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HEALTH AND REHABILITATION

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PREDICTORS OF SURGICAL SITE INFECTION FOLLOWING EMERGENCY LAPAROTOMY: A RETROSPECTIVE COHORT STUDY AT AYUB TEACHING HOSPITAL

Original Research

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Acknowledgement: The authors sincerely acknowledge the Department of General Surgery, Ayub Teaching Hospital, for facilitating data collection and institutional support throughout the study.

Conflict of Interest: None
Grant Support & Financial Support: None

ABSTRACT

Background: Surgical site infections (SSIs) remain one of the most common and preventable postoperative complications, particularly following emergency laparotomy performed under suboptimal conditions. Limited resources, delayed presentation, and high contamination rates contribute to increased infection risk in low- and middle-income countries. Understanding the magnitude and determinants of SSIs in such settings is essential for guiding targeted preventive strategies and improving surgical outcomes.

Objective: To determine the frequency, pattern, and independent risk factors associated with surgical site infections among patients undergoing emergency midline laparotomy at a tertiary care hospital.

Methods: A retrospective observational study was conducted at the Department of General Surgery, Ayub Teaching Hospital, Abbottabad, including 300 adult patients who underwent emergency midline exploratory laparotomy between January and December 2024. Patient demographics, comorbidities, operative parameters, and laboratory findings were extracted from hospital records. SSIs were identified and classified according to CDC/NHSN criteria within 30 days postoperatively. Data were analyzed using SPSS Version 26. Continuous variables were expressed as mean ± SD, and categorical data as frequencies and percentages. Univariate analysis employed chi-square and t-tests, while multivariable logistic regression determined independent predictors, reporting odds ratios (ORs) with 95% confidence intervals (CIs).

Results: The mean age was 48.0 ± 18.4 years, with males comprising 62.3% of patients. The overall SSI incidence was 28.7% (86/300), including 65% superficial, 29% deep, and 5% organ/space infections. Univariate analysis identified smoking (41.9% vs. 27.1%, p = 0.019), hypoalbuminemia (22.1% vs. 11.2%, p = 0.024), higher ASA grade (30.2% vs. 17.8%, p = 0.034), and contaminated/dirty wounds (61.6% vs. 48.1%, p = 0.05) as significant factors. Logistic regression confirmed smoking (OR = 2.01, 95% CI: 1.17–3.46, p = 0.012) and hypoalbuminemia (OR = 2.30, 95% CI: 1.17–4.56, p = 0.016) as independent predictors.

Conclusion: Surgical site infections represent a major postoperative complication after emergency laparotomy. Smoking and malnutrition significantly increase infection risk but remain modifiable through targeted preoperative counseling, nutritional support, and strict adherence to perioperative care bundles. Strengthening institutional infection prevention protocols may markedly improve surgical outcomes in resource-limited healthcare settings.

Keywords: Albumins, Emergency Treatment, Laparotomy, Risk Factors, Smoking, Surgical Wound Infection, Wound Healing.

INTRODUCTION

Emergency exploratory laparotomy remains a critical, high-risk surgical procedure commonly performed to manage acute abdominal conditions such as bowel perforation, intestinal obstruction, and traumatic injuries. Unlike elective operations, these surgeries are frequently undertaken in emergency settings with limited preparation, unstable hemodynamics, and suboptimal perioperative conditions, all of which heighten the risk of postoperative complications, particularly surgical site infections (SSIs) (1–3). SSIs are defined as infections occurring within 30 days of a surgical procedure or up to 90 days if prosthetic material is implanted, involving superficial incisional, deep incisional, or organ/space structures (4). They represent one of the most prevalent healthcare-associated infections globally, accounting for approximately 20% of all nosocomial infections, and are a major contributor to postoperative morbidity and mortality (5). The clinical and economic burden of SSIs is substantial, often resulting in delayed wound healing, prolonged hospital stays, increased antibiotic use, and higher healthcare costs (6). In low- and middle-income countries (LMICs) such as Pakistan, the incidence of SSIs is considerably higher than in high-income settings due to a combination of systemic and procedural factors. These include limited infection control infrastructure, delayed presentation of patients requiring emergency intervention, and inadequate postoperative monitoring (7,8). Evidence from South Asia demonstrates significant variability in SSI rates following emergency laparotomy. A study reported an incidence of 17.1% in India (9), while a Pakistani audit identified a prevalence of 33.5% in emergency abdominal surgeries (10). Similarly, another study observed a 21.7% infection rate among patients undergoing emergency exploratory laparotomy (11). Such differences may stem from heterogeneity in patient comorbidities, intraoperative techniques, wound contamination grades, and postoperative care protocols.

