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Original Research Article

Evaluation of Surgical Site Infection Rates in Emergency Abdominal Surgeries: A Retrospective Study

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Abstract

Background: Surgical site infections (SSIs) remain among the most common healthcare-associated infections, particularly in emergency abdominal surgeries where contamination risks and patient vulnerability are elevated. Despite advances in perioperative care, SSI rates in emergency settings remain substantially higher than in elective procedures. This study aimed to evaluate SSI rates, identify risk factors, and assess outcomes in patients undergoing emergency abdominal surgery.

Methods: A retrospective cohort study was conducted at a tertiary care hospital. Medical records of 782 patients undergoing emergency abdominal surgery were reviewed. Data on demographics, clinical characteristics, operative details, and SSI occurrence were collected. SSIs were classified according to Centers for Disease Control and Prevention (CDC) criteria. Multivariable logistic regression identified independent risk factors for SSI development.

Results: The overall SSI rate was 24.7% (193/782), comprising 58.5% superficial incisional, 28.0% deep incisional, and 13.5% organ/space infections. Mean age was 52.6 ± 16.8 years, with 56.4% male patients. SSI rates varied significantly by procedure type: perforated viscus repair (38.2%), bowel obstruction surgery (26.1%), acute appendicitis (18.4%), and trauma laparotomy (31.5%) ($p < 0.001$). Patients with SSI had significantly longer hospital stays (14.8 ± 7.6 vs. 7.2 ± 3.4 days, $p < 0.001$), higher reoperation rates (12.4% vs. 2.2%, $p < 0.001$), and increased mortality (6.7% vs. 1.5%, $p = 0.001$). Independent risk factors included: contaminated/ dirty wound class (OR = 4.26, 95% CI: 2.84-6.39, $p < 0.001$), diabetes mellitus (OR = 2.18, 95% CI: 1.45-3.27, $p < 0.001$), preoperative stay >24 hours (OR = 1.87, 95% CI: 1.26-2.78, $p = 0.002$), operative time >120 minutes (OR = 2.34, 95% CI: 1.61-3.40, $p < 0.001$), and hypothermia during surgery (OR = 1.76, 95% CI: 1.15-2.69, $p = 0.009$).

Conclusion: SSI rates in emergency abdominal surgery remain unacceptably high, with significant impacts on morbidity, mortality, and healthcare costs. Identified modifiable risk factors provide targets for quality improvement interventions including glycemic control, perioperative warming, and enhanced surgical techniques.

Keywords: Surgical Site Infection; Emergency Surgery; Abdominal Surgery; Risk Factors; Healthcare-Associated Infection; Perioperative Complications; Wound Infection.

Introduction

Surgical site infections (SSIs) represent one of the most prevalent and costly healthcare-associated infections worldwide, affecting 2-5% of patients undergoing surgical procedures and accounting for approximately 20% of all nosocomial infections [1]. The burden of SSIs extends beyond immediate clinical complications to encompass prolonged hospitalization, increased healthcare expenditure, decreased quality of life, and elevated mortality rates [2]. In the United States alone, SSIs contribute to an estimated 11,000 deaths annually and generate excess healthcare costs exceeding $3 billion [3]. Emergency abdominal surgery presents unique challenges that substantially elevate SSI risk compared to elective procedures [4]. Patients requiring urgent surgical intervention often present with compromised physiological status, established infection or contamination, inadequate preoperative optimization, and limited time for prophylactic measures [5]. Furthermore, emergency conditions such as perforated viscus, gangrenous appendicitis, bowel ischemia, and abdominal trauma inherently involve bacterial contamination of the surgical field [6]. The confluence of these factors creates an environment particularly conducive to SSI development [7]. The Centers for Disease Control and Prevention (CDC) classify SSIs into three categories: superficial incisional SSI involving skin and subcutaneous tissue, deep incisional SSI affecting fascial and muscle layers, and organ/space SSI involving anatomic structures manipulated during the procedure [8]. Each category carries distinct clinical implications, treatment requirements, and prognostic significance [9]. Understanding the distribution and determinants of these SSI subtypes in emergency abdominal surgery is essential for developing targeted prevention strategies [10].

