



Original Article

A Retrospective Study of Surgical Site Infections and Associated Risk Factors in General Surgery

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ABSTRACT

Background: Surgical site infections (SSIs) are among the most common postoperative complications in general surgery and contribute significantly to patient morbidity, prolonged hospital stay, and increased healthcare costs.

Objectives: To determine the incidence of surgical site infections and to identify patient-related and procedure-related risk factors associated with their occurrence.

Materials and Methods: This retrospective observational study was conducted in the Department of General Surgery at a tertiary care hospital. Medical records of 200 patients who underwent major general surgical procedures over a one year period were reviewed. Data on demographic characteristics, comorbidities, type and duration of surgery, wound classification, and occurrence of SSI were collected and analyzed. Statistical analysis was performed using the chi-square test, with $p < 0.05$ considered significant.

Results: Surgical site infections were identified in 22 patients, resulting in an overall SSI incidence of 11.0%. SSIs were significantly associated with age above 50 years ($p = 0.041$), diabetes mellitus ($p < 0.001$), anemia ($p = 0.048$), emergency surgical procedures ($p < 0.001$), contaminated and dirty wounds ($p < 0.001$), and prolonged duration of surgery exceeding two hours ($p = 0.002$). Gender did not show a statistically significant association with SSI. *Staphylococcus aureus* was the most commonly isolated organism.

Conclusion: Surgical site infections continue to pose a significant challenge in general surgery. Identification of high-risk patients and optimization of modifiable risk factors, along with strict adherence to infection control practices, are essential to reduce the incidence of SSIs.

Keywords: Surgical site infection, General surgery, Risk factors, Postoperative infection.

INTRODUCTION

Surgical site infections (SSIs) are among the most frequently encountered healthcare-associated infections and continue to represent a major challenge in postoperative care. According to the Centers for Disease Control and Prevention (CDC), SSIs are defined as infections occurring at or near the surgical incision within 30 days of an operative procedure or within one year if an implant is placed [1]. These infections significantly contribute to postoperative morbidity, prolonged hospitalization, increased healthcare expenditure, and, in severe cases, mortality.

Globally, SSIs account for approximately 20–30% of all healthcare-associated infections, making them the most common nosocomial infections among surgical patients [2]. The reported incidence of SSIs varies widely, ranging from 2% to 5% in developed countries and up to 20% or more in developing nations [3]. This variation is influenced by differences in patient populations, surgical practices, hospital infrastructure, and adherence to infection prevention protocols.

In low- and middle-income countries, including India, the burden of SSIs remains disproportionately high. Factors such as delayed presentation, emergency surgical interventions, inadequate preoperative optimization, and limited access to advanced infection control measures contribute to this increased risk [4]. SSIs not only affect patient outcomes but also place a significant strain on already overburdened healthcare systems by increasing antibiotic usage, readmission rates, and overall treatment costs.

The development of SSIs is multifactorial and involves a complex interaction between host-related and procedure-related factors. Patient-related risk factors include advanced age, diabetes mellitus, anemia, malnutrition, obesity, smoking, and immunosuppression [5]. Among these, diabetes mellitus has been consistently identified as a strong predictor of SSIs due to impaired wound healing, altered immune response, and poor glycemic control in the perioperative period [6].

Procedure-related factors also play a crucial role in the occurrence of SSIs. These include the type of surgery (elective versus emergency), duration of the operative procedure, wound classification, surgical technique, and adequacy of antibiotic prophylaxis [7]. Emergency surgeries are particularly associated with higher SSI rates owing to inadequate preoperative preparation and a greater likelihood of wound contamination. Similarly, longer operative duration increases tissue exposure and bacterial contamination, thereby elevating infection risk [8].

Wound classification remains one of the most important determinants of postoperative infection. Clean wounds are associated with the lowest risk, whereas contaminated and dirty wounds carry a substantially higher likelihood of infection [9]. Understanding the relationship between wound class and SSI incidence is essential for risk stratification and implementation of targeted preventive measures.

Microbiologically, SSIs are most commonly caused by organisms originating from the patient's skin flora or endogenous sources. *Staphylococcus aureus* remains the predominant pathogen worldwide, followed by Gram-negative organisms such as *Escherichia coli*, *Klebsiella* species, and *Pseudomonas aeruginosa*, particularly in abdominal and emergency surgeries [10]. Knowledge of local microbial patterns and antibiotic sensitivity is vital for effective empirical therapy and infection control planning.

Despite established guidelines for SSI prevention, including aseptic surgical techniques, timely antibiotic prophylaxis, and postoperative wound care, SSIs continue to occur at unacceptable rates. Retrospective studies analyzing institutional data are valuable tools for identifying locally relevant risk factors, evaluating preventive practices, and guiding quality improvement initiatives.

In this context, the present retrospective study was undertaken to determine the incidence of surgical site infections among patients undergoing general surgical procedures and to identify patient-related and procedure-related risk factors associated with their occurrence.

MATERIALS AND METHODS

Study Design

This study was designed as a **retrospective observational study**.