Multiple risk factors have been implicated in the development of SSIs, encompassing both patient-related and procedure-related determinants. Conditions such as diabetes mellitus, smoking, anemia, obesity, malnutrition—particularly hypoalbuminemia—and immunosuppression compromise wound healing and predispose to infection (12–15). Procedural aspects, including wound contamination class, prolonged operative duration, high ASA (American Society of Anesthesiologists) score, and the use of surgical drains, further elevate the risk. Recognizing these determinants, global and national surgical safety guidelines advocate preventive measures such as timely antibiotic prophylaxis, maintenance of normothermia, stringent glycemic control, limited drain use, and proper skin antisepsis to mitigate SSI occurrence (16,17). Despite these recommendations, local data from Pakistan—particularly from tertiary care centers—remain scarce regarding the true incidence and predictors of SSIs following emergency midline laparotomy. At Ayub Teaching Hospital, Abbottabad, where a high volume of such procedures is performed, no recent comprehensive study has systematically analyzed SSI burden and associated factors. Addressing this gap, the present study aimed to determine the frequency of surgical site infections following emergency exploratory laparotomy and to identify significant risk factors contributing to their development. The study was guided by the hypothesis that modifiable patient-related variables, including smoking and hypoalbuminemia, serve as major predictors of SSI in this population, consistent with previous international findings (13,15).

METHODS

The present study employed a retrospective observational design and was conducted in the Department of General Surgery at Ayub Teaching Hospital, Abbottabad, Pakistan. The study period spanned from January 1 to December 31, 2024. Prior to data collection, ethical clearance was obtained from the Institutional Review Board of Ayub Teaching Hospital. Since the study involved retrospective analysis of anonymized hospital records, the requirement for informed patient consent was waived by the ethics committee in accordance with institutional policy. All adult patients aged 18 years and above who underwent emergency midline exploratory laparotomy for acute intra-abdominal conditions—including peritonitis, intestinal obstruction, bowel perforation, or abdominal trauma—were included in the study population. Exclusion criteria encompassed individuals who had elective surgeries, laparoscopic procedures, or non-abdominal operations to ensure a homogeneous cohort of emergency laparotomy cases. Data were extracted from patient charts, operative notes, and electronic hospital records using a standardized data collection form to minimize information bias. The recorded parameters included demographic characteristics (age and sex), comorbidities (such as diabetes mellitus, hypertension, and smoking history), and relevant preoperative laboratory findings, specifically hemoglobin and serum albumin levels. Perioperative variables were also documented,

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including the American Society of Anesthesiologists (ASA) physical status classification, indication for surgery, wound contamination class (categorized as clean, contaminated, or dirty/infected), total operative duration (in minutes), and the use of surgical drains.

All patients received prophylactic antibiotics in accordance with institutional protocol, typically a third-generation cephalosporin administered intravenously within 60 minutes prior to skin incision. This adherence to timing was consistent with established international surgical prophylaxis guidelines aimed at minimizing postoperative infection risk. Postoperative outcomes were evaluated by reviewing inpatient records and outpatient follow-up notes for a minimum duration of 30 days following surgery. Surgical site infections (SSIs) were identified and categorized according to the standardized definitions of the Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) (13,14). These included superficial incisional, deep incisional, and organ/space SSIs, ensuring uniformity and comparability with other published data. Data were analyzed using IBM SPSS Statistics for Windows, Version 26. Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and as frequencies with percentages for categorical variables. Patients were stratified into two groups based on SSI occurrence—those who developed postoperative SSIs and those who did not. For inferential analysis, continuous variables were compared using the independent samples t-test, while categorical variables were analyzed using either the chi-square test or Fisher's exact test, depending on data distribution and expected cell counts. Variables demonstrating a p-value <0.10 in univariate analysis were subsequently entered into a multivariable logistic regression model to identify independent predictors of SSI. Results were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs), and a p-value <0.05 was considered statistically significant.

