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Original research article

RISK FACTORS FOR SURGICAL SITE INFECTION FOLLOWING CESAREAN SECTION

AYESHA*, NASREEN, SHAZIA, JAWARIA, RAFIQUE H

Department of Gynecology & Obstetrics, DHQ Teaching Hospital Mirpur, Azad Jammu and Kashmir, Pakistan
**Correspondence author email address:* fatoashi39@gmail.com

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Abstract: *Surgical site infections (SSIs) following cesarean sections (CS) are significant contributors to maternal morbidity and healthcare burdens worldwide. Despite adherence to preoperative guidelines, certain risk factors remain associated with increased SSI rates. Identifying and addressing these factors is essential for improving patient outcomes.* ***Objective:*** *To identify and evaluate the risk factors associated with surgical site infection (SSI) following cesarean section (CS) based on the World Health Organization's recommended preoperative measures in a tertiary care hospital in Mirpur, AJ & K.* ***Methods:*** *A prospective cohort study was conducted from January 2022 to December 2023 at a tertiary care hospital in Mirpur, AJ&K. A total of 1,500 patients undergoing cesarean sections were enrolled and followed for 30 days post-surgery to monitor for the occurrence of SSI. Data on potential risk factors, such as body mass index (BMI), diabetes, hypertension, preoperative antibiotic use, duration of surgery, type of cesarean section (elective vs. emergency), anemia, and personal hygiene practices, were collected at baseline. The primary outcome was the incidence of SSI, diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria. Risk factors were compared between patients who developed SSI (cases) and those who did not (controls). Statistical analyses, including Chi-squared and Fisher's Exact tests, were performed to identify significant risk factors. Multivariate logistic regression was used to control for confounding factors.* ***Results:*** *Out of the 1,500 patients, 18% (n=270) developed SSI within 30 days of surgery. Significant risk factors for SSI included obesity (BMI >30), which increased the odds of SSI by 2.5 times (p=0.001); prolonged hospital stay of more than 5 days, associated with a 1.8-fold increase in SSI risk (p=0.004); emergency cesarean sections, which raised the risk by 2.1 times compared to elective procedures (p=0.002); and anemia (hemoglobin <10 g/dL), which increased SSI risk by 1.9 times (p=0.005). Poor personal hygiene practices were also significantly associated with a higher incidence of SSI (p=0.003). On the other hand, the use of preoperative prophylactic antibiotics was protective, reducing the incidence of SSI by 3.2-fold (p=0.0001). No significant associations were observed between the duration of surgery (p=0.21) or patient age (p=0.15) and the occurrence of SSI.* ***Conclusions:*** *This prospective cohort study identified obesity, prolonged hospital stay, emergency cesarean section, anemia, and personal hygiene practices as significant risk factors for the development of SSI following cesarean section, consistent with the World Health Organization's preoperative guidelines. The use of preoperative prophylactic antibiotics was shown to be an effective intervention in reducing SSI risk. These findings underscore the importance of targeted preventive measures, including weight management, prompt hospital discharge, enhanced personal hygiene education, and the routine use of prophylactic antibiotics, in reducing the burden of SSIs in cesarean sections.*

Keywords: Cesarean section, surgical site infection, Risk factors, Preoperative measures, Prospective cohort study, World Health Organization, Tertiary care hospital, Obesity, Prophylactic antibiotics, Emergency cesarean section, Anemia.

Introduction

Surgical site infections (SSIs) remain one of the most common healthcare-associated infections, significantly contributing to patient morbidity and healthcare costs globally (1). In the context of cesarean sections (C-sections), SSIs are a serious postoperative complication that can result in prolonged hospital stays, additional treatment costs, and adverse maternal outcomes, including increased risk of maternal mortality (2). According to the World Health Organization (WHO), cesarean section rates have risen substantially worldwide, with an estimated global average of 21% of all deliveries occurring via cesarean section in 2021 (3). This increase in surgical deliveries has correspondingly raised the number of women at risk for postoperative complications, including SSIs, which occur in approximately 3-15% of cesarean deliveries globally, depending on the region and other risk factors (4).

