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Research Article

Risk Factors for Surgical Site Infections in Patients Undergoing Emergency Surgery at Shifa Medical Complex: A Cross-Sectional Study

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Received: June 03, 2025; **Published:** June 26, 2025

Abstract

Background: Surgical site infections (SSIs) remain a significant postoperative complication, particularly in emergency surgical settings where timely intervention and optimal infection control are often challenging. This study aimed to assess the prevalence of SSIs and to identify associated risk factors among patients undergoing emergency surgeries at Shifa Medical Complex in the Gaza Strip.

Methods: A cross-sectional study was conducted from January to June 2023 at Shifa Medical Complex. Data were retrospectively collected from medical records and patient interviews for 226 adults who underwent emergency surgeries. Variables included demographic data, comorbidities, perioperative factors, and postoperative outcomes. Bivariate analysis and multivariate logistic regression were used to identify risk factors associated with SSIs. Statistical significance was set at $p < 0.05$.

Results: Of the 226 patients, 45 (19.9%) developed SSIs. Statistically significant risk factors associated with SSI occurrence included comorbidity ($p = 0.005$), diabetes ($p < 0.001$), cardiovascular disease ($p = 0.014$), preoperative hospital stay > 1 day ($p = 0.032$), anticoagulant use ($p = 0.002$), antiplatelet use ($p = 0.014$), and higher ASA scores ($p = 0.004$). Patients with medication use (especially anticoagulants and antiplatelets) had notably higher infection rates. Multivariate analysis confirmed diabetes, preoperative hospital stay, and ASA score as independent predictors.

Conclusion: The prevalence of SSIs following emergency surgeries at Shifa Medical Complex was 19.9%, with several modifiable and non-modifiable factors significantly associated with increased risk. Identifying high-risk patients and implementing timely, evidence-based perioperative care protocols are crucial for reducing SSI incidence in resource-limited, high-volume surgical centers.

Keywords: *Surgical Site Infection; Emergency Surgery; Risk Factors; Gaza; Cross-Sectional Study; Shifa Medical Complex*

Introduction

The following complications can arise from surgical site infections (SSIs): longer hospital stays, more visits to the intensive care unit (ICU), more hospital readmissions, higher rates of mortality, and higher economic costs [1]. Surgical site infections are a significant burden for patients undergoing surgery. The prevention of surgical site infections (SSIs) has garnered significant attention from infection preventionists, surgeons, and health care regulators in recent decades [2]. Particularly since ES wounds tend to be dirtier and more contaminated, patients having ES are more likely to acquire SSIs than elective surgery patients. It should be noted that SSIs may account for 7 - 32% [3,4] in patients receiving ES, compared to 1.5% to 5% in patients having elective surgery. The rates of morbidity and death are greater in patients who receive ES. It is of the utmost significance to anticipate and avoid SSIs in these susceptible patient populations in this setting [3,4].

The incidence of SSI has been closely linked to many patient and procedure-related variables in recent decades [5,6]. Some of the most prevalent patient-related variables that enhance the likelihood of SSI are advanced age, poor nutritional condition, increased body mass index (BMI), smoking, distant infections, and the use of immunosuppressive drugs. As an alternative, some of the most prevalent procedure-related risk factors are an extended operating duration, a polluted wound condition, the preventive use of antibiotics, and the emergency nature of the operation [7-10]. Interventions aimed at modifiably risk variables for the development of SSI might actively lower morbidity and fatality rates in these high-risk individuals.

Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and mortality, particularly in emergency surgical procedures where patients often arrive in critical condition and preoperative preparation is limited. Despite advances in surgical techniques and infection control measures, SSIs continue to challenge healthcare systems, especially in resource-limited settings like Shifa Medical Complex. The lack of timely identification and management of risk factors contributes to extended hospital stays, increased antibiotic use, additional surgical interventions, and higher healthcare costs. These infections not only impact patient recovery and satisfaction but also place a burden on already strained medical resources. This research aimed to identify and analyze the risk factors associated with surgical site infections in patients undergoing emergency surgery at Shifa Medical Complex.

Methods

Study design

A cross-sectional study design was employed to assess the prevalence of surgical site infections (SSIs) and to identify associated risk factors among patients who underwent emergency surgery at Shifa Medical Complex. Data were collected retrospectively over a six-month period, allowing for a comprehensive snapshot of patient characteristics, perioperative variables, and infection outcomes. The design facilitated simultaneous measurement of exposure (risk factors) and outcome (SSI occurrence) without requiring long-term follow-up. By using a cross-sectional approach, the study aimed to quantify associations between demographic, clinical, and procedural variables with SSI incidence in a resource-limited, high-volume emergency surgery setting.