RESULTS

The study included 300 patients who fulfilled the inclusion criteria, with a mean age of 48.0 ± 18.4 years. Males comprised 62.3% (n = 187) of the cohort. The overall incidence of surgical site infection (SSI) was 28.7% (86 out of 300 cases). Among those with SSI, 66% (n = 57) were superficial incisional infections, 29% (n = 25) were deep incisional, and 5% (n = 4) were organ/space infections, aligning with established global patterns where superficial infections predominate (1,2). No significant differences were found between SSI and non-SSI groups with respect to age (47.1 ± 19.2 vs. 48.3 ± 18.1 years; p = 0.595) or sex distribution (64.0% vs. 61.7%; p = 0.814). The prevalence of smoking was significantly higher among patients who developed SSI (41.9%) compared with those who did not (27.1%; p = 0.019). Similarly, hypoalbuminemia, defined as serum albumin < 3.0 g/dL, was more common in the SSI group (22.1% vs. 11.2%; p = 0.024), indicating a potential influence of poor nutritional status on postoperative infection risk. A greater proportion of patients with contaminated or dirty wounds developed SSI (61.6% vs. 48.1%; p = 0.050), and those with ASA grade IV had higher infection rates (30.2% vs. 17.8%; p = 0.034). Other comorbidities, such as diabetes mellitus (23.3% vs. 18.2%; p = 0.406) and hypertension (38.4% vs. 30.4%; p = 0.230), as well as operative duration, showed non-significant trends toward higher SSI rates. Age stratification (< 40, 40–60, and > 60 years) revealed no statistically significant effect on infection occurrence (p > 0.5), consistent with findings from regional and international cohorts (2,3). Multivariable logistic regression identified two independent predictors of SSI: current smoking (odds ratio = 2.01; 95% CI: 1.17–3.46; p = 0.012) and hypoalbuminemia (odds ratio = 2.30; 95% CI: 1.17–4.56; p = 0.016). Other factors, including ASA classification, wound contamination, and drain usage, were not statistically significant in the adjusted model. No patient was lost to follow-up during the 30-day postoperative surveillance period.

Table 1: Patient Characteristics by SSI Status

Variable	All Patients (N=300)	SSI (n=86)	No SSI (n=214)	p-value
Age, mean± SD (yr.)	48.0±18.4	47.1±19.2	48.3±18.1	0.595
Male sex, n (%)	187 (62.3%)	55 (64.0%)	132 (61.7%)	0.814
Diabetes, n (%)	59 (19.7%)	20 (23.3%)	39 (18.2%)	0.406
Hypertension, n (%)	98 (32.7%)	33 (38.4%)	65 (30.4%)	0.230

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Variable	All Patients (N=300)	SSI (n=86)	No SSI (n=214)	p-value
Smoker, n (%)	94 (31.3%)	36 (41.9%)	58 (27.1%)	0.019
Hypo albumin, n (%)	43 (14.3%)	19 (22.1%)	24 (11.2%)	0.024
Wound dirty/infected, n (%)	156 (52.0%)	53 (61.6%)	103 (48.1%)	0.050
ASA grade 4, n (%)	64 (21.3%)	26 (30.2%)	38 (17.8%)	0.034

Table 2: Multivariable Predictors of SSI (Logistic Regression)

Variable	Odds Ratio (95% CI)	p-value
Smoking	2.01 (1.17–3.46)	0.012
Hypoalbumin	2.30 (1.17–4.56)	0.016
(Other factors in the model were not significant at p<0.05.)		

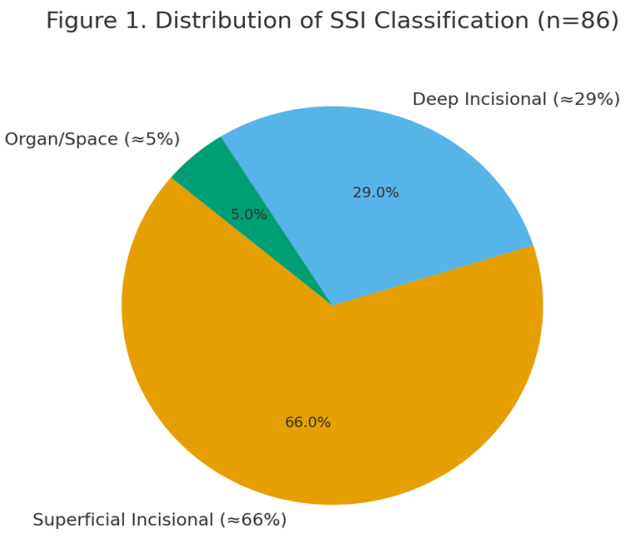

Figure 1 Distribution of SSI Classification (n=86)

