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Md. Mehedi Hasan Iqbal
Assistant Registrar (Surgery), Community Based Medical College Hospital, Mymensingh, Bangladesh

Shakila Chowdhury
MO (MCH-FP), Jamalpur, Sadar, Bangladesh

Md. Safwanur Karim Sakib
Registrar (Pediatric Surgery), Community Based Medical College Hospital, Mymensingh, Bangladesh

Corresponding Author:
Md. Mehedi Hasan Iqbal
Assistant Registrar (Surgery), Community Based Medical College Hospital, Mymensingh, Bangladesh

Risk factors and the role of preoperative antibiotic prophylaxis in the prevention of surgical site infections

Md. Mehedi Hasan Iqbal, Shakila Chowdhury and Md. Safwanur Karim Sakib

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Abstract
Background: Surgical Site Infections (SSIs) remain a common healthcare-associated infection despite advances in surgical techniques and aseptic protocols. Identifying risk factors and evaluating the efficacy of preoperative antibiotic prophylaxis is crucial to improving patient outcomes.
Aim: To analyze the risk factors associated with SSIs and assess the role of preoperative antibiotic prophylaxis in their prevention among surgical patients.
Methods: A prospective observational study was conducted on 125 surgical patients. Demographic variables, comorbidities, risk factors, and use of preoperative antibiotics were recorded. Incidence and type of SSIs were evaluated postoperatively. Statistical analysis was performed using SPSS.
Results: SSIs were observed in 28% of patients. Risk factors such as diabetes (32%), smoking (34%), obesity (28%), and immunosuppression (10%) were significantly associated with increased SSI rates. Preoperative antibiotics were administered in 85% of patients and were associated with a reduced incidence of SSI.
Conclusion: Preoperative antibiotic prophylaxis significantly reduces the risk of SSIs. Patients with comorbid conditions require closer surveillance and optimized perioperative care to prevent infections.

Keywords: Surgical Site Infection, Preoperative Antibiotics, Risk Factors, Prophylaxis, Surgery

Introduction

Surgical Site Infections (SSIs) are a significant cause of postoperative complications globally and represent a major burden on healthcare systems. These infections occur at or near the surgical incision site within 30 days of the procedureor up to 90 days if an implant is placed. Despite advances in surgical techniques, aseptic protocols, and antimicrobial therapy, SSIs continue to be among the most common healthcare-associated infections (HAIs), accounting for 20-30% of such infections in hospitalized patients [1, 2]. SSIs not only prolong the duration of hospital stay but also increase the risk of rehospitalization, secondary complications, and even mortality, particularly in immunocompromised or comorbid individuals [3]. Multiple factors contribute to the risk of SSIs. These are generally classified into patient-related and procedure-related factors. Patient-related risk factors include age, gender, nutritional status, diabetes mellitus, smoking, obesity, and immunosuppressive conditions such as malignancies or corticosteroid use [4-6]. Procedure-related factors include the type and duration of surgery, wound classification (clean, clean-contaminated, contaminated, dirty), use of surgical drains, sterility of the environment, and surgical technique [7, 8]. For instance, a longer operative time has been associated with increased infection rates due to prolonged exposure of tissues to potential contaminants. In resource-limited settings, these challenges are often compounded by inadequate infrastructure, lack of surgical bundles, and inconsistent adherence to prophylactic protocols. One of the most cost-effective and evidence-based strategies to minimize the risk of SSIs is the use of preoperative antibiotic prophylaxis. Numerous studies have shown that the administration of a single dose of an appropriate antibiotic within 30 to 60 minutes prior to incision significantly reduces microbial load and lowers the incidence of infections, especially in clean-contaminated and contaminated surgeries [9-11]. Guidelines from the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) emphasize the importance of proper selection, timing, and dosing of antibiotics in surgical patients [12].

However, real-world data suggest substantial variability in compliance with these recommendations, and the effectiveness of these measures may be influenced by other concurrent patient-related risks. Given the complex interplay between host-related risk factors and procedural practices, this study aims to explore the role of preoperative antibiotic prophylaxis in the prevention of SSIs and to identify the significant risk factors contributing to infection among patients undergoing surgery. By understanding these associations, clinicians can better stratify patients according to their risk and implement tailored perioperative strategies to reduce complications. This is particularly important in low- and middle-income countries, where SSI rates are often higher due to limited access to resources, training, and infection control infrastructure. Therefore, this study seeks to generate context-specific evidence to inform both clinical practice and institutional policy for improving surgical outcomes.

