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Original Article

Association Between Timing of Preoperative Antibiotic Prophylaxis and Surgical Site Infection Rates in Elective Abdominal Surgeries

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ABSTRACT

Background: Surgical site infections (SSIs) remain one of the most common postoperative complications associated with increased morbidity, prolonged hospitalization, higher healthcare costs, and delayed recovery. Appropriate timing of preoperative antibiotic prophylaxis is considered an important modifiable factor in reducing SSI incidence in abdominal surgeries. Aim of the present study was to evaluate the association between timing of preoperative antibiotic prophylaxis and surgical site infection rates in patients undergoing elective abdominal surgeries.

Materials and Methods: The present prospective observational study was conducted in the Department of General Surgery at Mamata Academy of Medical Sciences from July 2025 to January 2026. A total of 60 patients undergoing elective abdominal surgeries were included. Patients were categorized into three groups based on timing of prophylactic antibiotic administration: Group A (<30 minutes before incision), Group B (30–60 minutes before incision), and Group C (>60 minutes before incision). Demographic details, operative variables, and postoperative outcomes were recorded. Patients were followed for 30 days for development of SSI according to CDC criteria.

Results: The overall SSI rate observed in the study was 15%. Group B patients who received antibiotics within 30–60 minutes before incision demonstrated the lowest SSI rate (5%) compared to Group A (15%) and Group C (25%). The association between antibiotic timing and SSI was statistically significant (Chi-square = 6.34, p = 0.041). Diabetes mellitus (p = 0.018), drain placement (p = 0.031), and duration of surgery greater than 120 minutes (p = 0.022) were significantly associated with increased SSI risk. Patients with SSI had significantly prolonged hospital stay compared to patients without SSI.

Conclusion: Administration of prophylactic antibiotics within 30–60 minutes prior to surgical incision was associated with significantly lower SSI rates in elective abdominal surgeries. Appropriate timing of antibiotic prophylaxis represents a simple, effective, and cost-efficient strategy for reducing postoperative infective complications and improving surgical outcomes.

Keywords*: Surgical site infection; Antibiotic prophylaxis; Elective abdominal surgery; Timing of antibiotics; Postoperative infection; Perioperative care; SSI prevention.*

INTRODUCTION

Surgical site infections (SSIs) continue to represent one of the most frequent and clinically significant postoperative complications in modern surgical practice, contributing substantially to patient morbidity, prolonged hospitalization, increased healthcare expenditure, and postoperative mortality. SSIs account for a major proportion of healthcare-associated infections globally and remain an important indicator of quality of surgical care. Despite considerable

advances in operative techniques, sterilization procedures, perioperative monitoring, minimally invasive approaches, and antimicrobial therapy, the burden of SSIs remains considerable, particularly following abdominal surgeries. Recent global estimates suggest that SSI incidence ranges from 5% to 30% depending on the type of surgery, patient comorbidities, wound contamination status, and institutional infection control practices.(1,2)

The Centers for Disease Control and Prevention (CDC) defines surgical site infection as an infection occurring within 30 days after an operative procedure or within one year when an implant is placed and the infection appears related to surgery.(3) SSIs are classified into superficial incisional, deep incisional, and organ/space infections based on the anatomical extent of involvement. These infections significantly affect postoperative recovery and are associated with increased rates of wound dehiscence, reoperation, prolonged antibiotic use, intensive care admission, and readmissions.

Elective abdominal surgeries are particularly vulnerable to postoperative infective complications because of exposure to endogenous gastrointestinal flora, bowel handling, prolonged operative duration, and increased risk of contamination during surgery.(4) The incidence of SSI is influenced by multiple patient-related and operative factors including diabetes mellitus, obesity, smoking, anemia, malnutrition, hypoalbuminemia, immunosuppression, advanced age, prolonged hospital stay, duration of surgery, drain placement, blood loss, and wound classification.(5,6)