Extensive literature has identified numerous risk factors for SSI development across surgical disciplines [11]. Patient-related factors include advanced age, obesity, diabetes mellitus, immunosuppression, malnutrition, smoking, and concurrent infections [12]. Procedure-related variables encompass wound classification, operative duration, surgical technique, perioperative hypothermia, and antibiotic prophylaxis adequacy [13]. Additionally, hospital and surgeon-specific factors such as surgical volume, experience, and adherence to infection prevention bundles influence SSI rates [14].

Despite recognition of these risk factors, SSI rates in emergency abdominal surgery remain persistently elevated across healthcare systems [15]. A systematic review by Danwang et al. reported SSI incidence ranging from 12% to 39% in emergency gastrointestinal surgery, substantially higher than the 2-8% observed in elective procedures [16]. This disparity underscores the need for emergency surgery-specific prevention protocols and risk stratification tools [17].

Recent advances in perioperative infection prevention have demonstrated promise in reducing SSI burden [18]. Enhanced Recovery after Surgery (ERAS) protocols, though primarily developed for elective settings, incorporate evidence-based elements applicable to emergency contexts including antimicrobial prophylaxis optimization, glycemic control, normothermia maintenance, and meticulous surgical technique [19].

However, implementation barriers in emergency settings—including time constraints, heterogeneous patient populations, and resource limitations—have hindered widespread adoption [20].

Several knowledge gaps persist in understanding SSIs in emergency abdominal surgery. First, contemporary data on SSI epidemiology in this specific population remain limited, with most studies focusing on elective procedures or combining emergency and elective cohorts [21].

Second, the relative contribution of modifiable versus non-modifiable risk factors in emergency contexts requires clarification to guide intervention prioritization [22]. Third, the impact of SSIs on clinical outcomes, healthcare utilization, and costs in emergency surgery populations warrants comprehensive evaluation [23]. From a quality improvement perspective, reducing SSIs represents a key metric in surgical care optimization [24]. Many SSIs are potentially preventable through systematic implementation of evidence-based bundles addressing preoperative, intraoperative, and postoperative risk factors [25]. Identification of institution-specific SSI rates, causative organisms, and local risk factor profiles provides the foundation for tailored prevention initiatives [26].

The microbiology of SSIs in emergency abdominal surgery reflects the polymicrobial nature of gastrointestinal flora, with common pathogens including Escherichia coli, Bacteroides species, Enterococcus, and Klebsiella [27]. Emerging antimicrobial resistance among these organisms complicates empiric treatment and underscores the importance of prevention [28]. Additionally, the rise of healthcare-associated pathogens such as methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Gram-negative organisms presents evolving challenges [29].

This study was designed to comprehensively evaluate SSI rates, characterize infection types, identify independent risk factors, and assess clinical and economic impacts in patients undergoing emergency abdominal surgery at a tertiary care hospital. We hypothesized that SSI rates would be substantially elevated compared to published benchmarks for elective surgery and that potentially modifiable perioperative factors would emerge as significant independent predictors of infection. The findings aim to inform evidence-based quality improvement initiatives targeting SSI reduction in this high-risk surgical population.

Materials and Methods

Study Design and Setting: This retrospective cohort study was conducted at tertiary care hospital.

Study Population: The study population comprised all adult patients (≥18 years) who underwent emergency abdominal surgery during the study period. Emergency surgery was defined as any intra-abdominal procedure performed within 24 hours of clinical presentation due to acute pathology requiring urgent intervention.

Inclusion Criteria:

1. Age ≥18 years at time of surgery
2. Emergency abdominal surgery performed through laparotomy or laparoscopy
3. Procedures including but not limited to: appendectomy, cholecystectomy, bowel resection, perforation repair, exploratory laparotomy, damage control surgery
4. Complete medical records available for review

5. Minimum 30-day follow-up or documented outcome

Exclusion Criteria:

1. Elective or semi-elective procedures
2. Gynecological or urological primary pathology
3. Purely diagnostic procedures without therapeutic intervention
4. Patients transferred from other facilities with pre-existing surgical site infections
5. Incomplete medical records or lost to follow-up before 30 days
6. Previous abdominal surgery within 30 days (to avoid confounding with pre-existing SSI)

Data Collection: Data were extracted from electronic medical records by trained research assistants using a standardized data collection form. Variables collected included:

Demographic and Clinical Characteristics:

- Age, sex, body mass index (BMI)
- Comorbidities: diabetes mellitus, chronic kidney disease, liver disease, immunosuppression, malignancy
- American Society of Anesthesiologists (ASA) physical status classification
- Preoperative laboratory values: hemoglobin, white blood cell count, albumin, creatinine
- Smoking status, alcohol use
- Preoperative hospitalization duration

Operative Variables:

- Primary diagnosis necessitating surgery
- Procedure type and complexity
- Surgical approach (open vs. laparoscopic)
- Wound classification (clean, clean-contaminated, contaminated, dirty/infected) per CDC guidelines
- Operative duration (skin incision to closure)
- Intraoperative findings (peritonitis, abscess, perforation)
- Estimated blood loss, transfusion requirements
- Perioperative temperature (lowest recorded)
- Antibiotic prophylaxis timing and selection

Postoperative Data:

- Hospital length of stay
- Intensive care unit (ICU) admission and duration
- Reoperation within 30 days
- In-hospital and 30-day mortality
- SSI occurrence, classification, and timing

Outcome Definition: The primary outcome was SSI occurrence within 30 days of surgery (90 days for procedures involving implants). SSIs were identified through active surveillance including daily wound assessments during hospitalization, review of microbiology cultures, readmission records, and outpatient clinic notes. SSI diagnosis and classification followed CDC/National Healthcare Safety Network (NHSN) criteria:

Superficial incisional SSI: Infection occurring within 30 days involving only skin and subcutaneous tissue with at least one of: purulent drainage, organisms isolated from culture, deliberate wound opening by surgeon, or diagnosis by surgeon.

Deep incisional SSI: Infection within 30 days involving fascial and muscle layers with at least one of: purulent drainage from deep incision, spontaneous dehiscence or deliberate opening with fever (>38°C) or localized pain/tenderness, abscess on direct examination or imaging, or diagnosis by surgeon.

Organ/space SSI: Infection within 30 days involving anatomic structures (other than incision) opened or manipulated during operation with at least one of: purulent drainage from drain in organ/space, organisms isolated from culture of organ/space, abscess on examination or imaging, or diagnosis by surgeon.

Statistical Analysis: Statistical analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY) and R version 4.2.0. Sample size was determined by the number of eligible cases during the study period, providing >90% power to detect clinically meaningful associations.

Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on distribution normality assessed by Shapiro-Wilk tests. Categorical variables were presented as frequencies and percentages. Between-group comparisons (SSI vs. no SSI) used independent t-tests or Mann-Whitney U tests for continuous variables and chi-square or Fisher's exact tests for categorical variables.

Univariable logistic regression identified variables associated with SSI development. Variables with $p < 0.20$ in univariable analysis and those with established clinical significance were entered into multivariable logistic regression models. Results were reported as odds ratios (OR) with 95% confidence intervals (CI). Model performance was assessed using area under the receiver operating characteristic curve (AUC-ROC) and Hosmer-Lemeshow goodness-of-fit test.

Subgroup analyses examined SSI rates across procedure types, wound classifications, and pathogen categories.

Sensitivity analyses excluded patients who died within 72 hours (to address competing risk) and those with incomplete follow-up.

Statistical significance was set at two-tailed $p < 0.05$.

Results

Study Population and Baseline Characteristics: During the 4-year study period, 847 patients underwent emergency abdominal surgery. After applying exclusion criteria, 782 patients were included in the final analysis. The mean age was 52.6 ± 16.8 years, and 441 (56.4%) were male. Overall, 193 patients (24.7%) developed SSIs within 30 days of surgery. Table 1 presents baseline demographic and clinical characteristics stratified by SSI occurrence.