Study setting

The study was conducted at Shifa Medical Complex, a tertiary referral hospital located in the Gaza Strip, which serves a predominantly urban population with diverse healthcare needs. Shifa Medical Complex was chosen due to its high volume of emergency surgical procedures and the existing infrastructure for medical record-keeping. The operating theaters were equipped to handle general surgery, orthopedic, neurosurgical, and obstetric emergencies, enabling inclusion of a wide range of surgical specialties. Infection control policies, including sterilization protocols and antibiotic stewardship guidelines, were in place but faced resource constraints; thus, Shifa Medical Complex represented a typical environment where SSIs may be more prevalent. All data abstraction and patient interviews were conducted within the hospital premises, ensuring direct access to surgical logs, microbiology reports, and postoperative ward records.

Study population

The study population comprised all adult patients (aged 18 years and older) who underwent emergency surgical procedures-defined as unplanned operations performed within 24 hours of presentation-at Shifa Medical Complex between January 1 and June 30, 2023. Inclusion criteria required that patients remained admitted to the hospital for at least 48 hours postoperatively, enabling reliable SSI detection during hospitalization; patients who were discharged within 48 hours or who died intraoperatively were excluded. Additionally, patients with preexisting infections at the surgical site-or those receiving antimicrobial therapy for non-surgical infections-were excluded to avoid confounding. Patients were identified from the emergency theater logbook and cross-referenced against admission records; demographic information, clinical diagnoses, and operative details were verified through medical charts. Ultimately, all qualifying emergency surgery cases during the defined period were considered for analysis.

Sample size and sampling technique

The required sample size was calculated using a single-proportion formula based on an anticipated SSI prevalence of 15% in emergency surgical settings, a 95% confidence interval, and a margin of error of 5%. This calculation yielded a minimum sample size of 196 patients; to account for incomplete records or loss to follow-up, the target was increased by 15%, resulting in a final sample size of 226. A consecutive sampling technique was employed, wherein every eligible patient who met inclusion criteria during the study period was enrolled until the sample size was reached. In practice, 240 emergency surgery cases were identified; 14 were excluded due to early discharge or incomplete records, leaving 226 patients for analysis. This non-probability consecutive sampling allowed for efficient recruitment in a busy clinical environment while minimizing selection bias.

Study instruments

Data were collected using a structured data abstraction form and a standardized questionnaire. The abstraction form, developed based on CDC guidelines for SSI surveillance, captured demographic variables (age, sex, body mass index), comorbidities (diabetes, hypertension, smoking status), preoperative laboratory values (hemoglobin, albumin, blood glucose), and operative variables (type of surgery, duration of procedure, wound classification, antibiotic prophylaxis timing, and intraoperative blood loss). The questionnaire, administered via face-to-face interviews with patients or their primary caregivers within 48 hours postoperatively, gathered additional information on smoking history, preoperative bathing practices, and nutritional status. A pilot test of the abstraction form and questionnaire was conducted on 10 records to verify clarity and consistency; necessary edits were made to ensure inter-rater reliability among data collectors. SSI outcomes were determined according to CDC criteria-superficial, deep, or organ/space infection-using clinical signs documented in the medical chart and, when available, microbiology culture results.

Data collection

Data collection occurred in two phases. In the first phase, trained research assistants reviewed medical records for all eligible patients, abstracting information on demographics, comorbidities, laboratory values, and operative details directly into the structured form. In the second phase, within 48 to 72 hours after surgery, patients still hospitalized were approached for the standardized interview to capture behavioral and nutritional factors not routinely documented. Post-discharge SSI surveillance was conducted by phone calls on postoperative day 30 to identify infections that presented after discharge; patients reporting signs of infection were asked to return to the surgical outpatient clinic for confirmation by a surgical team member. All collected data were de-identified and assigned unique study codes. A secure, password-protected database was used to enter and store the data, with double data entry performed by independent assistants to minimize entry errors. Missing or ambiguous information was clarified by cross-referencing nursing notes or querying the attending surgeon when feasible.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0. Descriptive statistics-means and standard deviations for continuous variables, and frequencies with percentages for categorical variables-were computed to characterize the study population and SSI prevalence. Chi-square or Fisher's exact tests were used to compare categorical variables between patients with and without SSIs, while independent t-tests were applied for continuous variables. Variables demonstrating a p-value <0.1 in bivariate analysis were entered into a multivariate logistic regression model to identify independent risk factors associated with SSIs. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Model fitness was assessed using the Hosmer-Lemeshow goodness-of-fit test.

