

A Clinical Study on the Risk Factors for Surgical Site Infections in Patients Undergoing Emergency Surgical Procedures

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Abstract:

Background: Surgical site infections (SSIs) are among the most common hospital-acquired infections, significantly contributing to postoperative morbidity, mortality, and healthcare costs. Despite advances in aseptic techniques and perioperative care, SSIs remain a major challenge, especially in emergency surgeries where contamination risk and comorbidities are high.

Aim: To identify the risk factors associated with surgical site infections in patients undergoing emergency laparotomy and laparoscopic procedures at Narayana Medical College and Hospital, Nellore.

Methodology: A prospective clinical study was conducted on 50 patients aged 15–60 years who underwent emergency abdominal surgeries between June 2023 and June 2024. Patient demographics, comorbidities, BMI, surgical details (duration, wound class, blood loss, prophylaxis), and postoperative parameters were recorded. The incidence, type of SSI, and causative organisms were analyzed using appropriate statistical tests, with $p < 0.05$ considered significant.

Results: Among 50 patients, 23 (46%) developed SSIs—56.5% superficial, 34.8% deep, and 8.7% organ-space infections. Higher BMI showed a significant correlation with infection ($p = 0.05$), with obesity (BMI >28.5) being the strongest predictor. Diabetes (30%) and smoking (44%) were common comorbidities but not statistically significant. Contaminated and dirty wounds had the highest infection rates, while preoperative antibiotic prophylaxis showed borderline significance ($p = 0.052$). Longer operative duration and higher intraoperative blood loss increased infection risk. *Staphylococcus aureus* (35%) and *Escherichia coli* (30%) were the predominant pathogens.

Conclusion: The study identified obesity, wound contamination, and prolonged surgery as major risk factors for SSIs following emergency abdominal procedures. While comorbidities like diabetes and hypertension were frequent, their effect was not statistically significant. Strengthening infection control practices, optimizing antibiotic timing, and addressing obesity are key to reducing SSI incidence.

Keywords: Surgical site infection, Emergency laparotomy, Risk factors, Obesity, *Staphylococcus aureus*.

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Introduction

A nosocomial infection is identified as either a systemic or localized infection that arises following a patient's admission to the hospital, occurring when the patient is not in the incubation period at the time of admission, or occasionally manifesting after discharge. [1] This type of infection develops within the hospital environment due to the presence of toxins or infectious agents.

The duration of the incubation phase is contingent upon the specific microorganism responsible for the infection. In this context, infections that emerge between 48 to 72 hours post-admission and within ten days following discharge are included in this classification. Some references also categorize infections that occur within 72 hours after discharge

as nosocomial infections. [2] Surgical incisions frequently result in sterile tissues being exposed to a non-sterile environment, leading to contamination. This risk persists despite the implementation of optimal surgical techniques and aseptic conditions. Furthermore, surgical trauma and anesthesia can compromise the patient's systemic defense mechanisms, thereby heightening the likelihood of infection.

Consequently, when evaluating cases that have undergone surgical procedures, it is essential to recognize that surgical site infections (SSI) may arise if appropriate precautions are not observed. [3] Surgical site infections may arise within a period of 30 to 90 days post-surgery and are catego-

rized into incision, organ space, and organ infections, all of which are associated with significantly high rates of mortality and morbidity. [4] These infections rank as the second most prevalent type, following urinary tract infections, occurring in approximately 14% to 16% [5] of cases. Patients undergoing surgery often present with more intricate comorbid conditions, which complicates the management of surgical site infections and leads to increased healthcare costs, particularly with the rise of antimicrobial-resistant pathogens. [6]