Among the evidence-based preventive strategies available, perioperative antibiotic prophylaxis remains one of the most effective and widely recommended interventions for reducing SSI rates.(7) The principal objective of surgical antimicrobial prophylaxis is to ensure adequate bactericidal antibiotic concentrations in serum and tissues at the time of surgical incision and throughout the operative procedure. Appropriate prophylactic antibiotic administration has been shown to significantly reduce postoperative wound infection, shorten hospital stay, and improve surgical outcomes.
Current international guidelines issued by the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), American Society of Health-System Pharmacists (ASHP), and Surgical Infection Society recommend administration of prophylactic antibiotics within 60 minutes prior to surgical incision for most commonly used antibiotics, while agents requiring prolonged infusion such as vancomycin and fluoroquinolones should be administered within 120 minutes before incision.(3,7,8) However, despite the availability of clear recommendations, inappropriate timing of antibiotic prophylaxis continues to be frequently encountered in routine surgical practice because of workflow inefficiencies, communication gaps, unexpected operating room delays, and variations in institutional protocols.

Several recent studies have emphasized the importance of optimal antibiotic timing in preventing SSIs. Evidence suggests that administration too early before incision may lead to declining tissue drug concentrations during surgery, whereas delayed administration after incision may fail to achieve adequate antimicrobial levels during initial bacterial inoculation.(9,10) Adequate timing is therefore essential to maximize prophylactic efficacy and minimize postoperative infective complications.

Although substantial international literature exists regarding perioperative antibiotic prophylaxis, limited prospective observational studies from Indian tertiary care centers have specifically evaluated the association between timing of preoperative antibiotic prophylaxis and SSI rates in elective abdominal surgeries. Considering the growing concern regarding healthcare-associated infections and antimicrobial stewardship, further evaluation of prophylactic antibiotic practices in real-world surgical settings remains clinically important.

The present study was undertaken to evaluate the association between timing of preoperative antibiotic prophylaxis and the incidence of surgical site infections among patients undergoing elective abdominal surgeries. The study aimed to determine whether administration of prophylactic antibiotics within the recommended preoperative window was associated with reduced postoperative infective complications. In addition, the study assessed the influence of patient-related and operative factors such as diabetes mellitus, duration of surgery, drain placement, and associated comorbidities on SSI development. Secondary objectives included evaluation of duration of hospital stay, need for antibiotic escalation, postoperative morbidity, and readmission rates among patients who developed surgical site infections.

MATERIALS AND METHODS

Study Design and Setting

The present study was conducted as a prospective observational study in the Department of General Surgery at Mamata Academy of Medical Sciences from July 2025 to January 2026. A total of 60 patients undergoing elective abdominal surgeries were included in the study after obtaining informed written consent. Institutional Ethical Committee approval was obtained prior to commencement of the study.

Study Population

Adult patients undergoing elective abdominal surgical procedures during the study period were evaluated for eligibility and enrolled consecutively based on the predefined inclusion and exclusion criteria.

Inclusion Criteria

- Patients aged more than 18 years
- Patients undergoing elective abdominal surgeries
- Patients willing to provide informed written consent
- Patients available for postoperative follow-up for 30 days

Exclusion Criteria

- Emergency abdominal surgeries
- Contaminated and dirty surgical procedures
- Immunocompromised patients
- Patients with pre-existing local or systemic infections
- Patients already receiving therapeutic antibiotics
- Patients lost to follow-up

Study Tool and Data Collection

All patients underwent detailed preoperative clinical evaluation including history taking, physical examination, and routine laboratory investigations. Demographic and clinical variables such as age, gender, body mass index, diabetes mellitus, smoking history, hypertension, ASA grade, haemoglobin level, and serum albumin were recorded using a structured proforma. Appropriate radiological investigations were performed depending on the underlying surgical pathology.

Prophylactic antibiotics were administered according to institutional protocol. Commonly used antibiotics included intravenous ceftriaxone 1 g or cefuroxime 1.5 g administered before surgical incision. The exact timing of antibiotic administration and surgical incision was documented carefully for each patient.

