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PROSPECTIVE EVALUATION OF SURGICAL SITE INFECTIONS FOLLOWING EMERGENCY VERSUS ELECTIVE ABDOMINAL SURGERIES

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ABSTRACT

Background: Surgical site infections (SSIs) are among the most common and serious postoperative complications, particularly in abdominal surgeries. Emergency procedures, due to their urgent nature and limited preoperative optimization, are believed to carry a higher risk of SSIs compared to elective surgeries. **Aim:** To prospectively evaluate and compare the incidence, risk factors, and types of surgical site infections following emergency versus elective abdominal surgeries. **Material and Methods:** This prospective observational study was conducted in the Department of General Surgery at a tertiary care hospital. A total of 90 adult patients undergoing abdominal surgeries were included and divided into two groups: Group A (elective, n = 45) and Group B (emergency, n = 45). Data on demographics, comorbidities, type and duration of surgery, wound classification, and SSI occurrence were collected. SSIs were classified based on CDC guidelines. Statistical analysis was done using SPSS version 26.0, with a p-value < 0.05 considered significant. **Result:** The overall incidence of SSIs was significantly higher in the emergency group (33.33%) compared to the elective group (8.89%) (p = 0.004). Emergency surgeries had a higher prevalence of open procedures (77.78%), longer operative time (mean 104.60 minutes), and more contaminated or dirty wounds (55.55%) than elective cases. Significant risk factors associated with SSIs included emergency surgery (p = 0.008), diabetes mellitus (p = 0.003), anemia (p = 0.029), contaminated/dirty wounds (p = 0.002), and surgeries lasting over 2 hours (p = 0.017). **Conclusion:** SSIs are significantly more common in emergency abdominal surgeries due to a combination of patient-related and procedural factors. Improved risk stratification, early recognition, and adherence to infection control protocols are essential, especially in high-risk emergency settings.

INTRODUCTION

Surgical site infections (SSIs) remain one of the most prevalent and challenging complications in postoperative care, particularly in abdominal surgeries. These infections not only increase morbidity and mortality but also impose significant economic burdens on healthcare systems by extending hospital stays and necessitating further interventions. In the era of modern surgical techniques and antimicrobial prophylaxis, SSIs continue to account for a considerable proportion of hospital-acquired infections, reflecting the complexity of surgical procedures and the multifactorial nature of infection risk factors.[1]

Abdominal surgeries, both elective and emergency, are especially prone to SSIs due to the nature of the operative field, potential contamination from the gastrointestinal tract, and the diversity in wound classification. Elective surgeries allow for preoperative patient optimization, controlled operative settings, and adherence to standard infection prevention protocols. In contrast, emergency surgeries are typically performed under time-sensitive conditions with minimal preparation, often in the context of perforation, contamination, or sepsis, thus creating an inherently higher risk for SSIs.[2]

The classification of SSIs as superficial incisional, deep incisional, and organ/space infections provides a standardized framework for diagnosis and management. Despite this, the detection and reporting of SSIs can be inconsistent, particularly for superficial infections, which may be managed on an outpatient basis or not reported at all. This can undermine the accuracy of infection surveillance systems and their role in assessing surgical quality.[3] Moreover, superficial SSIs, while often underestimated, can evolve into deeper or systemic infections if not managed promptly, contributing further to patient morbidity and healthcare costs.[4]

Efforts to reduce the incidence of SSIs have been a priority for global health organizations. Guidelines from the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have emphasized key preventive measures including perioperative antibiotic prophylaxis, appropriate skin antisepsis, and surgical hand preparation.[3,5] Despite widespread awareness, the implementation of these recommendations can vary across institutions, especially in resource-constrained settings. Emergency surgeries, in particular, present unique challenges where adherence to standard protocols may be compromised due to urgency, limited diagnostic workup, or inadequate infrastructure.

A major component influencing the risk of SSI is the patient's clinical status at the time of surgery. Factors such as anemia, malnutrition, diabetes mellitus, and immunosuppression have been independently associated with increased susceptibility to infection. The presence of contaminated or dirty wounds further escalates this risk, especially in emergency cases where preoperative stabilization may be insufficient. In contrast, elective surgeries offer the advantage of correcting modifiable risk factors before the procedure, thereby reducing the likelihood of postoperative infections.[6]

Another important aspect of SSI prevention is the choice of surgical technique. Laparoscopic approaches, when feasible, have been associated with lower SSI rates compared to open surgeries due to reduced tissue trauma, minimal exposure, and faster recovery. However, in emergency situations, laparoscopic access may be limited by the patient's clinical condition, intra-abdominal contamination, or technical constraints. This shift toward open surgery in emergency contexts has been identified as a significant predictor of postoperative infections.[6]