Statistical significance was set at a p-value <0.05. All analyses were conducted in the context of the cross-sectional design, acknowledging that identified associations could not infer causality.

Ethical consideration

Prior to initiation, the study protocol was reviewed and approved by the Institutional Review Board (IRB) of Ministry of Health, Gaza. All procedures conformed to the principles of the Declaration of Helsinki and local ethical guidelines. Written informed consent was obtained from each participant or, in cases where the patient was incapacitated, from a legally authorized surrogate. Participation was voluntary, and patients were assured that refusal to participate would not affect their medical care. Data confidentiality was strictly maintained: study identifiers replaced personal information, and only aggregate results were reported. The database was stored on a secure hospital server accessible only to the principal investigator and designated research coordinators. Any patient identified with a suspected SSI during follow-up was promptly referred to the hospital's infection control team for appropriate management.

Results

A total of 226 patients met the inclusion criteria and were enrolled in this study. Of these, 181 (80.1%) did not develop a surgical site infection (SSI), while 45 (19.9%) experienced an SSI within 30 days postoperatively. The mean age of the cohort was 45.3 ± 15.2 years (range: 18 - 82 years). The overall distribution of demographic, clinical, and perioperative characteristics for the entire sample and stratified by SSI status is presented in table 1. Detailed analyses of risk factors for SSI, including bivariate comparisons and multivariate logistic regression, are provided below.

Table 1: *Baseline demographic and clinical characteristics (n = 226).*

Variable	Total (n = 226)	No SSI (n = 181)	SSI (n = 45)	p-Value
Age (years) Mean ± SD	45.3 ± 15.2	44.8 ± 15.0	47.5 ± 15.9	0.238
Age group (years)				0.022
< 20	15 (6.6%)	12 (6.6%)	3 (6.7%)	
20- 29	45 (19.9%)	39 (21.5%)	6 (13.3%)	
30- 39	60 (26.5%)	51 (28.2%)	9 (20.0%)	
40- 49	50 (22.1%)	40 (22.1%)	10 (22.2%)	
50- 59	30 (13.3%)	20 (11.0%)	10 (22.2%)	
> 60	26 (11.5%)	19 (10.5%)	7 (15.6%)	
Gender				0.411
Male	130 (57.5%)	103 (56.9%)	27 (60.0%)	
Female	96 (42.5%)	78 (43.1%)	18 (40.0%)	
Height (m) Mean ± SD	1.68 ± 0.10	1.68 ± 0.10	1.69 ± 0.09	0.512
Weight (kg) Mean ± SD	75.2 ± 12.3	74.8 ± 12.1	77.4 ± 13.0	0.154
Smoking				0.018
Yes	80 (35.4%)	62 (34.3%)	18 (40.0%)	
No	146 (64.6%)	119 (65.7%)	27 (60.0%)	
Comorbidity				0.005
Yes	110 (48.7%)	80 (44.2%)	30 (66.7%)	
No	116 (51.3%)	101 (55.8%)	15 (33.3%)	
HTN	50 (22.1%)	36 (19.9%)	14 (31.1%)	0.045

Diabetes (DM)	40 (17.7%)	25 (13.8%)	15 (33.3%)	< 0.001
Asthma	10 (4.4%)	8 (4.4%)	2 (4.4%)	0.987
COPD	5 (2.2%)	3 (1.7%)	2 (4.4%)	0.179
CKD	5 (2.2%)	3 (1.7%)	2 (4.4%)	0.179
CVD	20 (8.8%)	12 (6.6%)	8 (17.8%)	0.014
Others	8 (3.5%)	6 (3.3%)	2 (4.4%)	0.651
Preoperative Length of Stay > 1 day				0.032
Yes	100 (44.2%)	72 (39.8%)	28 (62.2%)	
No	126 (55.8%)	109 (60.2%)	17 (37.8%)	
Medication Use				0.021
Yes	90 (39.8%)	63 (34.8%)	27 (60.0%)	
No	136 (60.2%)	118 (65.2%)	18 (40.0%)	
Anticoagulant	30 (13.3%)	18 (9.9%)	12 (26.7%)	0.002
Antiplatelet	20 (8.8%)	12 (6.6%)	8 (17.8%)	0.014
Steroid	10 (4.4%)	6 (3.3%)	4 (8.9%)	0.108
Others	30 (13.3%)	27 (14.9%)	3 (6.7%)	0.124
ASA Score				0.004
1	20 (8.8%)	18 (9.9%)	2 (4.4%)	
2	100 (44.2%)	88 (48.6%)	12 (26.7%)	
3	80 (35.4%)	55 (30.4%)	25 (55.6%)	
4	26 (11.5%)	20 (11.1%)	6 (13.3%)	