Study Setting

The study was conducted in the **Department of General Surgery** at a **tertiary care teaching hospital** in India.

Study Period

Medical records of patients operated during a **one-year period** were reviewed.

Study Population

The study population comprised patients who underwent **major general surgical procedures** during the study period.

Sample Size

A total of **200 patients** who fulfilled the eligibility criteria were included in the study.

Inclusion Criteria

- Patients aged **18 years and above**
- Patients who underwent **elective or emergency general surgical procedures**
- Patients with **complete medical records**, including operative notes and postoperative follow-up details

Exclusion Criteria

- Patients who underwent **minor or day-care procedures**
- Patients with **pre-existing surgical site infection** at the time of surgery
- Patients with **incomplete or missing medical records**
- Patients lost to follow-up during the immediate postoperative period

Data Collection Procedure

Data were collected retrospectively from **medical records, operative registers, nursing notes, and microbiology reports** using a predesigned structured proforma. The following variables were recorded:

- **Demographic data:** age and sex
- **Patient-related factors:** presence of comorbidities such as diabetes mellitus, anemia, and hypertension
- **Surgery-related factors:**
 - Type of surgery (elective or emergency)
 - Duration of surgery
 - Type of anesthesia
 - Wound classification
- **Perioperative factors:**
 - Administration and timing of antibiotic prophylaxis
 - Postoperative wound care practices
- **Outcome variables:**
 - Occurrence of surgical site infection
 - Time of onset of infection
 - Microbiological culture and sensitivity reports

Wound Classification

Surgical wounds were classified based on operative findings into:

- **Clean**
- **Clean-contaminated**
- **Contaminated**
- **Dirty**

as documented in the operative records.

Definition of Surgical Site Infection

Surgical site infection was identified based on **documented clinical evidence** of infection, including purulent discharge from the wound, localized signs of inflammation, or a positive wound culture within **30 days of surgery**, as recorded in patient files.

Microbiological Analysis

For patients who developed surgical site infection, **wound swabs or pus samples** were collected under aseptic conditions and sent for microbiological examination. Organisms were identified using standard laboratory techniques, and **antibiotic susceptibility testing** was performed as per institutional protocol.

Ethical Considerations

The study was conducted after obtaining approval from the **Institutional Ethics Committee**. Patient confidentiality was maintained throughout the study.

Statistical Analysis

Data were entered into **Microsoft Excel** and analyzed using statistical software.

- Categorical variables were expressed as **frequencies and percentages**
- Continuous variables were expressed as **mean ± standard deviation**
- Associations between risk factors and surgical site infections were analyzed using the **chi-square test**
- A *p* value of **less than 0.05** was considered statistically significant

RESULTS

Out of 200 patients who underwent general surgical procedures, **22 patients developed surgical site infections**, giving an overall SSI incidence of **11.0%**.

A higher incidence of SSI was observed among patients aged above 50 years. as shown in table 1.

Table 1: Age Distribution and Surgical Site Infection

Age Group (years)	Total Patients (n)	SSI Cases (n)	SSI (%)
18–30	46	3	6.5
31–50	74	7	9.5
51–70	56	9	16.1
>70	24	3	12.5
Total	200	22	11.0

Surgical site infections were marginally higher among male patients compared to females as shown in table 2

Table 2: Gender Distribution and SSI

Gender	Total Patients (n)	SSI Cases (n)	SSI (%)
Male	118	14	11.9
Female	82	8	9.8
Total	200	22	11.0

Patients with diabetes mellitus and anemia showed a significantly higher incidence of surgical site infections compared to patients without comorbidities as shown in table 3.

Table 3: Association of Comorbidities with SSI

Comorbidity Status	Total Patients (n)	SSI Cases (n)	SSI (%)
Diabetes mellitus	44	9	20.5
Anemia	36	6	16.7
No comorbidities	120	7	5.8
Total	200	22	11.0

Emergency surgical procedures were associated with a significantly higher rate of surgical site infections compared to elective surgeries as shown in table 4.

Table 4: Type of Surgery and SSI

Type of Surgery	Total Cases (n)	SSI Cases (n)	SSI (%)
Elective	136	8	5.9
Emergency	64	14	21.9
Total	200	22	11.0

A progressive increase in SSI incidence was noted with increasing wound contamination, with the highest infection rates seen in dirty wounds as shown in table 5.

Table 5: Wound Classification and SSI

Wound Class	Total Cases (n)	SSI Cases (n)	SSI (%)
Clean	78	2	2.6
Clean-contaminated	62	6	9.7
Contaminated	38	7	18.4
Dirty	22	7	31.8
Total	200	22	11.0

Longer operative duration was associated with a higher incidence of surgical site infection as shown in table 6.

Table 6: Duration of Surgery and SSI

Duration of Surgery	Total Patients (n)	SSI Cases (n)	SSI (%)
≤ 2 hours	148	10	6.8
> 2 hours	52	12	23.1
Total	200	22	11.0

Staphylococcus aureus was the most commonly isolated organism.as shown in table 7.