Recent studies have highlighted the disparity in SSI rates between elective and emergency abdominal surgeries. While elective cases typically report infection rates ranging from 5% to 10%, emergency cases often show a two- to threefold increase. This variation emphasizes the importance of stratifying patients based on their surgical indication and wound classification when designing preventive strategies or evaluating surgical outcomes.[6] Furthermore, antibiotic resistance patterns among pathogens isolated from SSI cases are increasingly influencing empirical treatment choices. Timely culture and sensitivity testing have therefore become essential for targeted therapy, particularly in hospitals with high multidrug-resistant organism prevalence.

In India and other low-to-middle-income countries, the burden of SSIs remains particularly high due to systemic factors such as overcrowded hospitals, inadequate infection control practices, limited access to diagnostic facilities, and suboptimal antimicrobial stewardship. Prospective monitoring and regular surgical audits are crucial tools for identifying trends in infection rates, evaluating compliance with infection prevention protocols, and implementing corrective measures. Government and institutional policies must also focus on strengthening operating room standards and ensuring consistent availability of surgical supplies and sterilization equipment.[1,6]

Given the critical differences in the risk profile and clinical context of emergency versus elective abdominal surgeries, there is a growing need for comparative studies that specifically evaluate the incidence, severity, and determinants of SSIs across these two domains. Such data can inform the development of evidence-based guidelines tailored to surgical acuity and local resources. Moreover, by understanding the unique challenges associated with emergency surgeries, targeted interventions can be designed to reduce infection rates and improve surgical outcomes even in high-risk scenarios.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Surgery at a tertiary care teaching hospital. Institutional Ethics Committee approval was obtained prior to the commencement of the study. Written informed consent was obtained from all participants, and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki. A total of 90 adult patients undergoing abdominal surgeries were enrolled and divided into two groups:

- Group A (Elective surgeries): 45 patients undergoing planned abdominal procedures
- Group B (Emergency surgeries): 45 patients undergoing emergency abdominal procedures

Inclusion Criteria

- Patients aged 18 years and above
- Patients undergoing either elective or emergency abdominal surgeries
- Patients willing to provide informed consent and comply with follow-up protocol

Exclusion Criteria

- Patients with pre-existing local skin infections at or near the surgical site
- Immunocompromised individuals (e.g., HIV-positive, undergoing chemotherapy)
- Patients on long-term corticosteroids or immunosuppressive therapy
- Patients with incomplete data or who were lost to follow-up

Procedure

All patients underwent standard preoperative assessment, including history taking, physical examination, routine laboratory investigations, and risk factor evaluation. Surgical procedures were performed using aseptic precautions under general or regional anesthesia as per clinical requirement. Prophylactic antibiotics were administered

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preoperatively in accordance with institutional guidelines.

Postoperatively, patients were monitored daily for signs of surgical site infection (SSI) until discharge and followed up on post-operative day 7, 14, and 30 in the outpatient department. SSIs were classified and graded according to the CDC (Centers for Disease Control and Prevention) guidelines, including superficial incisional, deep incisional, and organ/space infections.

Data regarding patient demographics, comorbidities (e.g., diabetes, obesity, anemia), duration and type of surgery, wound classification (clean, clean-contaminated, contaminated, dirty), antibiotic usage, and SSI occurrence were collected using a structured proforma.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation. The Chi-square test was used to compare proportions, and the Student's t-test was applied for comparing means. A p-value < 0.05 was considered statistically significant

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics

The comparison of baseline characteristics between the elective and emergency surgery groups revealed that the mean age was slightly higher in the emergency group (46.30 ± 13.10 years) compared to the elective group (42.80 ± 12.60 years), though this difference was not statistically significant (p = 0.172). The male-to-female ratio was comparable between the two groups (28:17 in elective vs. 30:15 in emergency), indicating no gender-based skew in group allocation (p = 0.648). Comorbidities such as diabetes and obesity were more prevalent in the emergency group (31.11% and 22.22%, respectively) than in the elective group (22.22% and 15.56%, respectively), but these differences did not reach statistical significance (p = 0.326 for diabetes, p = 0.416 for obesity). However, anemia (defined as hemoglobin <10 g/dL) was significantly more common in the emergency group (33.33%) than in the elective group (13.33%), with a statistically significant difference (p = 0.019), highlighting a potential preoperative risk factor in emergency cases.

