Biomedical and Biopharmaceutical Research
Abbreviation: Biomed. Biopharm. Res.
Volume: 22: Issue: 01 |Year: 2025
Page Number: 948-952

Evaluation of Surgical Site Infections in Abdominal Surgeries: Risk Factors, Microbial Patterns, and Prevention Strategies in a Tertiary Care Setting

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Article Received:26-04-2025

Article Accepted:11-06-2025

Abstract

Background: Surgical site infections (SSIs) are a leading cause of postoperative morbidity in abdominal surgeries, contributing to prolonged hospital stay and increased healthcare costs. Understanding the risk factors and microbial profiles is essential for effective prevention and management.
Objective: To evaluate the incidence, risk factors, microbial patterns, and outcomes of SSIs in patients undergoing abdominal surgeries in a tertiary care setting.
Methods: A prospective observational study was conducted over one year involving 100 patients undergoing elective and emergency abdominal surgeries. Clinical data including patient demographics, comorbidities, perioperative factors, and wound classification were collected. Patients were monitored postoperatively for SSI development. Samples from infected wounds were cultured for microbial identification and antibiotic susceptibility testing.
Results: The overall SSI incidence was 18%. Diabetes mellitus (50%), obesity (BMI >25 kg/m², 61.1%), anemia, smoking, emergency surgery status, longer operative duration (>2 hours), use of surgical drains, and contaminated wound class were significantly associated with higher SSI risk ($p < 0.05$). *Staphylococcus aureus* (38.9%), *Escherichia coli* (27.8%), and *Klebsiella pneumoniae* (16.7%) were the predominant pathogens isolated. MRSA accounted for 11.1% of infections. SSIs were associated with significantly increased mean hospital stay (12.4 ± 4.1 days vs. 5.8 ± 2.7 days; $p < 0.001$).
Conclusion: SSIs remain a substantial burden in abdominal surgeries, with identifiable patient- and surgery-related risk factors. Targeted interventions, including glycemic control, optimizing nutritional status, minimizing operative time, and strict aseptic protocols, alongside antimicrobial stewardship, are crucial to reducing SSIs and improving patient outcomes.

Keywords: Surgical site infection, abdominal surgery, risk factors, microbiology, antibiotic susceptibility, tertiary care.

INTRODUCTION

Surgical site infections (SSIs) are among the most common healthcare-associated infections (HAIs) and are a significant cause of postoperative morbidity and mortality globally. They account for approximately 20–30% of all HAIs in hospitalized surgical patients [1]. SSIs increase the length of hospital stay, healthcare costs, and the risk of reoperation and long-term disability.

The Centers for Disease Control and Prevention (CDC) defines SSIs as infections that occur at or near the surgical incision within 30 days of an operative procedure (or within 90 days if an implant is placed) [2]. SSIs can be categorized into three types: superficial incisional, deep incisional, and organ/space infections.

Abdominal surgeries, due to the involvement of the gastrointestinal tract and the potential for contamination, pose a higher risk for SSI development. Studies have reported SSI rates ranging from 10% to 25% following abdominal surgeries, particularly in emergency procedures, prolonged operations, or those involving contaminated/dirty wounds [3,4].

Multiple factors contribute to SSI development, including patient-related factors (age, diabetes, obesity, smoking, nutritional status), surgical factors (duration, technique, blood loss), and environmental and institutional practices (sterilization, antibiotic prophylaxis, operating room discipline) [5,6]. Among pathogens, Staphylococcus aureus, Escherichia coli, and Klebsiella species are frequently isolated organisms, with growing concern over multidrug-resistant strains [7].

Timely identification of modifiable risk factors and implementation of evidence-based prevention strategies, such as optimal timing of antimicrobial prophylaxis, strict aseptic technique, and adherence to surgical safety protocols, are crucial in reducing SSI incidence [8].
This study was undertaken to evaluate the incidence, risk factors, microbiological patterns, and preventive practices associated with SSIs in patients undergoing abdominal surgeries in a tertiary care hospital, thereby contributing to the formulation of targeted interventions and improved surgical outcomes.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of General Sri Muthukumaran Medical College Hospital and Research Institute, over one year from January 2024 to December 2024.

Study Population

A total of 100 patients undergoing various abdominal surgeries (both elective and emergency procedures) during the study period were enrolled after fulfilling the eligibility criteria.

Inclusion Criteria

- Patients aged 18 years and above undergoing abdominal surgeries such as laparotomy, appendectomy, cholecystectomy, hernia repair, and bowel resection.
- Patients who gave written informed consent for participation.
- Patients are available for 30-day postoperative follow-up.