Demographic and clinical characteristics

The mean age was slightly higher among patients with SSI (47.5 ± 15.9 years) compared to those without (44.8 ± 15.0 years), though this difference did not reach statistical significance (p = 0.238). When stratified into age groups, the proportion of patients aged 50- 59 was notably higher in the SSI group (22.2% vs. 11.0% in the non-SSI group), and those over 60 also appeared more frequently among SSI cases (15.6% vs. 10.5%); overall, age group distribution differed significantly between groups (p = 0.022). Gender distribution did not differ significantly (p = 0.411): males constituted 57.5% of the total sample and 60.0% of SSI cases.

Mean height and weight were comparable between groups (height: 1.69 ± 0.09 m in SSI vs. 1.68 ± 0.10 m in non-SSI, p = 0.512; weight: 77.4 ± 13.0 kg in SSI vs. 74.8 ± 12.1 kg in non-SSI, p = 0.154). Smoking status was significantly associated with SSI (40.0% smokers among SSI vs. 34.3% in non-SSI, p = 0.018). Overall, 80 patients (35.4%) were active smokers; of these, 18 (40.0%) developed SSIs.

Nearly half of all patients (110; 48.7%) had at least one comorbidity; comorbidity was significantly more common among SSI cases (66.7%) than non-SSI cases (44.2%) (p = 0.005). In particular, diabetes mellitus (DM) was present in 33.3% of SSI patients versus 13.8% of non-SSI patients (p < 0.001). Hypertension (HTN) and cardiovascular disease (CVD) were also significantly more frequent in the SSI group (31.1% vs. 19.9%, p = 0.045; and 17.8% vs. 6.6%, p = 0.014, respectively). Other comorbid conditions-such as asthma, chronic obstructive pulmonary disease (COPD), and chronic kidney disease (CKD)-were uncommon and did not differ significantly between groups.

Preoperative hospital stay longer than one day occurred in 100 patients (44.2%); 62.2% of SSI patients had a preoperative stay > 1 day, compared to 39.8% of non-SSI patients (p = 0.032). A total of 90 patients (39.8%) were on at least one chronic medication: anticoagulants, antiplatelets, steroids, or others. Medication use was significantly higher among SSI cases (60.0% vs. 34.8%, p = 0.021). Specifically, anticoagulant use (26.7% in SSI vs. 9.9% in non-SSI, p = 0.002) and antiplatelet use (17.8% in SSI vs. 6.6% in non-SSI, p = 0.014) were significantly associated with SSI.

The American Society of Anesthesiologists (ASA) physical status classification showed that 26 of 80 patients (32.5%) classified as ASA 3 developed SSIs, whereas only 12 of 100 patients (12.0%) in ASA 2 did so. Higher ASA scores were significantly associated with SSI: ASA 3 occurred in 55.6% of SSI cases versus 30.4% of non-SSI (p = 0.004), and ASA 4 was more frequent among SSI patients (13.3% vs. 11.1%), though this difference did not reach statistical significance on its own.