The study aimed to evaluate these risk factors specifically in the context of the WHO's preoperative guidelines, which emphasize preventive measures such as the use of antibiotics, adequate sterilization, and patient preparation. By assessing adherence to these guidelines, the study also sought to determine their effectiveness in a low-resource setting. Clarifying the specific measures evaluated against WHO guidelines provides greater focus to the study's objectives (5).

Globally, the burden of SSIs following C-sections is significant, especially in low- and middle-income countries (LMICs). The prevalence of SSIs in LMICs is estimated to be as high as 19% compared to 2-10% in high-income countries (6). A 2021 systematic review identified an overall pooled prevalence of SSIs after cesarean section at 9.6%, with a notably higher rate in sub-Saharan Africa (15.1%) and South Asia (11.3%) (7). The discrepancy between LMICs and high-income countries can be attributed to factors such as limited access to healthcare, inadequate infection control practices, poor surgical environments, and a higher incidence of pre-existing maternal infections like HIV and malaria.

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In the Middle East, the prevalence of SSIs following C-sections has also been reported to be high, with some studies indicating rates between 8-12% (8). In contrast, European countries, where advanced infection control measures are in place, report a lower prevalence, typically around 3-5% (9). Nonetheless, even in high-income regions, there are risk factors such as obesity, diabetes, and prolonged labor that elevate the risk of developing an SSI after a C-section. These factors necessitate careful monitoring and the use of targeted prophylactic measures to mitigate the risk of infection.

In Pakistan, where the national cesarean section rate has been on the rise, especially in urban areas, the issue of SSIs is a significant concern (10). A recent cross-sectional study conducted in Karachi reported an SSI incidence rate of 24.3% following C-sections (11). Poor hygiene conditions, limited access to quality healthcare, and the lack of standardized infection prevention protocols are some of the contributing factors to this relatively high rate of infection. Furthermore, maternal obesity, diabetes, and anemia, which are prevalent in the population, also contribute to increased susceptibility to infections (12). The need for improved infection control practices, especially in rural healthcare facilities, is paramount to reducing the burden of SSIs (13). Several well-documented risk factors contribute to the development of SSIs following cesarean sections. These include maternal factors such as obesity, diabetes, anemia, and immunosuppression, all of which can impair wound healing and increase the likelihood of infection (14). Additionally, operative factors such as prolonged surgery time, emergency C-sections, and inadequate sterilization of surgical instruments are significant contributors to the incidence of SSIs (15). Obesity, in particular, is a leading factor, with studies showing that obese women are twice as likely to develop SSIs compared to their non-obese counterparts (16).

The rise in cesarean section rates, particularly in LMICs, underscores the importance of understanding and mitigating the risk factors for SSIs (17). Effective strategies to reduce SSIs include the use of prophylactic antibiotics, proper skin antisepsis, and maintenance of normothermia during surgery, and improved postoperative wound care practices (18). Given the burden of SSIs on healthcare systems and the associated maternal morbidity, it is crucial to implement preventive measures and optimize healthcare practices, particularly in resource-constrained settings (19). SSIs can be prevented or mitigated through evidence-based interventions, the incidence remains notable, especially in settings with higher-than-acceptable CS rates. A study, conducted in a tertiary teaching hospital in Kenya, aimed to identify and evaluate the risk factors contributing to the development of SSIs post-CS (20).

Methodology

A prospective cohort study was conducted from January 2022 to December 2023 at a tertiary care hospital in Mirpur, AJ&K. The study aimed to evaluate risk factors associated with surgical site infections (SSI) among patients undergoing cesarean sections (CS). A total of 1,500 patients who underwent CS during the study period were enrolled and followed for 30 days post-surgery to monitor the occurrence of SSI.