Objective

The primary objective of this study is to determine the incidence and contributing risk factors of Surgical Site Infections in patients undergoing surgical procedures. By identifying these factors, we aim to facilitate early interventions and improve patient outcomes.

A secondary objective is to evaluate the efficacy of preoperative antibiotic prophylaxis in reducing the incidence of SSIs, with particular focus on high-risk patient groups. This will help reinforce the importance of adherence to prophylactic guidelines.

Methodology and Materials

This prospective observational study was conducted at Dept. of Surgery, Community Based Medical College Hospital, Mymensingh, Bangladesh from June 2024 to June 2025, over a period of 12 months. A total of 125 adult patients who underwent elective surgical procedures in general surgery, orthopedics, gynecology, and urology departments were enrolled after obtaining written informed consent. The aim was to observe the incidence of Surgical Site Infections (SSIs), assess predisposing risk factors, and evaluate the effectiveness of preoperative antibiotic prophylaxis.

Study Design and Setting

The study was hospital-based and observational in nature. Patients were included consecutively during the study period, ensuring a representative sample across various surgical disciplines. The surgeries ranged from clean to contaminated types. All procedures were performed in sterile operating rooms under standardized anesthesia protocols. The surgical wounds were classified as per CDC criteria, and postoperative wound care was uniform throughout the cohort.

Inclusion Criteria

- Adult patients aged 18 years and above
- Patients undergoing elective clean, clean-contaminated, or contaminated surgeries
- Patients with no active infections at the time of surgery
- Those who agreed to participate and provided informed consent
- Availability of complete medical and surgical records

Exclusion Criteria

- Patients with pre-existing skin or soft tissue infections near the surgical site
- Emergency surgery patients, where standardized preoperative antibiotic administration was not feasible
- Patients with incomplete or missing follow-up data
- Individuals with known allergies to standard prophylactic antibiotics
- Patients lost to follow-up within the 30-day postoperative period

Data Collection Procedure

Detailed demographic and clinical data were collected using a pre-designed proforma. This included age, gender, body mass index (BMI), comorbidities such as diabetes mellitus, smoking status, obesity, and immunosuppression (e.g., corticosteroid or chemotherapy use). Operative details like type of surgery, duration of procedure, classification of wound, and use and timing of preoperative antibiotics were recorded.

Preoperative antibiotic prophylaxis was administered as per institutional protocols, typically involving a single intravenous dose of a broad-spectrum antibiotic (commonly cefazolin or amoxicillin-clavulanate) given within 60 minutes before surgical incision. The adherence to prophylaxis timing and dosage was verified through nursing and anesthesia logs.

Patients were followed up postoperatively for a minimum of 30 days. Wound inspections were done on postoperative days 3, 7, 14, and 30. If infection was suspected, wound swabs were taken and sent for culture and sensitivity. SSIs were diagnosed based on CDC definitions:

- **Superficial Incisional SSI:** Infection within the skin or subcutaneous tissue
- **Deep Incisional SSI:** Infection involving deep soft tissues such as fascia and muscle
- **Organ/Space SSI:** Infection involving any part of the anatomy other than the incision

Telephone follow-up was also used for patients who were discharged early, and they were advised to report any signs of infection.

Statistical Data Analysis

The data collected were coded and entered into Microsoft Excel and then analyzed using SPSS version 25. Descriptive statistics were applied to summarize demographic and clinical characteristics. Continuous variables like age and BMI were expressed as mean ± standard deviation. Categorical variables such as gender, risk factors, and antibiotic use were expressed as frequencies and percentages. To evaluate associations between risk factors and SSI incidence, Chi-square (χ^2) tests were performed. The relationship between the administration of preoperative antibiotics and the occurrence of SSIs was examined. A p-value of less than 0.05 was considered statistically significant. Multivariate logistic regression was used to determine independent predictors of SSIs among identified variables.

Ethical clearance for this study was obtained from the hospital institutional ethics committee. All participants were assured confidentiality, and data were anonymized before analysis.

Results

Out of the 125 patients included in the study, SSIs were detected in 35 (28%) patients. The remaining 90 (72%) showed no signs of infection postoperatively. Among those with SSIs, the majority had superficial incisional infections (20 cases), followed by deep incisional (10 cases) and organ/space infections (5 cases) (Figure 1).