Exclusion Criteria

- Patients with pre-existing skin or soft tissue infections at or near the surgical site.
- Immunocompromised patients (e.g., HIV-positive individuals, those receiving chemotherapy or radiotherapy).
- Patients on long-term corticosteroid therapy.
- Patients who were lost to follow-up before 30 days.

Data Collection

A structured data collection sheet was used to record the following:

- Demographic variables: Age, sex, body mass index (BMI).
- Clinical parameters: Presence of comorbidities (e.g., diabetes mellitus, hypertension, anemia), history of smoking, ASA (American Society of Anesthesiologists) score.
- Surgical details:
    - Type of surgery: Elective or emergency.
    - Nature of procedure: Clean, clean-contaminated, contaminated, or dirty (as per CDC wound classification).
    - Duration of surgery.
    - Type of incision and closure method.
    - Use of surgical drains or implants.
- Perioperative management:
    - Timing and type of preoperative antibiotic prophylaxis.
    - Skin preparation method (e.g., povidone-iodine, chlorhexidine-alcohol).
    - Type of anesthesia used (general/regional).
    - Use of sterile techniques, including sterile drapes, gowns, gloves, and compliance with WHO surgical safety checklist.

Follow-Up and Diagnosis of SSI

Patients were monitored daily during the hospital stay for clinical signs of infection, including redness, swelling, warmth, discharge, fever, or wound dehiscence.
Post-discharge, follow-up was conducted at the 7th, 14th, and 30th postoperative day in outpatient clinics.
Surgical Site Infection (SSI) was diagnosed based on the Centers for Disease Control and Prevention (CDC) criteria, which classify SSIs as:

- Superficial incisional SSI
- Deep incisional SSI
- Organ/space SSI

Microbiological Evaluation
For patients with suspected SSIs, wound swabs or pus samples were collected using sterile technique and sent to the Microbiology Laboratory for:

- Gram staining
- Aerobic culture and sensitivity testing, using standard bacteriological methods.
- Antibiotic susceptibility testing was done using the Kirby-Bauer disk diffusion method, and interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Common pathogens isolated and their antibiotic resistance patterns were recorded.

Prevention Strategies Assessed
The study also evaluated adherence to the following preventive measures:

- Correct timing and dosage of surgical antibiotic prophylaxis.
- Use of proper sterilization techniques for surgical instruments.
- Maintenance of operation theater hygiene and temperature.
- Adherence to hand hygiene protocols and WHO surgical checklist.
- Use of laminar airflow and HEPA filtration (where applicable).

Ethical Considerations
The study was approved by the Institutional Ethics Committee of Sri Muthukumaran Medical College Hospital and Research Institute. Written informed consent was obtained from all participants before enrollment.

Statistical Analysis
The data were entered and analyzed using SPSS version 26.0. Descriptive statistics were applied to summarize the data. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD). To examine the association between various risk factors and the occurrence of surgical site infections (SSIs), the Chi-square test or Fisher's exact test was used for categorical data. Binary logistic regression analysis was performed to identify independent predictors of SSIs. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS
Out of 100 patients who underwent abdominal surgeries, 18 patients (18%) developed surgical site infections (SSIs), while 82 patients (82%) had no signs of SSI during the 30-day follow-up.

Table 1. Demographic Distribution of Patients with SSI

Parameter	SSI Present (n=18)	No SSI (n=82)	p-value
Mean Age (years)	54.6 ± 12.3	42.1 ± 11.5	0.02*
Gender (M/F)	12 / 6	46 / 36	0.43
BMI > 25 kg/m²	11 (61.1%)	23 (28.0%)	0.01*

*Statistically significant ($p < 0.05$)

Table 2 . Comorbidities and Risk Factors

Risk Factor	SSI Present (n=18)	No SSI (n=82)	p-value
Diabetes Mellitus	9 (50%)	12 (14.6%)	0.001*
Hypertension	6 (33.3%)	18 (21.9%)	0.29
Anemia (Hb <10 g/dL)	7 (38.9%)	11 (13.4%)	0.015*
Smoking	5 (27.8%)	9 (10.9%)	0.045*

*Statistically significant ($p < 0.05$)

Table 3. Surgical and Intraoperative Variables

Parameter	SSI Present (n=18)	No SSI (n=82)	p-value
Emergency Surgery	11 (61.1%)	17 (20.7%)	0.001*
Duration of Surgery > 2 hours	12 (66.7%)	14 (17.1%)	0.0001*
Contaminated/Dirty Wounds	10 (55.6%)	9 (10.9%)	<0.001*

Parameter	SSI Present (n=18)	No SSI (n=82)	p-value
Use of Surgical Drains	13 (72.2%)	21 (25.6%)	<0.001*

*Statistically significant ($p < 0.05$)

Table 4. Microbiological Profile of SSI Cases (n = 18)