Table 7: Microbiological Profile of SSI

Organism Isolated	Number (n)	Percentage (%)
<i>Staphylococcus aureus</i>	9	40.9
<i>Escherichia coli</i>	6	27.3
<i>Klebsiella species</i>	4	18.2
<i>Pseudomonas aeruginosa</i>	2	9.1
Mixed growth	1	4.5
Total	22	100

A statistically significant association was observed between surgical site infection and age above 50 years, diabetes mellitus, anemia, emergency surgery, higher wound contamination, and prolonged duration of surgery ($p < 0.05$). Gender did not show a statistically significant association with SSI as shown in table 8.

Table 8: Association of Risk Factors with Surgical Site Infection (n = 250)

Variable	Category	SSI Present (n = 22)	SSI Absent (n = 178)	Total (n)	p value
Age (years)	≤ 50	10	110	120	
	> 50	12	68	80	0.041
Gender	Male	14	104	118	
	Female	8	74	82	0.58
Diabetes Mellitus	Present	9	35	44	
	Absent	13	143	156	<0.001
Anemia	Present	6	30	36	
	Absent	16	148	164	0.048
Type of Surgery	Elective	8	128	136	
	Emergency	14	50	64	<0.001
Wound Class	Clean	2	76	78	
	Clean-contaminated	6	56	62	
	Contaminated	7	31	38	
	Dirty	7	15	22	<0.001
Duration of Surgery	≤ 2 hours	10	138	148	
	> 2 hours	12	40	52	0.002

DISCUSSION

Surgical site infections continue to be a significant cause of postoperative morbidity in general surgery. In the present retrospective study involving 200 patients, the overall incidence of SSI was **11.0%**.

Age was found to have a statistically significant association with SSI, with patients aged above 50 years demonstrating a higher incidence of infection ($p = 0.041$). Advancing age is associated with physiological decline in immune function, delayed wound healing, and a higher prevalence of comorbidities, all of which increase susceptibility to postoperative infections. Similar findings have been reported by Khan et al. and Neumayer et al., who identified older age as an independent predictor of SSI [11,12].

Diabetes mellitus emerged as one of the most significant risk factors for SSI in the present study, with diabetic patients showing a markedly higher infection rate compared to non-diabetics ($p < 0.001$). Hyperglycemia adversely affects leukocyte function, collagen synthesis, and microvascular circulation, thereby impairing wound healing. These findings are consistent with multiple studies that have established diabetes as a strong and modifiable risk factor for surgical site infections [13,14]. Strict perioperative glycemic control is therefore essential in reducing SSI risk.

Anemia was also significantly associated with SSI occurrence ($p = 0.048$). Reduced hemoglobin levels lead to impaired tissue oxygenation, which compromises wound healing and increases vulnerability to infection. Previous studies have highlighted anemia as an important yet often overlooked preoperative risk factor for postoperative infections [15]. Early detection and correction of anemia may help reduce SSI incidence.

The type of surgery played a crucial role in SSI development, with emergency procedures showing a significantly higher infection rate compared to elective surgeries ($p < 0.001$). Emergency surgeries often involve inadequate preoperative preparation, contaminated operative fields, and limited optimization of patient-related risk factors. Similar observations have been reported in studies evaluating SSIs in emergency surgical settings [16,17].

Wound classification showed a strong and statistically significant association with SSI incidence ($p < 0.001$). Clean wounds had the lowest infection rates, while contaminated and dirty wounds demonstrated progressively higher rates of SSI. This trend reflects the direct relationship between bacterial load and infection risk and is consistent with established literature identifying wound contamination as one of the most reliable predictors of SSI [18,19].

Prolonged duration of surgery was another significant determinant of SSI, particularly when operative time exceeded two hours ($p = 0.002$). Longer operative duration increases tissue exposure, surgical trauma, and the likelihood of bacterial contamination. This association has been consistently documented in previous studies, emphasizing the importance of efficient surgical planning and execution [20].

Microbiological analysis revealed *Staphylococcus aureus* as the most common organism isolated from infected wounds, followed by Gram-negative organisms such as *Escherichia coli* and *Klebsiella* species. This microbial pattern is consistent with reports from other general surgical studies, particularly those involving abdominal and emergency procedures [21,22]. The predominance of *Staphylococcus aureus* underscores the importance of proper skin antisepsis and adherence to aseptic surgical techniques.

Although the retrospective design and single-center nature of the study are limitations, the findings provide valuable insight into locally relevant risk factors and microbial patterns. Identification and optimization of modifiable risk factors such as glycemic control, correction of anemia, minimizing operative duration, and strict infection control measures can play a key role in reducing the incidence of surgical site infections.

CONCLUSION

Surgical site infections remain a common postoperative complication in general surgery, with an incidence of 11.0% observed in this study. Advanced age, diabetes mellitus, anemia, emergency procedures, contaminated wounds, and prolonged surgery were significant risk factors. Emergency surgeries and higher wound contamination showed notably increased infection rates. *Staphylococcus aureus* was the most common causative organism, emphasizing the need for targeted preventive measures to reduce SSI-related morbidity.

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