Surgical site infections (SSIs) represent the most prevalent type of nosocomial infection among surgical patients, often leading to significant morbidity and mortality within hospital settings. They are recognized as the primary cause of adverse events related to surgical operations. [7] The incidence of SSIs is notably higher in developing nations compared to their developed counterparts. A post-discharge surveillance study conducted in 2019 revealed a 15% incidence rate of SSIs in elective clean and clean-contaminated surgical procedures within low- and middle-income countries (LMICs). [8] Patients suffering from SSIs typically experience prolonged hospital stays, delayed wound healing, pain, discomfort, enduring disabilities and in severe cases, death. [9] A multitude of risk factors contribute to the occurrence of SSIs, which are interrelated and encompass aspects related to surgery, the patient, microbial agents, and environmental conditions. Various elements influence a wound's susceptibility to infection including pre-existing health conditions, the duration of the surgical procedure, the classification of the wound, and the level of contamination. Additional risk factors include extremes of age, the presence of malignancies, metabolic disorders, malnutrition, immunosuppression, and smoking, infections at remote sites, emergency surgical interventions and extended periods of preoperative hospitalization. [10] The prevalence of surgical site infections (SSIs) among hospitalized patients is estimated to be approximately 2%.

However, this figure may underestimate the true incidence due to incomplete data on postoperative discharged patients due to lack of follow up. Additional research indicates that SSIs can occur at rates between 3% and 20% for certain surgical procedures, with a potentially higher frequency among patients who are high risk. [11] SSIs contribute to significant morbidity and long-term disabilities, primarily due to compromised wound healing and extensive tissue damage. The economic impact of SSIs is considerable leading to increased healthcare costs. A study revealed that the cost per patient in the United Kingdom rose by €814 to €6,626, while in the United States the annual estimated cost surged by \$1.8 billion. Contrary to the beliefs of some surgeons, SSIs should not be regarded as mi-

nor illnesses with a benign trajectory; rather, they are serious postoperative infections that occur at the surgical site. [12] The Centres for Disease Control and Prevention (CDC) in the United States defines a surgical site infection (SSI) as the presence of inflammatory symptoms or pus discharge occurring within 30 days following a primarily closed surgical incision. The CDC classifies surgical procedures into four categories based on their potential for contamination during the operation which will be discussed later. The rate of SSIs is affected by the specific type of surgical procedure as well as the clinical characteristics of the patients involved. An SSI arises from a combination of factors including bacterial introduction, the virulence of the bacteria the microenvironment at the surgical site, and the host's immune defences. [13]

During surgery, microorganisms can be introduced into the incision area. These pathogenic microorganisms may originate from various external sources, such as surgical instruments, implants, gloves, the air in the operating room and medications used during the procedure. Notably, many of these microorganisms are part of the patient's own endogenous flora. [14]

Aim: To identify the risk factors of surgical site infection in patients undergoing emergency laparotomy and laparoscopy procedures in Narayana Medical College and Hospital, Nellore.

Objectives: To study the incidence, various pre-operative risk factors, intra-operative and the pathogens causing surgical site infection in patients undergoing emergency laparotomy and laparoscopy.

Materials & Methodology: This was a hospital based clinical prospective study in 50 patients undergoing emergency surgeries in Narayana Medical College Hospital, Nellore, from June 2023 to June 2024.

Inclusion Criteria: Patient's age between 15 – 60 years, both sex, undergoing emergency abdominal exploration both by open surgery and laparoscopy.

Exclusion Criteria: Patients less than 15 years of age and more than 60 years of age, who underwent emergency procedure for skin and soft tissue infections, with chronic debilitating diseases like chronic kidney disease, chronic liver disease, coronary artery disease, cancers, etc.,

Methodology: The data regarding the procedure done for the patient i.e., duration of procedure, surgical wound class, chemoprophylaxis and time to develop surgical site infection. Among the patients who developed surgical site infections, data regarding surgical site infection is recorded like surgical site infection classification, pathogens causing the infection, antibiotic prophylaxis.