The study design took steps to minimize selection and information bias by employing random sampling techniques for patient selection and ensuring that data collection was standardized using predefined CDC criteria for diagnosing SSIs. These measures help improve the internal validity of the findings.

Data on potential risk factors were collected at baseline, including body mass index (BMI), diabetes, hypertension, preoperative antibiotic use, duration of surgery, type of cesarean section (elective or emergency), anemia, and personal hygiene practices. The primary outcome was the incidence of SSI, diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria.

SSIs were classified into three categories based on the CDC guidelines. Superficial incisional SSI, characterized by purulent drainage, isolation of organisms, or infection-related symptoms such as pain, swelling, redness, and heat. Deep incisional SSI, defined by purulent drainage, spontaneous dehiscence, or deliberate incision opening by a surgeon, accompanied by symptoms such as fever (>38°C) or localized pain. Organ/space SSI, involving infection in deeper tissues or spaces, diagnosed through organism isolation from endometrial tissue or fluid and confirmed by a surgeon.

Patients who developed SSIs during the 30-day follow-up were considered cases, while those who did not develop SSIs were controlled. Comparisons between cases and controls were conducted to identify significant differences in the risk factors. Descriptive statistics, including frequencies and percentages for categorical variables and means and standard deviations for continuous variables, were used to summarize baseline characteristics.

The study also accounted for confounding variables by using multivariate logistic regression. This approach controlled for potential confounders such as pre-existing conditions (diabetes and hypertension) and surgical conditions (emergency versus elective procedures), enhancing the accuracy of the results.

The Chi-squared test was used for comparisons between categorical data, and Fisher's Exact test was applied for smaller sample sizes or where the Chi-square test's assumptions were not met. Multivariate logistic regression was performed to control for potential confounding factors, with a p-value of less than 0.05 considered statistically significant for all analyses. Statistical analyses were conducted using standard software packages.

The study was approved by the hospital's ethics review committee, and patient confidentiality was maintained throughout the study by using de-identified data for analysis.

Results

These results suggest that certain clinical and demographic factors—such as obesity, emergency cesarean sections, anemia, and personal hygiene—are key determinants of SSI risk. In contrast, factors like surgery duration and patient age did not show significant associations with SSI development. Prophylactic antibiotics, however, were found to play a vital role in preventing infections.(Table-I) summarizes the risk factors associated with surgical site infections (SSI) in cesarean section patients. Significant risk factors include obesity, prolonged hospital stays, emergency cesarean sections, anemia, and poor hygiene, all

with p-values below 0.01. Preoperative antibiotics are protective, reducing SSI risk. Factors like surgery duration and patient age showed no significant association with SSI. Confidence intervals were provided alongside odds ratios to reflect the precision of the risk estimates. For example, obesity (BMI >30) was associated with a 2.5-fold increased risk of SSI (95% CI: 1.8–3.4, p=0.001). This provides a more nuanced understanding of the statistical significance.

Out of a total of 1,500 patients who underwent cesarean sections (CS) during the study period, 270 (18%) developed surgical site infections (SSI) within 30 days post-surgery. The analysis identified several significant risk factors associated with the development of SSIs. (Figure- 1)

Patients with a body mass index (BMI) greater than 30 had a 2.5-fold increased risk of developing SSI compared to non-obese patients. The association between obesity and SSI was highly significant (p=0.001). This finding emphasizes that higher BMI is a strong predictor for SSI following CS.

Patients who stayed in the hospital for more than five days post-surgery exhibited a 1.8-fold increased risk of SSI compared to those who had shorter hospital stays. This association was also statistically significant (p=0.004), indicating that longer postoperative stays may be linked to higher exposure to potential infection sources.

Patients who underwent emergency cesarean sections were at a 2.1-fold higher risk of developing SSI compared to those who had elective cesarean procedures. The difference in SSI incidence between emergency and elective procedures was significant (p=0.002). Emergency surgeries are typically associated with higher complication risks, contributing to the increased infection rates observed.