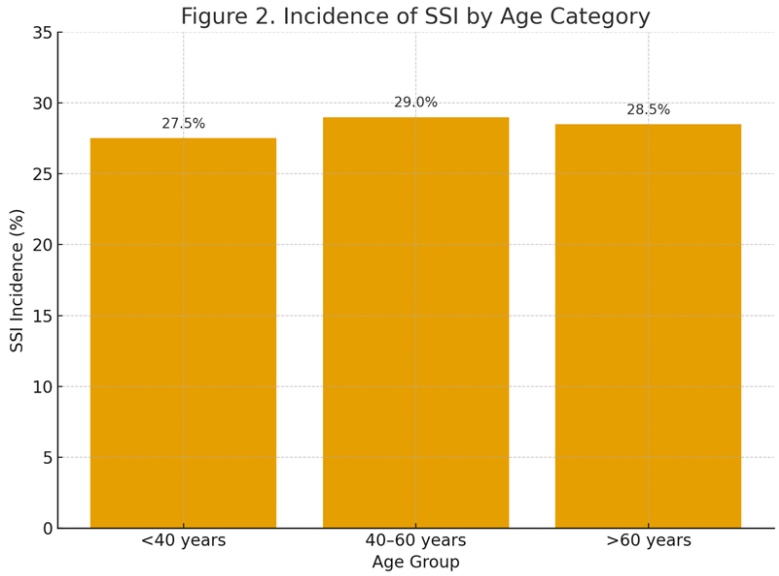

Figure 2 Incidence of SSI by Age Category

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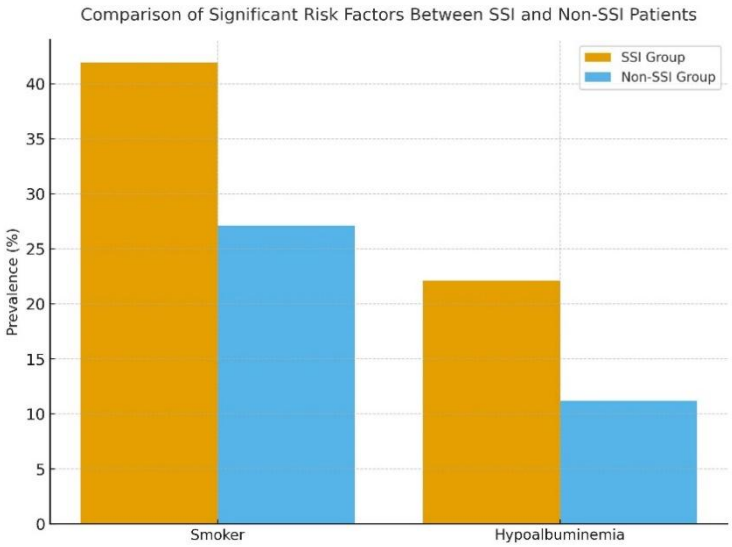

Figure 1 Comparison of Significant Risk Factors Between SSI and Non-SSI Patients

DISCUSSION

In this cohort of 300 patients undergoing emergency exploratory laparotomy, the overall surgical site infection (SSI) incidence of 28.7% was considerably higher than rates reported from several regional and international studies. This elevated infection frequency reflects the high contamination risk inherent to emergency abdominal procedures and highlights systemic limitations frequently encountered in low- and middle-income countries (LMICs), including delayed presentation, inadequate perioperative optimization, and restricted infection-control resources (1,7). The finding reinforces the global concern that emergency surgical environments inherently predispose to higher postoperative morbidity due to uncontrolled contamination and limited intraoperative stabilization opportunities. The distribution pattern of SSIs in the present study, with superficial incisional infections accounting for approximately two-thirds of cases, aligns with both World Health Organization and Centers for Disease Control and Prevention data, which consistently report superficial infections as the predominant SSI subtype (4–6). Deep and organ/space infections were less frequent but carry greater clinical significance because of their association with sepsis, delayed wound healing, and prolonged hospitalization (3). This distribution suggests that while infection prevention strategies must address general wound care protocols, targeted interventions for deeper infections—such as strict aseptic handling of surgical drains and intra-abdominal irrigation practices—remain crucial. Multivariable analysis identified smoking and hypoalbuminemia as independent predictors of SSI. Tobacco use impairs tissue oxygenation, reduces immune cell function, and interferes with collagen synthesis, thereby compromising wound healing (6). Malnutrition, reflected by low serum albumin levels, similarly affects immune competence and tissue repair (14). These findings reaffirm that modifiable preoperative factors substantially contribute to postoperative infection risk. Preventive strategies emphasizing smoking cessation and nutritional optimization should thus form integral components of preoperative evaluation and perioperative management, even in urgent surgical scenarios where time constraints exist (13,15).