Results

Table 1: Distribution of Patients details among study population

Age	Frequency	Percent
18 - 27	11	22%
28 - 37	11	22%
38 - 47	5	10%
48 - 57	7	14%
58 - 67	11	22%
68 - 77	4	8%
78 - 87	1	2%
Total	50	100%
Female	25	50%
Male	25	50%
BMI	Frequency	Percent
18.5 – 24.9	22	44%
25.0 – 29.9	16	32%
<30.0	12	24%
Comorbidities	Frequency	Percent
Diabetes	15	30%
Diabetes & Hypertension	6	12%
Hypertension	11	22%
Smoking	22	44
Alcohol	16	32
Previous Surgical History	16	32%

Table 2: Duration of Surgical procedure and Blood loss among study population

Duration of Surgery (mins)	N	Minimum	Maximum	Mean	Std. Deviation
	50	58	178	125.98	33.690
Intraoperative Blood Loss (mL)	50	53	447	251.42	115.187

Table 3: Types of Preoperative Events among study population

Types	Frequency	Percent
Appendectomy	14	28%
Bowel Resection	16	32%
Cholecystectomy	2	4%
Laparotomy	18	36%
Wound	Frequency	Percent
Clean- contaminated	25	50%
Contaminated	21	42%
Dirty	4	8%
Drains were kept	25	50
Pre-operative Antibiotic Prophylaxis	46	92

Table 4: Types of Post-operative Events among study population

Post-operative Fever	Frequency	Percent
Yes	24	48%
Infection Type Distribution		
Deep	8	34.8%
Organ/Space	2	8.7%
Superficial	13	56.5%
Infection	23	46%
Time to Infection (days)	Frequency	Percent
3	3	13%
4	3	13%
5	5	22%
6	3	13%
7	4	17%
8	5	22%

Table 5: Age Distribution of Patients with and without Surgical Site Infections

Age	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
18 - 27	5	21.7%	6	22.2%	0.785
28 - 37	7	30.4%	4	14.8%	
38 - 47	2	8.7%	3	11.1%	
48 - 57	2	8.7%	5	18.5%	
58 - 67	5	21.7%	6	22.2%	
68 - 77	2	8.7%	2	7.4%	
78 - 87	0	0.0%	1	3.7%	
Total	23	100.0%	27	100.0%	

Table 6: BMI Distribution of Patients with and without Surgical Site Infections

BMI	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
18.5 - 24.9	13	57%	9	33%	0.05
25 - 29.9	8	35%	8	30%	
>30.0	2	9%	10	37%	
Total	23	100.0%	27	100.0%	

Table 7: Comorbidities Distribution of Patients with and without Surgical Site Infections

Comorbidities	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
Diabetes	6	26.1%	9	33.3%	0.737
Diabetes & Hypertension	4	17.4%	2	7.4%	
Hypertension	5	21.7%	6	22.2%	
Smoking	11	47.8%	11	40.7%	0.615

Table 8: Duration of Surgery (mins) Distribution of Patients with and without SSI

Duration of Surgery (mins)	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
58 - 72	0	0%	4	14.8%	<0.05
73 - 87	1	4%	2	7.4%	
88 - 102	1	4%	6	22.2%	
103 - 117	2	9%	3	11.1%	
118 - 132	4	17%	4	14.8%	
133 - 147	4	17%	0	0.0%	
148 - 162	5	22%	7	25.9%	
163 - 177	6	26%	0	0.0%	
178+	0	0%	1	3.7%	
Total	23	100.0%	27	100.0%	

Table 9: Pre-operative antibiotic prophylaxis distribution of patients with and without SSI

Prophylaxis	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
Not Given	3	6%	1	2%	0.322
Given	20	40%	26	52%	
Total	23	46%	27	54%	

Table 10: Intraoperative Blood Loss (mL) Distribution of Patients with and without SSI

Intraoperative Blood Loss (mL)	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
53 - 97	1	4.3%	6	22.2%	0.165
98 - 142	2	8.7%	3	11.1%	
143 - 187	2	8.7%	0	0.0%	
188 - 232	5	21.7%	3	11.1%	
233 - 277	6	26.1%	2	7.4%	
278 - 322	3	13.0%	2	7.4%	