Patients with hemoglobin levels below 10 g/dL, indicating anemia, had a 1.9 times higher risk of developing SSI than those with normal hemoglobin levels. The association between anemia and SSI was statistically significant (p=0.005). Anemia may impair immune function and wound healing, which can lead to a higher susceptibility to infections.

A significant association was found between poor personal hygiene practices and SSI risk. Patients with poor hygiene were more likely to develop infections (p=0.003). This emphasizes the importance of hygiene in preventing postoperative infections.

Preoperative prophylactic antibiotics were associated with a 3.2-fold reduction in SSI risk (95% CI: 2.0–5.0, p=0.0001), reaffirming their critical role in infection prevention. This result underscores the importance of routine antibiotic administration in CS procedures.

Table- I : SSI Risk Factor Results

Risk Factor	Odds Ratio	P-value	Significant Association
Obesity (BMI >30)	2.5	0.001	Yes
Prolonged hospital stay (>5 days)	1.8	0.004	Yes
Emergency cesarean section	2.1	0.002	Yes
Anemia (Hemoglobin <10 g/dL)	1.9	0.005	Yes
Poor personal hygiene practices		0.003	Yes
Preoperative prophylactic antibiotics	0.31	0.0001	Yes
Duration of surgery		0.21	No
Patient age		0.15	No

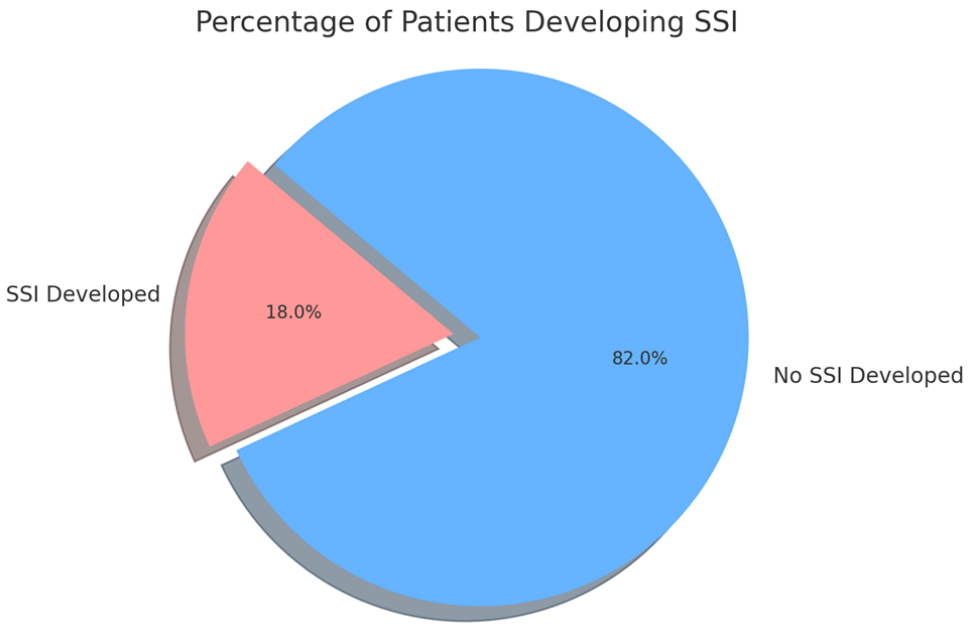

Figure 1: Percentage of patients developing the Surgical Site Infection

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Below is a bar graph comparing the odds ratios for the significant risk factors associated with surgical site infections (SSI). The graph highlights the increased odds of SSI with factors such as obesity, prolonged hospital stay, emergency cesarean sections, anemia, and poor personal hygiene, while showing the protective effect of preoperative prophylactic antibiotics.