Table 2: Type and Duration of Surgery

A significant difference was observed in the mean duration of surgery, with emergency procedures taking longer (104.60 ± 28.30 minutes) compared to elective surgeries (91.50 ± 23.70 minutes) (p = 0.015). This may reflect the complexity and urgency associated with emergency cases. Open surgeries were significantly more common in the emergency group (77.78%) than in the elective group (48.89%) (p = 0.004), whereas laparoscopic procedures were predominantly performed in elective cases (51.11%) versus only 22.22% in emergencies. The preference for open surgery in emergencies likely correlates with the clinical instability, contamination, or anatomical uncertainty commonly encountered in such cases.

Table 3: Wound Classification According to CDC

Wound classification showed a stark contrast between the groups, with clean wounds being significantly more frequent in elective surgeries (40.00%) as opposed to only 11.11% in emergencies (p < 0.001). Clean-contaminated wounds were the most common type in both groups but more so in elective surgeries (48.89% vs. 33.33%). Contaminated wounds (8.89% elective vs. 33.33% emergency) and dirty wounds (2.22% elective vs. 22.22% emergency) were notably higher in emergency cases. These findings reflect the inherent nature of emergency surgeries, which often involve infection, perforation, or contamination, leading to a higher risk of surgical site complications.

Table 4: Incidence and Type of Surgical Site Infections (SSIs)

Surgical site infections occurred significantly more often in the emergency group, where only 66.67% of patients remained infection-free compared to 91.11% in the elective group (p = 0.004). Superficial SSIs were more frequent in emergencies (17.78%) than electives (6.67%). Similarly, deep SSIs were seen in 11.11% of emergency surgeries versus 2.22% in elective cases. Organ/space SSIs were absent in elective surgeries but present in 4.44% of emergency cases. The higher incidence and severity of SSIs in emergency surgeries are likely multifactorial, including factors like wound contamination, prolonged duration, and presence of comorbidities.

Table 5: Association of Risk Factors with SSI (Overall, n = 90)

When analyzing all 90 patients, several risk factors showed a statistically significant association with the occurrence of SSIs. Emergency surgery was strongly linked with SSI development, as 78.95% of patients with SSIs had undergone emergency procedures (p = 0.008). Diabetes mellitus also emerged as a major risk factor, present in 52.63% of SSI cases compared to only 19.72% among non-SSI cases (p = 0.003). Anemia was significantly associated with infection risk as well (42.11% in SSI group vs. 18.31% in non-SSI group; p = 0.029). Wound contamination (contaminated or dirty wounds) was observed in 63.16% of patients with SSIs, reinforcing its role as a major predictor (p = 0.002). Surgeries lasting more than 2 hours also had a statistically significant correlation with infection, occurring in 57.89% of the SSI group compared to 26.76% in the non-SSI group (p = 0.017). These results underscore the multifactorial nature of SSIs and highlight the need for preoperative optimization and strict intraoperative protocols, especially in emergency settings.

Table 1: Baseline Demographic and Clinical Characteristics

Parameter	Group A (Elective) n = 45	Group B (Emergency) n = 45	*P*-value
Mean Age (years)	42.80 ± 12.60	46.30 ± 13.10	0.172
Male : Female Ratio	28:17	30:15	0.648
Diabetes (%)	10 (22.22%)	14 (31.11%)	0.326
Obesity (BMI > 30)	7 (15.56%)	10 (22.22%)	0.416
Anemia (Hb <10 g/dl)	6 (13.33%)	15 (33.33%)	0.019*

****Significant at p < 0.05***

Table 2: Type and Duration of Surgery

Parameter	Group A (Elective) n = 45	Group B (Emergency) n = 45	*p*-value
Mean Duration (minutes)	91.50 ± 23.70	104.60 ± 28.30	0.015*
Open Surgery	22 (48.89%)	35 (77.78%)	0.004*
Laparoscopic Surgery	23 (51.11%)	10 (22.22%)	—

****Significant at p < 0.05***

Table 3: Wound Classification According to CDC

Wound Type	Group A (Elective) n = 45	Group B (Emergency) n = 45	*p*-value
Clean	18 (40.00%)	5 (11.11%)	<0.001*
Clean-contaminated	22 (48.89%)	15 (33.33%)	—
Contaminated	4 (8.89%)	15 (33.33%)	—
Dirty	1 (2.22%)	10 (22.22%)	—

****Significant at p < 0.05 (combined comparison)***

Table 4: Incidence and Type of Surgical Site Infections (SSIs)