Other clinical variables such as age, gender, ASA classification, and comorbidities, including diabetes and hypertension, did not demonstrate significant associations with SSI in multivariate analysis. Although a trend toward higher SSI rates was observed among patients with severe ASA grades and contaminated wounds, these relationships did not reach statistical significance after adjustment for confounders. This observation supports the interpretation that modifiable clinical factors, particularly nutritional and behavioral determinants, may exert a stronger influence than non-modifiable demographic or baseline physiological factors in determining SSI outcomes (16,17). The non-significant relationship between wound contamination class and SSI in the adjusted model warrants further examination. Despite statistical non-significance, the high infection rate among contaminated and dirty wounds underscores their clinical importance. Previous evidence has consistently established wound class as a key determinant of postoperative infection, particularly in emergency laparotomy, where delayed source control, bowel spillage, and hemodynamic instability contribute to increased microbial

load (18,19). The current findings suggest that improvements in intraoperative contamination control, such as meticulous irrigation, use of wound protectors, and delayed primary closure techniques, could help mitigate this risk even when baseline contamination cannot be avoided. The present study holds important clinical implications. Implementation of structured perioperative bundles—encompassing timely antibiotic prophylaxis, chlorhexidine-alcohol skin preparation, glycemic control, maintenance of normothermia, and judicious drain use—has consistently demonstrated significant reductions in SSI rates across surgical disciplines (20,21). Furthermore, brief in-hospital smoking cessation counseling and nutritional supplementation for hypoalbuminemic patients represent cost-effective interventions feasible within resource-limited settings. Integrating these measures within a standardized emergency laparotomy care pathway may yield substantial improvements in postoperative outcomes and healthcare resource utilization.

From a broader public health perspective, SSIs impose a substantial economic and operational burden. Prolonged hospitalization, increased antibiotic consumption, and higher readmission rates collectively strain healthcare systems in LMICs. Meta-analytical data indicate that SSIs may extend hospital stays by 10 to 11 days on average, translating into significant cost escalation and reduced bed availability (10,22). Consequently, even modest reductions in SSI incidence could substantially improve hospital efficiency and patient turnover in high-volume surgical centers. The study's retrospective design represents its principal limitation, introducing potential bias due to reliance on record accuracy and completeness. Being a single-center study, generalizability may be restricted to comparable institutional settings. Additionally, certain intraoperative variables, such as duration of contamination exposure, intraoperative temperature regulation, and exact timing of antibiotic administration, were not consistently documented. Despite these constraints, the study's strengths include a clearly defined patient cohort, uniform diagnostic criteria based on CDC/NHSN definitions, and comprehensive statistical modeling, which collectively enhance internal validity. Future research should focus on prospective, multicenter trials assessing the effectiveness of perioperative care bundles and nutritional interventions in reducing SSIs after emergency laparotomy. Integration of microbiological surveillance to identify predominant pathogens and their resistance patterns would further refine preventive strategies. Overall, the study demonstrates that smoking and hypoalbuminemia remain critical, modifiable predictors of surgical site infections following emergency laparotomy. Targeted preoperative and perioperative interventions addressing these factors have the potential to significantly reduce infection-related morbidity and improve surgical outcomes in resource-constrained healthcare environments.

CONCLUSION

Emergency laparotomy remains a procedure with substantial postoperative infection risk, particularly in urgent and resource-limited environments. The study demonstrated that superficial surgical site infections were the most frequent complications, while smoking and poor nutritional status emerged as key modifiable contributors. These findings emphasize the importance of comprehensive preoperative assessment, including nutritional evaluation and smoking cessation, alongside strict adherence to perioperative infection prevention bundles. Strengthening institutional protocols and implementing multidisciplinary quality improvement strategies could significantly reduce infection-related morbidity and enhance overall surgical outcomes in emergency care settings.

AUTHOR CONTRIBUTION

Author	Contribution
Bahri Room	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Omar Khan	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Umar Khan Ghauri	Substantial Contribution to acquisition and interpretation of Data

Author	Contribution
	Has given Final Approval of the version to be published
Muhammad Tayyab Khan*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sabahat Rashid Qureshi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Musa Afridi	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Amir Sohail	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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