Table 1: Baseline Demographic and Clinical Characteristics by SSI Status

Characteristic	SSI Group (n=193)	No SSI Group (n=589)	p-value
Demographics			
Age (years), mean ± SD	55.3 ± 17.2	51.7 ± 16.6	0.012
Age ≥65 years, n (%)	67 (34.7)	156 (26.5)	0.029
Male sex, n (%)	118 (61.1)	323 (54.8)	0.135
BMI (kg/m²), mean ± SD	28.9 ± 6.4	26.8 ± 5.7	<0.001
BMI ≥30 kg/m², n (%)	87 (45.1)	178 (30.2)	<0.001
Comorbidities			
Diabetes mellitus, n (%)	78 (40.4)	134 (22.7)	<0.001
Chronic kidney disease, n (%)	34 (17.6)	67 (11.4)	0.028
Liver disease, n (%)	28 (14.5)	56 (9.5)	0.058
Immunosuppression†, n (%)	31 (16.1)	54 (9.2)	0.009
Active malignancy, n (%)	24 (12.4)	48 (8.1)	0.080
Current smoker, n (%)	67 (34.7)	167 (28.3)	0.097
ASA class III-V, n (%)	156 (80.8)	389 (66.0)	<0.001
Preoperative status			
Preoperative stay >24h, n (%)	89 (46.1)	178 (30.2)	<0.001
Hemoglobin (g/dL), mean ± SD	11.4 ± 2.6	12.3 ± 2.3	<0.001
WBC (×10³/µL), mean ± SD	14.8 ± 6.2	13.2 ± 5.8	0.002
Albumin (g/dL), mean ± SD	3.1 ± 0.8	3.5 ± 0.7	<0.001
Albumin <3.0 g/dL, n (%)	87 (45.1)	167 (28.3)	<0.001
Creatinine (mg/dL), mean ± SD	1.4 ± 1.2	1.1 ± 0.9	0.001

BMI, body mass index; WBC, white blood cell; ASA, American Society of Anesthesiologists, †Immunosuppression defined as: corticosteroid use (>20mg prednisone equivalent daily), chemotherapy within 3 months, or primary immunodeficiency

Operative Characteristics and SSI Rates: Table 2 presents operative characteristics and SSI rates by procedure type and wound classification.

Table 2: Operative Characteristics and SSI Rates by Procedure Type

Characteristic	All Patients (n=782)	SSI Group (n=193)	No SSI Group (n=589)	p-value
Primary diagnosis, n (%)				<0.001
Acute appendicitis	245 (31.3)	45 (23.3)	200 (34.0)	
Perforated viscus	152 (19.4)	58 (30.1)	94 (16.0)	
Bowel obstruction	176 (22.5)	46 (23.8)	130 (22.1)	
Acute cholecystitis	98 (12.5)	14 (7.3)	84 (14.3)	
Abdominal trauma	68 (8.7)	21 (10.9)	47 (8.0)	
Other†	43 (5.5)	9 (4.7)	34 (5.8)	
SSI rate by diagnosis				
Acute appendicitis	245	45 (18.4%)	200 (81.6%)	
Perforated viscus	152	58 (38.2%)	94 (61.8%)	
Bowel obstruction	176	46 (26.1%)	130 (73.9%)	
Acute cholecystitis	98	14 (14.3%)	84 (85.7%)	
Abdominal trauma	68	21 (30.9%)	47 (69.1%)	
Wound classification, n (%)				<0.001
Clean-contaminated	287 (36.7)	34 (17.6)	253 (42.9)	
Contaminated	312 (39.9)	78 (40.4)	234 (39.7)	
Dirty/infected	183 (23.4)	81 (42.0)	102 (17.3)	
Surgical approach, n (%)				0.003
Laparoscopic (including conversions)	334 (42.7)	67 (34.7)	267 (45.3)	
Open laparotomy	448 (57.3)	126 (65.3)	322 (54.7)	
Operative time (min), mean ± SD	128.4 ± 68.3	156.7 ± 74.2	119.2 ± 64.8	<0.001

Operative time >120 min, n (%)	367 (46.9)	124 (64.2)	243 (41.3)	<0.001
Intraoperative findings, n (%)				
Peritonitis	298 (38.1)	112 (58.0)	186 (31.6)	<0.001
Intra-abdominal abscess	134 (17.1)	56 (29.0)	78 (13.2)	<0.001
Bowel perforation	187 (23.9)	73 (37.8)	114 (19.4)	<0.001
Estimated blood loss (mL), mean ± SD	287 ± 324	368 ± 389	259 ± 298	<0.001
Transfusion required, n (%)	123 (15.7)	48 (24.9)	75 (12.7)	<0.001
Perioperative hypothermia				
Lowest temperature (°C), mean ± SD	35.8 ± 0.9	35.4 ± 1.1	35.9 ± 0.8	<0.001
Temperature <36°C, n (%)	267 (34.1)	89 (46.1)	178 (30.2)	<0.001
Antibiotic prophylaxis, n (%)				
Appropriate timing (<60 min), n (%)	687 (87.9)	162 (83.9)	525 (89.1)	0.061
Appropriate agent selection, n (%)	724 (92.6)	176 (91.2)	548 (93.0)	0.396

†Other diagnoses include: mesenteric ischemia, incarcerated hernia, spontaneous hemoperitoneum

SSI Characteristics and Clinical Outcomes: Among the 193 patients who developed SSI, the distribution was: 113 (58.5%) superficial incisional, 54 (28.0%) deep incisional, and 26 (13.5%) organ/space infections. Median time to SSI diagnosis was 8 days (IQR: 5-14 days). Table 3 presents clinical outcomes and healthcare utilization.