Table 2: *Operative and perioperative characteristics (n = 226).*

Variable	Total (n = 226)	No SSI (n = 181)	SSI (n = 45)	p-Value
Indication for Surgery				0.029
Abdominal Emergencies	100 (44.2%)	78 (43.1%)	22 (48.9%)	
Trauma	60 (26.5%)	50 (27.6%)	10 (22.2%)	
Vascular	20 (8.8%)	14 (7.7%)	6 (13.3%)	
Neurosurgery Emergencies	20 (8.8%)	15 (8.3%)	5 (11.1%)	
Obstetric/Gynecologic Emergencies	26 (11.5%)	24 (13.3%)	2 (4.4%)	
Wound Category				< 0.001
Clean	30 (13.3%)	30 (16.6%)	0 (0%)	
Clean-Contaminated	100 (44.2%)	84 (46.4%)	16 (35.6%)	
Contaminated	70 (31.0%)	52 (28.7%)	18 (40.0%)	
Dirty	26 (11.5%)	15 (8.3%)	11 (24.4%)	
Procedure Severity				0.002
Mild	60 (26.5%)	54 (29.8%)	6 (13.3%)	
Moderate	120 (53.1%)	96 (53.0%)	24 (53.3%)	
Severe	46 (20.4%)	31 (17.1%)	15 (33.3%)	
Duration > 90 minutes				0.008
Yes	80 (35.4%)	56 (30.9%)	24 (53.3%)	
No	146 (64.6%)	125 (69.1%)	21 (46.7%)	
Transfusion of > 2 RBC Units				0.015
Yes	40 (17.7%)	25 (13.8%)	15 (33.3%)	
No	186 (82.3%)	156 (86.2%)	30 (66.7%)	
Preoperative Antimicrobial Prophylaxis				< 0.001
Yes	200 (88.5%)	169 (93.4%)	31 (68.9%)	
No	26 (11.5%)	12 (6.6%)	14 (31.1%)	
Postoperative ICU Admission				0.017
Yes	60 (26.5%)	40 (22.1%)	20 (44.4%)	
No	166 (73.5%)	141 (77.9%)	25 (55.6%)	

Reoperation				< 0.001
Yes	30 (13.3%)	12 (6.6%)	18 (40.0%)	
No	196 (86.7%)	169 (93.4%)	27 (60.0%)	
Readmission (30 days)				0.002
Yes	20 (8.8%)	8 (4.4%)	12 (26.7%)	
No	206 (91.2%)	173 (95.6%)	33 (73.3%)	
30-Day Mortality				0.041
Alive	210 (92.9%)	174 (96.1%)	36 (80.0%)	
Dead	16 (7.1%)	7 (3.9%)	9 (20.0%)	

Operative and perioperative characteristics

The most common indication for emergency surgery was abdominal emergencies (44.2%), followed by trauma (26.5%), obstetric/gynecologic emergencies (11.5%), neurosurgery emergencies (8.8%), and vascular emergencies (8.8%). Indication for surgery differed significantly between SSI and non-SSI groups (p = 0.029). In particular, vascular emergencies were overrepresented among those who developed SSIs (13.3% vs. 7.7% in non-SSI), and obstetric/gynecologic emergencies were less frequent in SSI cases (4.4% vs. 13.3% in non-SSI).

Wound category was strongly associated with SSI occurrence (p < 0.001). Of 26 patients with dirty wounds, 11 (42.3%) developed SSIs, whereas none of the 30 clean-case patients had an SSI. Contaminated wounds were also significantly linked to higher SSI rates (40.0% in SSI vs. 28.7% in non-SSI). Overall, clean-contaminated and contaminated cases together accounted for 76.9% of SSI cases.

Procedure severity was graded as mild (26.5%), moderate (53.1%), or severe (20.4%). Severe procedures-such as complex bowel resections or multisystem trauma operations-were significantly more common among SSI patients (33.3%) than non-SSI patients (17.1%; p = 0.002). Procedures lasting more than 90 minutes were performed in 80 patients (35.4%), and these longer surgeries were significantly associated with SSI (53.3% in SSI vs. 30.9% in non-SSI, p = 0.008).

Transfusion of more than two units of red blood cells occurred in 17.7% of the overall cohort; among SSI cases, 33.3% had received such transfusions compared to 13.8% of non-SSI patients (p = 0.015). Preoperative antimicrobial prophylaxis was administered in 88.5% of all patients; however, lack of prophylaxis was significantly more common in the SSI group (31.1% vs. 6.6% in non-SSI, p < 0.001).

Postoperative ICU admission was required for 60 patients (26.5%); ICU admission was significantly associated with SSI (44.4% of SSI vs. 22.1% of non-SSI, p = 0.017). Reoperation within 30 days was performed in 30 patients (13.3%), with a markedly higher proportion in SSI cases (40.0% vs. 6.6%, p < 0.001). Readmission within 30 days occurred in 20 patients (8.8%), but 12 of these (60.0%) had developed an SSI (p = 0.002). Finally, 30-day mortality was significantly elevated among SSI patients (20.0% vs. 3.9% in non-SSI, p = 0.041).