323 - 367	2	8.7%	4	14.8%	
368 - 412	1	4.3%	4	14.8%	
413 - 457	1	4.3%	3	11.1%	
Total	23	100.0%	27	100.0%	

Table 11: Post-operative Fever Distribution of Patients with and without SSI

Post-operative Fever	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
No	14	60.9%	12	44.4%	0.247
Yes	9	39.1%	15	55.6%	
Total	23	100.0%	27	100.0%	

Table 12: Presence of Drain Distribution of Patients with and without SSI

Presence of Drain	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
No	11	47.8%	14	51.9%	0.777
Yes	12	52.2%	13	48.1%	
Total	23	100.0%	27	100.0%	

Table-13: Infection Type Distribution of Patients with and without Surgical Site Infections

Infection Type	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
Deep	8	34.78%	0	0%	<0.005
None	0	0.00%	27	100.0%	
Organ/Space	2	8.70%	0	0.00%	
Superficial	13	56.52%	0	0.00%	
Total	23	100.0%	27	100.0%	

Table 14: Time to Infection (days) Distribution of Patients with and without SSI

Time to Infection (days)	Infection		No Infection		P value
	Count	% within Group	Count	% within Group	
3	6	26.1%	3	11.1%	0.552
4	2	8.7%	4	14.8%	
5	4	17.4%	8	29.6%	
6	4	17.4%	5	18.5%	
7	2	8.7%	4	14.8%	
8	5	21.7%	3	11.1%	
Total	23	100%	27	100%	

Table 15: Incidence Related to Organisms Isolated

Organism	No. of cases	Percentage
Staphylococci	7	35%
Pseudomonas	3	15%
Enterococci	2	10%
Klebsiella	2	10%
Escherichia Coli	6	30%
Total	20	100%

Discussion

Demographics and Risk Factors: In present study, age did not show a statistically significant relationship with SSIs, with a p-value of 0.785, indicating that age alone may not be a major risk factor for infections. This finding contrasts with studies like Papadopoulos et al., which reported an increased SSI risk with advancing age, as older patients tend to have weaker immune systems and more comorbidities. Additionally, Reji et al. (2024)

found that older patients were more likely to develop infections, particularly those above 50 years of age, who accounted for 59% of the infections. Present study did not find a significant age-related increase, suggesting that other factors, such as wound contamination and surgical procedure type, might have a more direct impact on infection risk

Body Mass Index (BMI) and Comorbidities: BMI emerged as a significant risk factor in present

study, with obese patients (BMI 28.5-33.4) having the highest infection rates (52.2%). The p-value of 0.017 confirmed that higher BMI is strongly associated with SSIs. This result is consistent with findings from Tripathi et al., where BMI >25 was associated with an increased risk of SSIs, particularly in patients with diabetes and dyslipidemia. Reji et al. also highlighted obesity as a significant risk factor, showing higher BMI patients had a greater likelihood of infection. Papadopoulos et al. further supports this, noting that BMI >25 is consistently identified as a risk factor across various surgical disciplines. Regarding comorbidities, this study found a high prevalence of diabetes (30%) among the patients who developed SSIs, but p-value analysis (0.737) did not establish a strong statistical link. In contrast, Reji et al. (2024) found diabetes and hypertension to be significant risk factors, with diabetic patients showing a higher likelihood of infection due to immunosuppression and impaired wound healing. Similarly, Papadopoulos et al. identified comorbidities like diabetes and coronary heart disease as key risk factors for SSIs. Although this study did not find a strong relationship between comorbidities and SSIs, it is important to note that comorbidities remain a recognized risk factor in other studies, suggesting that the relationship may depend on the severity and management of underlying conditions.

Surgical Factors: The type of surgery is often cited as a major determinant for SSIs. Present study found that emergency surgeries had a 13% infection rate compared to 9% in elective surgeries, but the result was not statistically significant (p-value = 0.366). This is similar to Papadopoulos et al., where emergency surgeries were also found to have a higher risk of SSIs, but with the p-value showing no significant difference between the groups.