Table 3: Clinical Outcomes and Healthcare Utilization by SSI Status

Outcome	**SSI Group (n=193)**	**No SSI Group (n=589)**	**Difference/OR (95% CI)**	**p-value**
SSI characteristics				
Time to SSI diagnosis (days), median (IQR)	8 (5-14)	—	—	—
SSI type, n (%)				
Superficial incisional	113 (58.5)	—		
Deep incisional	54 (28.0)	—		
Organ/space	26 (13.5)	—		
Microbiology (n=167 with cultures)				
Escherichia coli	89 (53.3)	—		
Enterococcus species	56 (33.5)	—		
Bacteroides species	45 (26.9)	—		
Staphylococcus aureus	34 (20.4)	—		
Klebsiella species	28 (16.8)	—		
Polymicrobial infection	78 (46.7)	—		
MRSA	12 (7.2)	—		
Clinical outcomes				
Hospital LOS (days), mean ± SD	14.8 ± 7.6	7.2 ± 3.4	7.6 (6.8-8.4)	<0.001
Prolonged LOS (>7 days), n (%)	167 (86.5)	267 (45.3)	7.8 (5.2-11.6)	<0.001
ICU admission, n (%)	112 (58.0)	234 (39.7)	2.1 (1.5-2.9)	<0.001
ICU LOS (days), mean ± SD*	5.8 ± 4.2	3.2 ± 2.6	2.6 (1.8-3.4)	<0.001
Mechanical ventilation, n (%)	67 (34.7)	123 (20.9)	2.0 (1.4-2.9)	<0.001
Reoperation within 30 days, n (%)	24 (12.4)	13 (2.2)	6.3 (3.1-12.7)	<0.001
Wound dehiscence, n (%)	18 (9.3)	8 (1.4)	7.3 (3.1-17.2)	<0.001
Sepsis/septic shock, n (%)	56 (29.0)	78 (13.2)	2.7 (1.8-4.0)	<0.001
Acute kidney injury, n (%)	48 (24.9)	89 (15.1)	1.9 (1.3-2.8)	0.002
Mortality outcomes				
In-hospital mortality, n (%)	13 (6.7)	9 (1.5)	4.7 (2.0-11.0)	0.001
30-day mortality, n (%)	15 (7.8)	12 (2.0)	4.1 (1.9-8.8)	<0.001
Healthcare utilization				
30-day readmission, n (%)	45 (23.3)	67 (11.4)	2.4 (1.6-3.6)	<0.001
Readmission for SSI management	34 (17.6)	—		
Home healthcare services, n (%)†	89 (46.1)	134 (22.7)	2.9 (2.0-4.1)	<0.001
Total hospital charges ($), median (IQR)	48,670 (32,450-72,340)	22,340 (15,680-34,120)	—	<0.001

LOS, length of stay; ICU, intensive care unit; IQR, interquartile range; CI, confidence interval; MRSA, methicillin-resistant Staphylococcus aureus *Among patients admitted to ICU; †Among survivors

Multivariable Analysis of SSI Risk Factors: Multivariable logistic regression identified independent predictors of SSI (Table 4, presented within text). After adjustment for confounders, the following factors remained significantly associated with SSI:

- **Contaminated/dirty wound classification** (vs. clean-contaminated): OR = 4.26, 95% CI: 2.84-6.39, $p < 0.001$
- **Diabetes mellitus**: OR = 2.18, 95% CI: 1.45-3.27, $p < 0.001$
- **Operative time >120 minutes**: OR = 2.34, 95% CI: 1.61-3.40, $p < 0.001$
- **Preoperative hospitalization >24 hours**: OR = 1.87, 95% CI: 1.26-2.78, p = 0.002
- **Perioperative hypothermia (<36°C)**: OR = 1.76, 95% CI: 1.15-2.69, p = 0.009
- **Obesity (BMI ≥30 kg/m²)**: OR = 1.68, 95% CI: 1.14-2.47, p = 0.008
- **Hypoalbuminemia (<3.0 g/dL)**: OR = 1.64, 95% CI: 1.11-2.42, p = 0.013
- **Open surgical approach** (vs. laparoscopic): OR = 1.52, 95% CI: 1.04-2.22, p = 0.032
- **ASA class IV-V** (vs. I-III): OR = 1.48, 95% CI: 1.01-2.18, p = 0.045

The final model demonstrated good discrimination (AUC-ROC = 0.78, 95% CI: 0.75-0.82) and calibration (Hosmer-Lemeshow p = 0.324).

Discussion

This large retrospective cohort study of 782 emergency abdominal surgery patients revealed an overall SSI rate of 24.7%, substantially exceeding rates reported for elective abdominal procedures. SSI occurrence was associated with significant adverse outcomes including doubled hospital length of stay, 5-fold increased reoperation rates, and 4-fold higher mortality. Multivariable analysis identified several independent risk factors, many of which are potentially modifiable through targeted perioperative interventions. These findings underscore the persistent burden of SSI in emergency surgery and highlight opportunities for quality improvement.

The 24.7% SSI rate observed in our study aligns with the upper range of published estimates for emergency abdominal surgery, which vary from 12% to 39% [30]. This rate is 3-5 times higher than typical SSI rates in elective colorectal surgery (5-10%) [31], reflecting the inherent challenges of emergency surgical care. The distribution of SSI types—with superficial incisional infections comprising 58.5% of cases—parallels previous reports and suggests that enhanced wound management strategies may yield substantial benefit [32].

The strong association between wound classification and SSI risk (OR = 4.26 for contaminated/dirty wounds) demonstrates the fundamental role of bacterial contamination in SSI pathogenesis [33]. Emergency conditions such as perforated viscus, where gross contamination is inevitable, exhibited SSI rates approaching 40%. These findings align with the CDC wound classification system's predictive validity and emphasize the importance of meticulous source control, copious irrigation, and appropriate antimicrobial therapy in contaminated cases [34].

Diabetes mellitus emerged as the strongest patient-related SSI predictor (OR = 2.18), consistent with extensive literature documenting hyperglycemia's detrimental effects on immune function, wound healing, and infection susceptibility [35]. This finding supports perioperative glucose optimization as a high-priority intervention. The NICE-SUGAR trial and subsequent guidelines recommend target glucose levels of 140-180 mg/dL in critically ill surgical patients [36]. Implementation of glycemic control protocols specifically for emergency surgery patients represents an actionable quality improvement target [37].

Prolonged operative duration (>120 minutes) independently predicted SSI (OR = 2.34), reflecting multiple mechanisms including increased tissue trauma, prolonged anesthesia exposure, greater bacterial inoculum, and potential hypothermia [38]. While operative complexity often necessitates extended procedures, this finding suggests that surgical efficiency, when safely achievable, may reduce infection risk. Enhanced surgical training, standardized techniques, and availability of experienced personnel during emergency cases merit consideration [39].

Perioperative hypothermia (<36°C) demonstrated significant SSI association (OR = 1.76), supporting previous studies linking hypothermia to vasoconstriction, tissue hypoxia, and impaired immune function [40]. The relationship between hypothermia and SSI is well-established, with landmark trials by Kurz et al. demonstrating 3-fold increased infection risk in hypothermic patients [41]. Active warming interventions including forced-air warming blankets, warmed intravenous fluids, and increased ambient operating room temperature represent evidence-based, readily implementable prevention strategies [42].

Preoperative hospitalization exceeding 24 hours independently predicted SSI (OR = 1.87), possibly reflecting disease severity, nosocomial pathogen colonization, or delayed surgical intervention [43]. This finding suggests that minimizing preoperative delays when clinically safe may reduce infection risk. However, the relationship is complex, as some patients require extended resuscitation before surgery [44]. Balancing appropriate preoperative optimization with timely surgical intervention represents a clinical challenge requiring individualized judgment [45].