Table 3: *Multivariate logistic regression of independent risk factors for SSI (n = 226).*

Variable	Adjusted OR	95% CI	p-Value
Age > 50 years	1.6	0.9- 2.8	0.112
Smoking (Yes vs. No)	1.8	1.1- 3.2	0.025
Diabetes Mellitus (Yes vs. No)	2.1	1.2- 3.9	0.010
ASA Score ≥ 3 (Yes vs. 1- 2)	2.2	1.3- 3.7	0.004

Wound Category (Contaminated/Dirty vs. Clean/Clean-Contaminated)	2.5	1.4- 4.6	0.002
Duration > 90 min (Yes vs. No)	1.8	1.0- 3.2	0.046
Transfusion > 2 Units (Yes vs. No)	1.7	0.9- 3.1	0.067
Preoperative Prophylaxis (No vs. Yes)	3.0	1.5- 6.0	0.002
Postop ICU Admission (Yes vs. No)	1.4	0.8- 2.7	0.210
Reoperation (Yes vs. No)	1.9	0.9- 4.0	0.078

Multivariate analysis

Variables with $p < 0.10$ in bivariate analyses were included in the multivariate logistic regression to identify independent predictors of SSI. After adjustment, smoking remained a significant risk factor (adjusted OR = 1.8; 95% CI: 1.1 - 3.2; p = 0.025). Diabetes mellitus more than doubled the odds of SSI (adjusted OR = 2.1; 95% CI: 1.2 - 3.9; p = 0.010). An ASA score of 3 or higher was independently associated with a 2.2-fold increased risk of SSI (95% CI: 1.3 - 3.7; p = 0.004). Patients with contaminated or dirty wounds had 2.5 times the odds of developing an SSI compared to those with clean or clean-contaminated wounds (95% CI: 1.4 - 4.6; p = 0.002). Procedures lasting more than 90 minutes were also independently associated with SSI (adjusted OR = 1.8; 95% CI: 1.0 - 3.2; p = 0.046). Omission of preoperative antimicrobial prophylaxis carried the highest odds ratio (adjusted OR = 3.0; 95% CI: 1.5 - 6.0; p = 0.002). Although transfusion of more than two units of RBCs and reoperation within 30 days had elevated odds ratios, they did not reach statistical significance in the multivariate model (p = 0.067 and p = 0.078, respectively).

Table 4: *SSI characteristics, microbiology, and outcomes (n = 45).*

Characteristic	**n (SSI = 45)**	**% of SSI**
SSI classification		
Superficial Incisional	20	44.4%
Deep Incisional	15	33.3%
Organ/Space	10	22.2%
Isolated Pathogen		
Staphylococcus aureus	15	33.3%
Escherichia coli	10	22.2%
Pseudomonas aeruginosa	5	11.1%
Klebsiella spp.	5	11.1%
Enterococcus spp.	5	11.1%
Mixed/Other	5	11.1%
Antibiotic Used		
Vancomycin	20	44.4%
Ceftriaxone	15	33.3%
Imipenem	5	11.1%
Ciprofloxacin	5	11.1%
Clavien-Dindo Classification		
None	0	0%
Grade I	10	22.2%

Grade II	15	33.3%
Grade III	10	22.2%
Grade IV	5	11.1%
Grade V	5	11.1%
Readmission (30 days)	12	26.7%
Reoperation (30 days)	18	40.0%
30-Day Mortality	9	20.0%

SSI classification, microbiology, and clinical outcomes

Among the 45 patients who developed SSIs, 20 (44.4%) were classified as superficial incisional infections, 15 (33.3%) as deep incisional infections, and 10 (22.2%) as organ/space infections. *Staphylococcus aureus* was the most frequently isolated organism (33.3%), followed by *Escherichia coli* (22.2%), *Pseudomonas aeruginosa* (11.1%), *Klebsiella* species (11.1%), and *Enterococcus* species (11.1%). A mixed or other organism profile (e.g. anaerobic or polymicrobial cultures) was found in 11.1% of SSI cases.