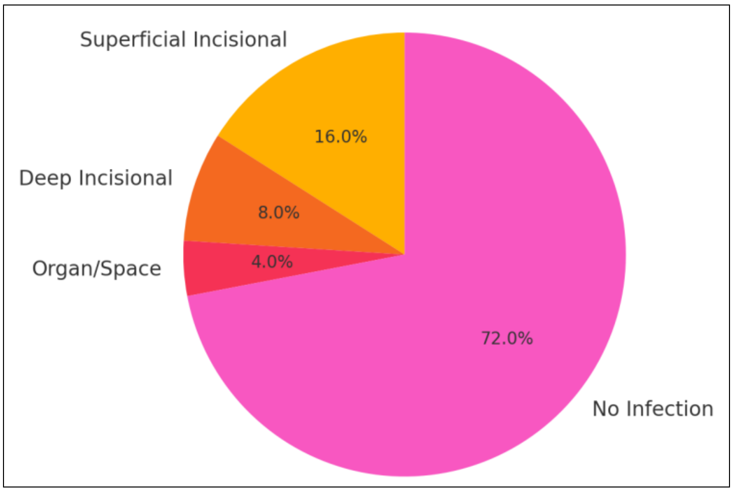

Fig 1: Distribution of Surgical Site Infection (SSI) types among affected patients

A higher frequency of SSIs was observed in patients with comorbid conditions: 34 of the 42 diabetic patients developed SSIs, compared to 8 out of 83 non-diabetic patients. Similarly, obesity, smoking, and immunosuppression were found to be positively correlated with SSI development (Figure 2).

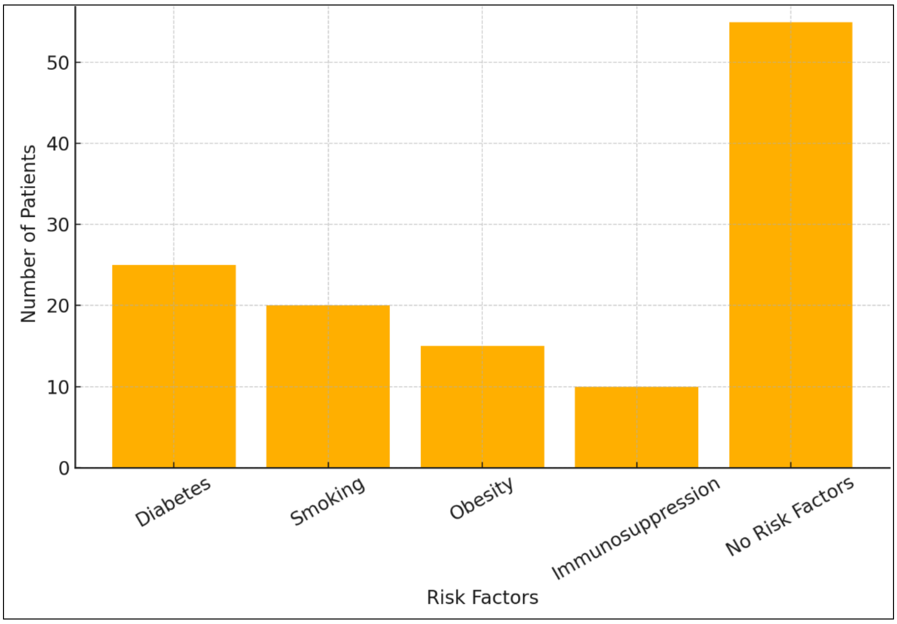

Fig 2: Distribution of patients by risk factor and corresponding incidence of Surgical Site Infections

Administration of preoperative antibiotics had a significant impact. Among the 106 patients who received antibiotics, only 24 developed SSIs, compared to 11 out of 19 patients who did not receive antibiotics.

Table 1: Demographic Characteristics of the Patients (N = 125)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	45.8 ± 13.6	-
Gender	Male	72	57.6%
	Female	53	42.4%
Body Mass Index (BMI)	Normal (<25)	78	62.4%
	Overweight/Obese (≥25)	47	37.6%
Diabetes Mellitus	Yes	42	33.6%
	No	83	66.4%
Smoking Status	Smoker	43	34.4%
	Non-smoker	82	65.6%
Immunosuppression	Yes	12	9.6%
	No	113	90.4%
Preoperative Antibiotics Given	Yes	106	84.8%
	No	19	15.2%

Table 2: Distribution of Risk Factors among Patients (N = 125)