The protective effect of laparoscopic versus open approaches (OR = 1.52 for open surgery) aligns with extensive literature demonstrating reduced SSI rates with minimally invasive techniques [46]. Smaller incisions, reduced tissue trauma, and decreased exposure to environmental contaminants likely contribute to this benefit [47]. Expanding laparoscopic capabilities for emergency procedures, where anatomically and clinically feasible, may improve outcomes. However, patient selection, disease severity, and surgeon expertise must guide approach decisions [48].

Obesity (BMI ≥30 kg/m²) increased SSI risk by 68%, consistent with multiple mechanisms including adipose tissue hypoperfusion, increased wound tension, and altered immune function [49]. While obesity is not modifiable in the acute setting, it necessitates heightened infection surveillance and may justify extended antimicrobial prophylaxis or alternative wound closure techniques [50]. Hypoalbuminemia similarly predicted SSI (OR = 1.64), reflecting malnutrition's impact on wound healing and immune competence [51]. Nutritional screening and early supplementation in malnourished emergency surgery patients warrant investigation [52].

The microbiological profile, dominated by Escherichia coli (53.3%), Enterococcus (33.5%), and anaerobes (26.9%), reflects gastrointestinal flora typical of intra-abdominal infections [53]. The 46.7% rate of polymicrobial infections underscores the importance of broad-spectrum empiric antimicrobial coverage and source control [54]. The 7.2% MRSA rate, while relatively low, indicates ongoing need for surveillance and appropriate coverage in high-risk patients [55]. The substantial clinical and economic impacts of SSI documented in this study—including 7.6 additional hospital days, 6-fold increased reoperation rates, and more than doubled hospitalization costs—align with previous cost-of-illness studies [56]. The CDC estimates SSIs cost $3.5 billion annually in the United States [57]. Given that many SSIs are preventable, investment in evidence-based prevention bundles represents cost-effective healthcare improvement [58].

Several study limitations warrant acknowledgment. The retrospective design limits causal inference and introduces potential information bias, though use of standardized CDC definitions and systematic surveillance minimize this concern. Single-center design may limit generalizability to other institutions with different patient populations, resources, or practices. However, our tertiary care center with a busy emergency surgery service likely represents a typical high-volume acute care hospital. We lacked detailed data on compliance with specific infection prevention practices (e.g., skin preparation protocols, antibiotic dosing adequacy), limiting ability to identify process measure gaps. Some SSIs diagnosed in outpatient settings may have been missed despite chart review and readmission surveillance, though our 30-day follow-up completion rate exceeded 95%. Finally, we did not assess long-term outcomes beyond 30 days, including chronic wound complications or incisional hernias.

Strengths include large sample size, comprehensive data collection across 4 years, standardized SSI definitions, multivariable adjustment for confounders, and assessment of clinically relevant outcomes. The findings provide institution-specific data to guide quality improvement while contributing to broader understanding of SSI epidemiology in emergency surgery.

Future research directions include prospective studies evaluating bundled SSI prevention interventions tailored to emergency surgery contexts, investigation of novel wound management techniques (negative pressure therapy, antimicrobial sutures) [59], development and validation of SSI risk prediction tools specific to emergency populations [60], and cost-effectiveness analyses of prevention strategies.

Additionally, studies examining the impact of enhanced recovery protocols adapted for emergency settings may identify additional modifiable risk factors [61].

Conclusion

This study demonstrates that surgical site infections remain a major complication of emergency abdominal surgery, affecting nearly one-quarter of patients and resulting in significant morbidity, mortality, and healthcare costs. The identified independent risk factors—including contaminated wound class, diabetes mellitus, prolonged operative time, perioperative hypothermia, and preoperative hospitalization—provide actionable targets for quality improvement initiatives. Several of these factors are potentially modifiable through systematic implementation of evidence-based prevention bundles including glycemic control protocols, active perioperative warming, antimicrobial prophylaxis optimization, and expanded use of minimally invasive techniques when appropriate. The substantial clinical and economic burden of SSI justifies investment in comprehensive prevention programs tailored to the unique challenges of emergency surgical care.

Healthcare institutions should prioritize SSI surveillance, identify local risk factor profiles, and implement multidisciplinary interventions addressing patient optimization, surgical technique, and perioperative care protocols. Continued research refining risk stratification tools and evaluating novel prevention strategies will further advance efforts to reduce this persistent and costly complication in vulnerable emergency surgery populations.

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