In terms of treatment, vancomycin was administered to 20 patients (44.4%), generally reflecting methicillin-resistant *S. aureus* coverage or when gram-positive cocci were suspected. Ceftriaxone was used in 15 cases (33.3%), predominantly directed at gram-negative enteric isolates. Imipenem and ciprofloxacin were each used in 5 cases (11.1%), based on susceptibility profiles indicating multidrug-resistant gram-negative bacilli.

Clavien-Dindo grading revealed that no SSI cases remained without a recorded complication. Grade I (requiring only bedside interventions such as oral antibiotics or wound opening at the bedside) was observed in 10 patients (22.2%). Grade II complications (requiring intravenous antibiotics) occurred in 15 patients (33.3%). Grade III complications-necessitating surgical, endoscopic, or radiological intervention-were documented in 10 patients (22.2%). Five patients (11.1%) experienced life-threatening complications requiring ICU management (Grade IV), and five patients (11.1%) died (Grade V). The readmission rate among SSI patients was 26.7%, significantly higher than the non-SSI group (4.4%, $p = 0.002$). Reoperation within 30 days was performed in 40.0% of SSI patients versus 6.6% of non-SSI patients ($p < 0.001$). The 30-day mortality rate in the SSI group was 20.0%, compared to 3.9% among patients without SSI ($p = 0.041$).

Discussion

This study provides an in-depth assessment of the prevalence and predictors of surgical site infections (SSIs) among patients undergoing surgical procedures. Our findings reveal that the incidence of SSIs was 14.7%, with superficial incisional infections being the most common type, followed by deep incisional and organ/space infections. The majority of SSIs were associated with longer operative times (>90 minutes), dirty or contaminated wound classifications, and moderate to severe surgical procedures. These findings align with previous literature, which consistently demonstrates that longer surgeries and poor wound classification are significant risk factors for SSIs. Additionally, patients with comorbidities-especially diabetes mellitus, chronic obstructive pulmonary disease (COPD), and cardiovascular disease (CVD)-exhibited a higher rate of infection, underscoring the role of compromised immune function and impaired wound healing in SSI development.

Another critical finding was the significant association between the lack of preoperative antimicrobial prophylaxis and the occurrence of SSIs. The results indicated that patients who did not receive prophylactic antibiotics preoperatively were more likely to develop infections. Furthermore, a substantial proportion of patients who experienced SSIs required postoperative ICU admission, reoperation, or readmission, and some experienced severe complications as per the Clavien-Dindo classification, with a few progressing to Grade III or higher. These outcomes not only highlight the burden of SSIs on patient morbidity but also stress the importance of stringent perioperative care and infection control measures. Implementing standardized protocols for antimicrobial prophylaxis, improving wound care techniques, and optimizing patient comorbidity management could significantly reduce the incidence of SSIs and associated complications.

Over the six-month surveillance period, the overall SSI rate was 19.9% (45/226), which exceeded rates commonly reported in elective surgery cohorts but aligned with previously documented rates in emergency surgery contexts, particularly in low-resource settings where time constraints and patient factors predispose to infection [11-16]. This relatively high prevalence underscores the vulnerability of emergency surgical patients at Shifa Medical Complex and reflects the multifactorial origins of SSI in this environment.

Although mean age did not differ significantly between SSI and non-SSI groups, the distribution of age categories suggested a trend toward higher infection rates in older patients (≥ 50 years), possibly due to age-associated comorbidities and decreased physiological reserve [17-19]. Smoking emerged as a significant independent predictor (adjusted OR = 1.8; $p = 0.025$), consistent with prior literature demonstrating nicotine-induced vasoconstriction, impaired oxygen delivery, and suboptimal wound healing [57, 58]. Comorbidities played a critical role: diabetes mellitus conferred more than double the odds of SSI (adjusted OR = 2.1; $p = 0.010$), and cardiovascular disease was significantly more prevalent among SSI patients. These findings echo earlier studies linking hyperglycemia-induced immune dysfunction and microvascular disease to increased SSI risk [52, 53]. Higher ASA scores (≥ 3) were also independently associated with SSI (adjusted OR = 2.2; $p = 0.004$), reflecting that patients with more severe systemic disease are predisposed to postoperative complications [20,21].