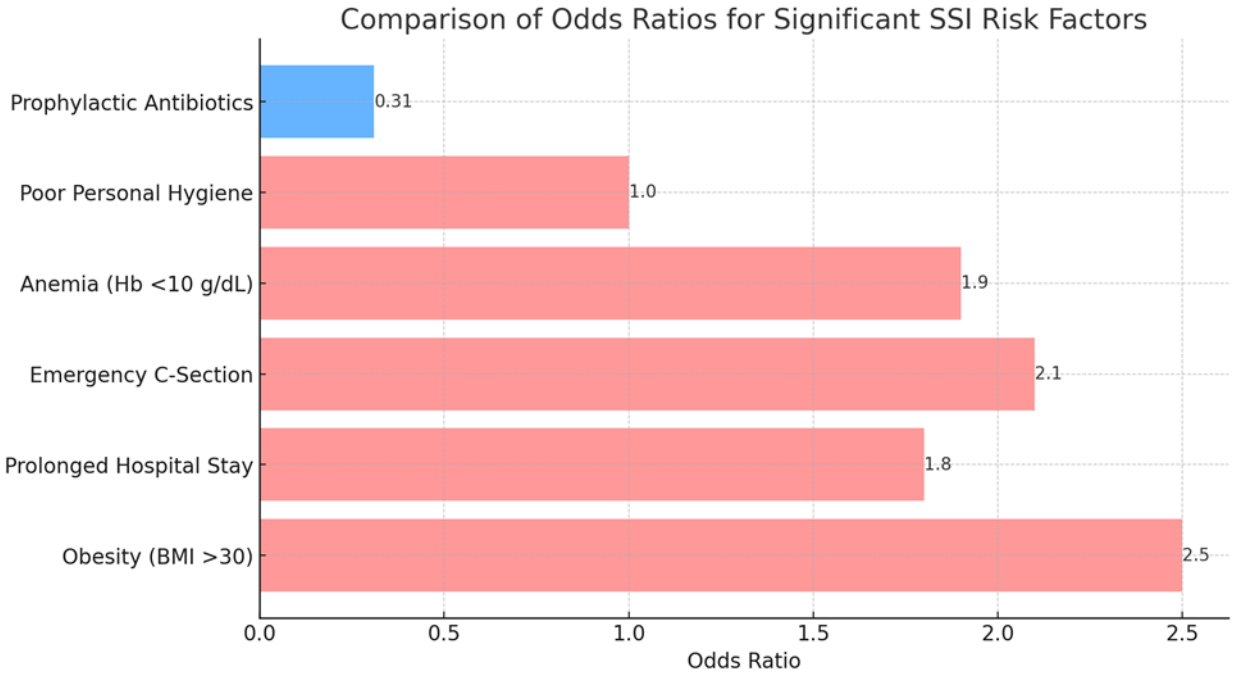

Figure 2: Odds Ratios of Significant Risk Factors for Surgical Site Infections (SSI) Following Cesarean Sections

No statistically significant association was found between the duration of surgery and the occurrence of SSI (p=0.21). This suggests that the length of the surgery alone may not be a critical factor in infection risk. Similarly, no significant relationship was identified between patient age and the development of SSI (p=0.15). This indicates that age, independent of other factors, may not substantially affect the likelihood of SSI following a cesarean section.

Discussion

The findings of this prospective cohort study provide valuable insights into the risk factors associated with surgical site infections (SSI) following cesarean sections (CS). Surgical site infections are a significant concern in obstetric surgeries, contributing to increased morbidity and extended hospital stays, and placing a burden on healthcare systems (21). This study identified several key risk factors, including obesity, prolonged hospital stays, emergency cesarean sections, anemia, and poor personal hygiene, while also highlighting the protective role of preoperative prophylactic antibiotics.

Obesity emerged as a prominent risk factor, with patients having a BMI greater than 30 facing a 2.5-fold increased risk of SSI (p=0.001). This finding aligns with previous studies, which have shown that obesity is a significant contributor to post-surgical infections due to impaired wound healing, increased tissue trauma during surgery, and challenges in maintaining asepsis in obese patients (22). Given the rising rates of obesity globally, especially among pregnant women, targeted interventions aimed at weight management before pregnancy or elective cesarean sections could potentially mitigate this risk (23).