Based on the timing of prophylactic antibiotic administration, patients were categorized into the following groups:

- **Group A:** Antibiotics administered less than 30 minutes before incision
- **Group B:** Antibiotics administered between 30 and 60 minutes before incision
- **Group C:** Antibiotics administered more than 60 minutes before incision

Intraoperative variables including type of surgery, duration of surgery, blood loss, drain placement, surgical approach, wound classification, and intraoperative complications were documented. Postoperatively, all patients were monitored during hospital stay and followed up for 30 days for evidence of surgical site infection. Clinical features such as fever, wound erythema, purulent discharge, local tenderness, and wound dehiscence were assessed. Surgical site infection was diagnosed according to the Centers for Disease Control and Prevention (CDC) criteria.

Outcome Measures

The primary outcome measure was the incidence of surgical site infection. Secondary outcome measures included duration of hospital stay, requirement for secondary procedures, antibiotic escalation, postoperative morbidity, and readmission rates.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25. Quantitative variables were expressed as mean ± standard deviation, while qualitative variables were presented as frequencies and percentages. Chi-square test or Fisher's exact test was used for analysis of categorical variables, and Student's t-test or analysis of variance (ANOVA) was used for comparison of continuous variables. Logistic regression analysis was performed to identify independent predictors of surgical site infection. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (n = 60)

Variable	Value
Mean age (years)	46.2 ± 12.4
Male	38 (63.3%)
Female	22 (36.7%)
Diabetes mellitus	16 (26.7%)
Mean BMI (kg/m²)	25.8 ± 3.2
Mean duration of surgery (minutes)	112 ± 28

The study population consisted predominantly of male patients, accounting for 38 cases (63.3%), while females constituted 22 cases (36.7%). The mean age of the patients was 46.2 ± 12.4 years. Diabetes mellitus was present in 16 patients (26.7%). The mean body mass index of the study participants was 25.8 ± 3.2 kg/m², and the average duration of surgery was 112 ± 28 minutes.

Table 2: Distribution of Patients According to Timing of Preoperative Antibiotic Prophylaxis (n = 60)

Group	Timing of Antibiotic Administration Before Incision	Number of Patients (n)	Percentage (%)
Group A	< 30 minutes	20	33.3
Group B	30–60 minutes	20	33.3
Group C	> 60 minutes	20	33.3
Total		**60**	**100.0**

Patients were equally distributed among the three study groups based on timing of prophylactic antibiotic administration. Each group included 20 patients (33.3%). Group A received antibiotics less than 30 minutes before incision, Group B between 30 and 60 minutes, and Group C more than 60 minutes prior to surgical incision.

Table 3: Comparison of Surgical Site Infection Rates According to Timing of Preoperative Antibiotic Prophylaxis

Group	SSI Present (n)	SSI Absent (n)	SSI Rate (%)
Group A (<30 min)	3	17	15.0
Group B (30–60 min)	1	19	5.0
Group C (>60 min)	5	15	25.0
Total	**9**	**51**	**15.0**

Chi-square = 6.34, p-value = 0.041

Surgical site infection was observed in 9 out of 60 patients, with an overall SSI rate of 15.0%. The lowest SSI rate was noted in Group B, where antibiotics were administered between 30 and 60 minutes before incision, with only 1 patient (5.0%) developing SSI. Group A showed an SSI rate of 15.0%, whereas the highest SSI rate of 25.0% was observed in Group C. The association between timing of antibiotic prophylaxis and SSI occurrence was statistically significant (p = 0.041).

Table 4: Association of Clinical and Operative Risk Factors with Surgical Site Infection

Variable	SSI Present (n = 9)	SSI Absent (n = 51)	p-value
Diabetes mellitus	6	10	0.018
Drain placement	7	18	0.031
Surgery duration >120 minutes	6	12	0.022
Mean hospital stay (days)	9.8	5.1	<0.001

Among patients who developed surgical site infection, diabetes mellitus was present in 6 patients and was significantly associated with SSI (p = 0.018). Drain placement was observed in 7 patients with SSI and showed a statistically significant association with postoperative infection (p = 0.031). Prolonged surgical duration greater than 120 minutes was also significantly associated with increased SSI risk (p = 0.022). Patients with SSI had a significantly longer mean hospital stay of 9.8 days compared to 5.1 days among patients without SSI (p < 0.001).

