanda. Of the 486 patients who underwent surgical procedures at Muhororo Hospital between July and December 2023, five developed surgical site infections, corresponding to a prevalence of 1.0%. The identified factors were primarily related to patient-related exposures, wound classification, the presence of chronic comorbidities, and aspects of patient admission and discharge, as well as potential sources of infection. The results showed that the personal hygiene of patient, duration of surgical procedure, frequent movement of visitor, poor hygiene of ward (irregularity of general cleaning), delayed detection of infections and inconsistencies in routine cleaning practices contributed to the occurrence of surgical site infections. Inadequate hygiene measures, particularly environmental disinfection, further increased the risk of SSIs. Addressing these gaps through strengthened prevention strategies and appropriate management is essential to achieve meaningful improvements in health outcomes

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