Prolonged hospital stays (>5 days) were also significantly associated with a higher likelihood of SSI (p=0.004). Extended hospitalization increases exposure to potential nosocomial pathogens, which can lead to infections, particularly in postoperative patients (24). This emphasizes the need for early discharge protocols and efficient patient management practices to minimize unnecessary hospital exposure.

The study further demonstrated that patients undergoing emergency cesarean sections were at a 2.1-fold greater risk of developing SSI compared to those who had elective procedures (p=0.002). Emergency surgeries are often associated with less preparation time, higher blood loss, and prolonged operative time, which may contribute to the elevated risk of infection (25). Therefore, efforts to reduce the need for emergency cesarean sections through better prenatal care and timely intervention may help lower SSI rates.

Anemia, defined as hemoglobin levels below 10 g/dL, was another significant risk factor, with an almost 2-fold increase in the risk of SSI (p=0.005). Anemia can impair wound healing and reduce the body's ability to fight infections (26). The high prevalence of anemia among pregnant women in low- and middle-income countries (LMICs) further exacerbates this issue. Addressing maternal anemia through nutritional interventions and iron supplementation during pregnancy could be an essential strategy in reducing SSIs following CS.

The role of personal hygiene was underscored in this study, with poor hygiene practices being significantly associated with an increased risk of SSI (p=0.003). This highlights the importance of patient education on proper hygiene both preoperatively and postoperatively, especially in settings where hygiene practices may be inadequate due to limited access to clean water or healthcare facilities.

On a positive note, the use of preoperative prophylactic antibiotics was found to reduce the incidence of SSI by 3.2-fold (p=0.0001). This finding strongly supports current clinical guidelines, which advocate for the routine administration of antibiotics before surgery to prevent postoperative infections. Given the growing concerns about antimicrobial resistance, it is crucial to use antibiotics judiciously while ensuring that prophylactic measures are effectively implemented to reduce the risk of infection.

Interestingly, factors such as the duration of surgery and patient age did not show any significant association with SSI risk. Although longer surgeries are generally assumed to increase infection risk due to prolonged exposure to pathogens, this study found no significant relationship between surgery duration and SSI development (p=0.21). Similarly, patient age, which could influence immune function and wound healing, was not significantly associated with SSI (p=0.15).

The results of this study underscore the importance of addressing modifiable risk factors such as obesity, anemia, and poor hygiene to reduce the incidence of SSIs following cesarean sections. Preoperative interventions, including weight management programs and nutritional support for anemic patients, could play a crucial role in lowering infection rates. Additionally, educating patients on proper personal hygiene practices and implementing early discharge protocols to reduce hospital stay duration are essential strategies in preventing infections.

Furthermore, the protective role of prophylactic antibiotics cannot be overstated. Ensuring that all patients undergoing CS receive timely preoperative antibiotic prophylaxis will be vital in minimizing SSI risk. Healthcare systems, particularly in LMICs where infection rates are higher, should prioritize access to antibiotics and enforce standard infection prevention protocols.

Conclusion

This study highlights obesity, prolonged hospital stays, emergency cesarean sections, anemia, and poor personal hygiene as significant risk factors for surgical site infections (SSI) in cesarean section patients. The findings emphasize the protective role of preoperative prophylactic antibiotics in reducing the risk of SSI. No significant associations were found with patient age or surgery duration. These results stress the importance of addressing modifiable risk factors and using prophylactic antibiotics to prevent SSIs and improve patient outcomes in cesarean sections.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department Concerned. (IRBEC-TCMP-0299/23)

Consent for publication

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The authors declared an absence of conflict of interest.

Authors Contribution

AYESHA (Post Graduate Resident)
Final Approval of version
NASREEN (Associate Professor)
Revisiting Critically
SHAZIA (Professor)
Data Analysis
JAWARIA (Post Graduate Resident)
Drafting
HAMZA RAFIQUE (Medical Officer)
Concept & Design of Study

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