DISCUSSION

Surgical site infections (SSIs) continue to be one of the most common postoperative complications in abdominal surgeries despite advancements in surgical techniques, sterilization protocols, and perioperative care.(9) SSIs contribute significantly to postoperative morbidity, prolonged hospitalization, delayed recovery, increased antibiotic use, and healthcare costs. The present prospective observational study evaluated the association between timing of preoperative antibiotic prophylaxis and SSI rates among patients undergoing elective abdominal surgeries. The overall SSI rate observed in the present study was 15%.

In the present study, patients who received prophylactic antibiotics within 30–60 minutes before surgical incision demonstrated the lowest SSI rate (5%) compared to patients receiving antibiotics less than 30 minutes before incision (15%) and more than 60 minutes before incision (25%). The association between timing of prophylactic antibiotic administration and SSI occurrence was statistically significant (p = 0.041). These findings emphasize the importance of maintaining adequate tissue antibiotic concentration at the time of incision and during the operative period for effective prevention of bacterial contamination.

The findings of the present study are comparable with those reported by de Jonge et al., who demonstrated increased SSI risk when prophylactic antibiotics were administered outside the recommended preoperative interval.(9) Similarly, Weber et al. observed that delayed antibiotic administration significantly increased postoperative wound infection rates, particularly in abdominal surgeries.(11) Current WHO and ASHP guidelines also recommend administration of prophylactic antibiotics within one hour prior to incision for effective SSI prevention.(7,8)

The present study further identified diabetes mellitus as a significant risk factor associated with SSI ($p = 0.018$). Diabetes impairs wound healing and immune response, thereby increasing susceptibility to postoperative infections. Similar findings were reported by Martin et al., who demonstrated higher SSI rates among diabetic patients undergoing abdominal procedures.(5)

Prolonged duration of surgery greater than 120 minutes was also significantly associated with SSI development ($p = 0.022$). Longer operative duration may increase tissue handling, bacterial exposure, and tissue trauma, thereby predisposing patients to postoperative wound infections. Comparable findings were reported by Cheng et al.(12)

Drain placement was another important factor significantly associated with SSI in the present study ($p = 0.031$). Surgical drains may facilitate bacterial migration and local inflammation, thereby increasing postoperative infection risk. Similar observations were reported by Lee et al.(13)

Patients who developed SSI had significantly prolonged hospital stay compared to patients without SSI, highlighting the substantial clinical and economic burden associated with postoperative infections. Similar findings were reported by Ban et al., who observed increased hospitalization and treatment costs among patients with SSI.(14)

The present study supports that appropriate timing of prophylactic antibiotics is a simple, effective, and cost-efficient intervention for reducing SSI rates in elective abdominal surgeries. However, the study was limited by relatively small sample size and single-center observational design. Nevertheless, the findings provide valuable prospective observational data supporting adherence to standardized perioperative antibiotic prophylaxis protocols.

CONCLUSION

The present study demonstrated a significant association between timing of preoperative antibiotic prophylaxis and surgical site infection rates in elective abdominal surgeries. Administration of prophylactic antibiotics within 30–60 minutes prior to surgical incision was associated with lower SSI incidence compared to earlier or delayed administration. Diabetes mellitus, prolonged duration of surgery, and drain placement were identified as significant risk factors for postoperative infection.

The findings emphasize that proper timing of antibiotic prophylaxis is a simple, cost-effective, and evidence-based strategy capable of reducing postoperative morbidity, prolonged hospital stay, and healthcare burden. Strict adherence to standardized perioperative antibiotic protocols may substantially improve surgical outcomes and reduce SSI incidence in elective abdominal surgeries.

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