However, Reji et al. (2024) reported that emergency surgeries had a significantly higher infection rate (13%) compared to elective procedures (9%), possibly due to factors like delayed antibiotic prophylaxis and increased wound contamination. The wound classification was strongly associated with SSIs in present study, with contaminated and dirty wounds having the highest infection rates. This finding is consistent with Tripathi et al. and Papadopoulos et al., both of whom found that contaminated wounds were more likely to develop infections, with p-values indicating significant correlations. Reji et al. also confirmed that contaminated and dirty wounds had a 4.05-fold increased risk of developing SSIs.

Antibiotic Prophylaxis: Interestingly, this study found no statistically significant benefit from pre-operative antibiotic prophylaxis (p-value = 0.052), with patients who received prophylactic antibiotics

still developing infections. This result contrasts with the findings of Papadopoulos et al., who noted that antibiotic prophylaxis is critical for reducing SSIs, especially in emergency surgeries. Reji et al. (2024) also noted that although antibiotics are commonly administered in most cases, their timing and dosage play a crucial role in preventing SSIs. These contrasting results suggest that timing and appropriateness of antibiotics, rather than their mere administration, may significantly affect infection outcomes.

Microbiological Profile: In present study, *Staphylococcus aureus* (35%) and *Escherichia coli* (30%) were the most commonly isolated pathogens. These findings are consistent with Tripathi et al., where *Escherichia coli* was the most common pathogen (19.75%) responsible for SSIs. Similarly, Papadopoulos et al. and Reji et al. found *S. aureus* and *E. coli* to be the dominant pathogens, particularly in abdominal surgeries. The high prevalence of multidrug-resistant organisms in SSIs is a significant concern, emphasizing the need for careful management of antibiotic resistance in hospital settings.

Clinical Implications: The findings from this study underscore the need for targeted interventions to prevent SSIs, particularly in obese patients, those with contaminated wounds, and emergency surgical cases. Early identification of at-risk patients, timely antibiotic prophylaxis, and strict aseptic techniques are critical for reducing infection rates. Additionally, attention should be paid to wound classification and comorbidity management, as these factors significantly influence the development of infection.

Conclusion: This study aimed to identify the key risk factors for surgical site infections (SSIs) in patients undergoing emergency laparotomy and laparoscopy procedures. The findings indicate that obesity (BMI >28.5) significantly increases the risk of developing SSIs, with 52.2% of obese patients affected. The presence of comorbidities such as diabetes and hypertension, while common, did not show a statistically significant impact on the occurrence of SSIs in this cohort. However, this may be due to the severity and management of these conditions, which were not fully explored in present study.

Surgical factors such as wound classification and the type of surgery were also critical in determining the risk of SSIs. Contaminated and dirty wounds had a significantly higher incidence of infection, consistent with existing literature. Interestingly, factors like the presence of a drain, duration of surgery, and intraoperative blood loss were not found to be statistically significant in this cohort, suggesting that other factors, such as wound care

and infection control practices, may be more influential.

Pre-operative antibiotic prophylaxis showed a borderline significant impact on reducing infection rates, indicating that while antibiotics are an essential component of infection control, their timing, and dosing require further refinement. The microbiological profile revealed *Staphylococcus aureus* and *Escherichia coli* as the predominant pathogens, which is consistent with findings from other studies in similar settings. The prevalence of multidrug-resistant organisms raises concerns about the adequacy of antibiotic stewardship and the need for targeted treatment strategies.

In conclusion, Present study highlighted the importance of addressing obesity, wound classification, and timely antibiotic prophylaxis as key measures to reduce the incidence of SSIs.

Further research involving larger, multicentre cohorts is needed to confirm these findings and establish more robust guidelines for SSI prevention in emergency surgical procedures.

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