Isolated Organism	Number of Cases	Percentage (%)
Staphylococcus aureus (MSSA)	6	33.3%
Escherichia coli	4	22.2%
Klebsiella pneumoniae	3	16.7%
Pseudomonas aeruginosa	2	11.1%
Staphylococcus aureus (MRSA)	2	11.1%
Polymicrobial	1	5.6%

Table 5. Antibiotic Sensitivity Patterns of Major Isolates

Organism	Most Sensitive Antibiotics
MSSA	Cefazolin, Amoxiclav, Clindamycin
MRSA	Vancomycin, Linezolid
E. coli	Amikacin, Meropenem, Piperacillin-Tazobactam
Klebsiella pneumoniae	Meropenem, Colistin
Pseudomonas aeruginosa	Piperacillin-Tazobactam, Ciprofloxacin

Table 6; Outcome and Hospital Stay

Parameter	SSI Present (n=18)	No SSI (n=82)	p-value
Mean Hospital Stay (days)	12.4 ± 4.2	5.8 ± 2.1	<0.001*
Wound Dehiscence	3 (16.7%)	0 (0%)	0.005*
Reoperation Required	2 (11.1%)	0 (0%)	0.01*

DISCUSSION

In the present study, the incidence of surgical site infections (SSIs) among patients undergoing abdominal surgeries was found to be 18%, which aligns with rates reported in other tertiary care settings in developing countries, where SSI rates range from 10% to 25% depending on the type of surgery and healthcare infrastructure [3,4].

Patient-Related Risk Factors

Advanced age, obesity, diabetes mellitus, anemia, and smoking were significantly associated with higher SSI rates. Diabetes, in particular, was a major independent risk factor (50% among SSI patients), corroborating findings from other studies where hyperglycemia was linked to impaired wound healing and reduced neutrophil function [9]. Similarly, anemia has been associated with tissue hypoxia, which delays healing and increases infection risk [10].

The significant association of BMI >25 kg/m² with SSIs (61.1% of infected patients) in this study echoes global evidence indicating that obese patients are at a higher risk due to poor tissue perfusion, difficulty in maintaining asepsis, and increased operative times [11].

Surgical and Procedural Variables

Emergency surgeries were associated with a 3-fold increased risk of SSIs compared to elective surgeries. This is likely due to limited preoperative optimization and higher contamination risk. A statistically significant correlation was observed between SSIs and longer duration of surgery (>2 hours), consistent with earlier reports [12]. Prolonged surgeries increase tissue exposure, blood loss, and handling, which compromise tissue defenses.

Use of surgical drains was also associated with an increased SSI rate (72.2% among infected patients), as supported by literature suggesting that drains may act as a conduit for microbial entry [13]. Additionally, contaminated or dirty wounds had higher infection rates, consistent with CDC classifications where wound class is a strong predictor of infection risk [2].

Microbial Etiology

The most commonly isolated organisms were *Staphylococcus aureus* (including MSSA and MRSA), *Escherichia coli*, and *Klebsiella pneumoniae*. This microbial distribution mirrors findings from other Indian and international studies

[7,14]. Notably, Gram-negative organisms, especially *E. coli* and *Klebsiella*, are increasingly reported as leading pathogens in abdominal surgeries due to fecal contamination and breach in bowel integrity [15].

MRSA was isolated in 11.1% of cases, highlighting the need for effective infection control measures and judicious antibiotic use to prevent the spread of resistant organisms. Antibiotic sensitivity patterns in this study revealed that while most Gram-positive organisms were sensitive to vancomycin and linezolid, Gram-negative organisms responded to carbapenems and amikacin, indicating the need for institutional antibiotic stewardship programs.

Outcomes

SSI was associated with a significantly prolonged hospital stay, with an average duration of 12.4 days compared to 5.8 days in non-infected patients. These findings reaffirm the economic and psychological burden of SSIs on patients and the healthcare system [5]. Complications such as wound dehiscence and reoperations were also significantly more frequent among infected patients.

Strengths and Limitations

This prospective observational study provides valuable insight into SSI incidence and associated risk factors in abdominal surgeries. However, the limitations include a single-center design, a relatively small sample size (n=100), and lack of long-term follow-up. Despite this, the study highlights critical areas for intervention and supports the implementation of evidence-based SSI prevention strategies.

CONCLUSION

Surgical Site Infections (SSIs) remain a significant complication in abdominal surgeries, with an 18% incidence in this study. Key risk factors included diabetes, obesity, anemia, emergency procedures, and prolonged surgeries. Common pathogens were *Staphylococcus aureus* and *E. coli*, with notable antibiotic resistance. SSIs led to increased hospital stays and morbidity. Strengthening infection control practices, risk factor management, and antibiotic stewardship are essential to reduce SSI rates in surgical patients.

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