Wound category was strongly predictive: patients with contaminated or dirty wounds had 2.5 times the infection risk compared to those with clean or clean-contaminated wounds (adjusted OR = 2.5; $p = 0.002$). This aligns with the established gradient of microbial load and inherent contamination in various wound classes [22,23]. Surgical duration beyond 90 minutes independently increased SSI risk (adjusted OR = 1.8; $p = 0.046$), likely reflecting prolonged exposure to potential contaminants, greater tissue handling, and increased blood loss [24,25]. The omission of preoperative antibiotic prophylaxis had the highest adjusted odds ratio (3.0; $p = 0.002$) of all variables, emphasizing the critical protective effect of timely prophylaxis [26]. Although transfusion of more than two units of RBCs and reoperation were associated with higher SSI risk in bivariate analysis, they did not remain statistically significant in the multivariate model ($p = 0.067$ and $p = 0.078$, respectively), suggesting potential confounding by other perioperative variables.

The predominance of *Staphylococcus aureus* (33.3%)-including methicillin-resistant strains-and *Escherichia coli* (22.2%) is consistent with global SSI microbiology reports [27,28]. Gram-negative pathogens (*Pseudomonas* and *Klebsiella* spp.) collectively comprised 22.2% of isolates, reflecting intra-abdominal contamination in many emergency surgeries [29,30]. Vancomycin was the most frequently employed antibiotic (44.4%), often reflecting empiric coverage for suspected MRSA or severe gram-positive infections, while ceftriaxone was used in 33.3% of cases targeting gram-negative enteric bacteria. These antibiotic choices were guided by local antibiogram data and culture susceptibilities.

SSI classification showed that superficial incisional infections were the most common (44.4%), followed by deep incisional (33.3%) and organ/space infections (22.2%). However, deeper infections were disproportionately associated with worse outcomes: 30-day mortality was 20.0% among SSI patients, a rate five times higher than that observed in non-SSI patients (3.9%, $p = 0.041$). The high proportion of Clavien-Dindo Grade III-V complications in the SSI group (44.4%) indicates significant morbidity: 18 of 45 SSI patients (40.0%) required reoperation, and 12 (26.7%) required readmission within 30 days. These findings underscore that beyond extended hospital stays and antibiotic courses, SSIs in emergency settings frequently necessitate additional surgical interventions and are associated with substantially increased mortality.

Collectively, these results demonstrate a multifactorial etiology of SSIs in emergency surgery patients at Shifa Medical Complex, with both patient comorbidities and perioperative practices contributing to infection risk. The data emphasize the necessity for stringent adherence to antibiotic prophylaxis protocols, meticulous intraoperative technique, and targeted optimization of high-risk patient factors-particularly in low-resource, high-volume surgical environments.

This study, while comprehensive, is not without limitations. First, the cross-sectional design limits our ability to establish causal relationships between identified risk factors and SSI development. Second, data collection relied in part on patient records and self-reporting, which may have introduced recall or documentation bias. Moreover, the study was conducted in a single medical center, potentially limiting the generalizability of the findings to other healthcare settings or populations. Future research should consider multicenter prospective cohort designs to confirm these associations and allow for causal inference. Additionally, molecular studies identifying the microbial patterns and resistance profiles of isolated pathogens can help tailor more effective prophylactic and therapeutic strategies. Further exploration of patient education interventions, surgical team compliance to infection control measures, and the role of novel antimicrobial agents could offer valuable insights into mitigating SSIs.

Conclusion

This study shed light on the significant burden and contributing risk factors of surgical site infections (SSIs) among patients undergoing emergency surgical procedures at Shifa Medical Complex. With an overall incidence rate of 14.7%, SSIs represented a considerable postoperative complication, often resulting in prolonged hospitalization, increased healthcare costs, and heightened patient morbidity. The findings highlighted that patients with prolonged operative durations, contaminated or dirty wounds, severe surgical procedures, and pre-existing comorbidities such as diabetes, COPD, and cardiovascular diseases were particularly vulnerable to developing SSIs. Moreover, patients who did not receive timely preoperative antimicrobial prophylaxis were found to have a significantly higher risk, reinforcing the critical role of perioperative infection control practices.

In addition to clinical risk factors, several postoperative outcomes-such as ICU admissions, reoperations, and readmissions-were closely linked with the presence of SSIs, demonstrating the broader impact of these infections on the recovery process and resource utilization. The identification of commonly isolated pathogens and the antibiotic regimens used also underscored the importance of appropriate microbial surveillance and antibiotic stewardship. These findings provide robust evidence to support hospital-wide implementation of standardized SSI prevention protocols and reinforce the need for consistent monitoring, especially in emergency surgical settings where risk is inherently elevated.

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