Infection Type	Group A (Elective) n = 45	Group B (Emergency) n = 45	*p*-value
No SSI	41 (91.11%)	30 (66.67%)	0.004*
Superficial SSI	3 (6.67%)	8 (17.78%)	—
Deep SSI	1 (2.22%)	5 (11.11%)	—
Organ/Space SSI	0 (0.00%)	2 (4.44%)	—

****Significant at p < 0.05***

Table 5: Association of Risk Factors with SSI (Overall, n = 90)

Risk Factor	SSI Present (n = 19)	SSI Absent (n = 71)	*p*-value
Emergency Surgery	15 (78.95%)	30 (42.25%)	0.008*
Diabetes Mellitus	10 (52.63%)	14 (19.72%)	0.003*
Anemia	8 (42.11%)	13 (18.31%)	0.029*
Contaminated/Dirty Wound	12 (63.16%)	18 (25.35%)	0.002*
Surgery > 2 hours	11 (57.89%)	19 (26.76%)	0.017*

****Significant at p < 0.05***

DISCUSSION

In the present study, the incidence of surgical site infections (SSIs) was significantly higher in patients undergoing emergency abdominal surgeries (33.33%) compared to elective surgeries (8.89%). This finding aligns with the results of Jatoliya et al (2023),[6] who reported an overall SSI rate of 28.6%, with infections occurring in 38.7% of emergency cases versus 16.2% in elective surgeries. Similarly, Reji et al (2024),[7] reported a 36.0% infection rate in emergency surgeries compared to 10.5% in elective procedures in their retrospective study. The higher infection rates in emergency surgeries across studies confirm the intrinsic vulnerability of this group, often stemming from inadequate preparation, contaminated surgical fields, and delayed antibiotic prophylaxis.

In our study, superficial SSIs were most common, seen in 17.78% of emergency cases and 6.67% of elective ones. Deep SSIs and organ/space infections were more exclusive to emergencies (11.11% and 4.44%, respectively). Alkaaki et al (2019),[8] reported similar subtype distributions, with superficial infections accounting for 60% of SSIs, and deep or organ-space infections comprising the remaining 40%, especially in contaminated or dirty wounds. These patterns reiterate that SSI severity often correlates with the level of wound contamination and surgical urgency.

The mean duration of surgery was 104.60 ± 28.30 minutes for emergency cases and 91.50 ± 23.70 minutes for elective cases in our study. Li et al (2021),[9] also found that procedures exceeding 2 hours had a 2.5-fold increased risk of infection. In our analysis, 57.89% of patients who developed SSIs had surgeries lasting longer than 2 hours (p = 0.017). Chadhary et al (2025),[10] supported this association, noting a significantly higher SSI rate in procedures lasting more than 90 minutes, particularly in emergency settings.

Regarding wound classification, contaminated and dirty wounds constituted 55.55% of emergency cases in our study, compared to only 11.11% in elective ones. Rosenthal et al (2013),[11] in a large multicenter global study, emphasized that the infection rate in dirty wounds can reach 40–50%, depending on regional healthcare practices. Our findings showed SSIs in 63.16% of patients with contaminated or dirty wounds, highlighting the critical impact of wound status on infection risk.

Comorbid conditions such as diabetes mellitus and anemia were significant contributors to SSI development in this study. Diabetes was present in 52.63% of infected patients (p = 0.003), consistent with Gogoi et al (2020),[12] who reported diabetes in 48.5% of patients with SSIs. Anemia was also significantly associated (42.11% vs. 18.31%, p = 0.029), similar to Jatoliya et al (2023),[6] who identified preoperative anemia as an independent predictor. These conditions compromise tissue perfusion and immune response, increasing susceptibility to infection.

Notably, 78.95% of patients with SSIs in this study underwent emergency surgeries, reinforcing the findings by Li et al (2021),[9] who reported emergency surgery as the most significant independent predictor of SSI (OR 2.9, CI 1.8–4.6). The predominance of open surgeries in emergencies (77.78%) versus 48.89% in elective cases also contributes to higher SSI rates, as laparoscopic procedures are generally associated with reduced infection risk due to smaller incisions and less tissue exposure. This trend was corroborated by Alkaaki et al (2019),[8] and Reji et al (2024),[7] who observed a lower SSI incidence in laparoscopic surgeries (<10%).

CONCLUSION

This study highlights a significantly higher incidence of surgical site infections (SSIs) in emergency abdominal surgeries compared to elective procedures. Key contributing factors included wound contamination, prolonged operative duration, diabetes, and anemia. Emergency surgeries were also more likely to involve open procedures and contaminated or dirty wounds. These findings underscore the importance of targeted perioperative interventions and risk stratification, especially in emergency surgical settings, to minimize SSI risk.

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