Risk Factor	Status	Frequency (n)	Percentage (%)
Diabetes Mellitus	No	101	80.8%
	Yes	24	19.2%
Smoking	No	90	72.0%
	Yes	35	28.0%
Obesity	No	96	76.8%
	Yes	29	23.2%
Immunosuppression	No	113	90.4%
	Yes	12	9.6%

Table 3: SSI Occurrence in Relation to Antibiotic Prophylaxis (N = 125)

Preoperative Antibiotic Prophylaxis	SSI Present (n)	SSI Absent (n)	Total (n)	Percentage with SSI (%)
Given	24	82	106	22.6%
Not Given	11	8	19	57.9%
Total	35	90	125	28.0%

Table 4: Frequency of Surgical Site Infection (SSI) Types (N = 125)

SSI Type	Frequency (n)	Percentage (%)
None	90	72.0%
Superficial	20	16.0%
Deep	10	8.0%
Organ/Space	5	4.0%
Total	125	100%

Table 5: SSI Occurrence by Risk Factor (N = 125)

Risk Factor	Status	SSI Present (n)	SSI Absent (n)	Total (n)	SSI Rate (%)
Diabetes Mellitus	No	8	75	83	9.6%
	Yes	27	15	42	64.3%
Smoking	No	13	77	90	14.4%
	Yes	22	13	35	62.9%
Obesity	No	9	87	96	9.4%
	Yes	26	3	29	89.7%
Immunosuppression	No	32	81	113	28.3%
	Yes	3	9	12	25.0%

Discussion

The findings of this study reaffirm the significance of several modifiable and non-modifiable risk factors in the development of SSIs. The overall SSI rate of 28% observed is relatively high and warrants critical evaluation of surgical infection control practices. This may reflect underlying issues such as surgical complexity, environmental sanitation, and patient characteristics.

Diabetes, smoking, obesity, and immunosuppression emerged as significant risk contributors. Hyperglycemia impairs neutrophil function and delays wound healing, making diabetic patients particularly vulnerable [10-12]. Similarly, smoking compromises tissue perfusion and oxygenation, while obesity increases the area of tissue trauma and potential dead space, thus predisposing to infection [13-16].

The use of preoperative antibiotics demonstrated substantial protective benefits. Patients who received timely prophylactic antibiotics had a significantly lower incidence of SSIs. This supports current CDC and WHO recommendations on perioperative antibiotic use [17-20]. However, the small subset of patients who did not receive antibiotics had an alarmingly high rate of SSIs, indicating gaps in adherence or protocol implementation.

In addition to host-related factors, it is important to consider surgical duration, environment, and wound classification in future studies. A multidimensional approach involving surgeons, anesthetists, and infection control teams is essential for SSI reduction. Proper education, surveillance, and compliance with infection control guidelines can lead to better outcomes [21-23].

Limitations of the Study

This study has several limitations. Firstly, the relatively small sample size (n=125) may limit the generalizability of findings. Secondly, it was conducted in a single tertiary care center, which may not represent broader healthcare settings. Additionally, the follow-up period of 30 days might miss late-onset infections, especially organ/space SSIs. Lastly, patient adherence to postoperative care and reporting bias may have influenced the results.

Despite these limitations, the study offers valuable insights into SSI risk factors and the protective effect of antibiotic prophylaxis in a real-world clinical setting.

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Conclusion

Surgical Site Infections (SSIs) remain one of the most common and challenging postoperative complications, contributing significantly to patient morbidity, prolonged hospitalization, and increased healthcare expenditure. This study reaffirms that the occurrence of SSIs is not merely dependent on surgical techniques but is intricately linked to several patient-related and perioperative factors. Among these, comorbidities such as diabetes mellitus, obesity, smoking, and immunosuppression emerged as statistically significant risk factors that elevate the likelihood of infection. These findings underscore the importance of thorough preoperative risk assessment and stratification.

The role of preoperative antibiotic prophylaxis in the prevention of SSIs cannot be overstated. Our study demonstrated a clear reduction in the incidence of SSIs among patients who received antibiotics within the recommended window before surgical incision. The protective benefit of this practice aligns with international guidelines and highlights the need for strict adherence to prophylactic protocols. Institutions must ensure the availability, timely administration, and proper documentation of antibiotics as part of their routine surgical workflow.

Furthermore, this study calls attention to the necessity of developing standardized SSI prevention bundles that combine antibiotic prophylaxis with other evidence-based interventions such as glycemic control, smoking cessation, nutritional optimization, and appropriate skin antisepsis. Training healthcare providers, enforcing protocol compliance, and fostering a culture of infection control will be essential in minimizing SSI rates.

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