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Surgical site infection; exploratory laparotomy; emergency surgery; elective surgery; antibiotic resistance; postoperative complications.

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Occurrence, Management and Complications of Surgical Site Infections in Emergency vs Elective Exploratory Laparotomy

Abstract

Background: Surgical site infections are among the most common healthcare-associated infections worldwide and disproportionately affect patients undergoing emergency laparotomy.

Objective: To evaluate and compare the occurrence, microbiological profile and outcomes of SSIs following emergency versus elective exploratory laparotomy.

Methods: This prospective observational study was conducted in the Department of General Surgery, Dhiraj General Hospital, India, between November 2023 and March 2025. 102 patients undergoing exploratory laparotomy were enrolled (elective n = 61, 59.8%; emergency n = 41, 40.2%) and followed for 30 postoperative days. SSIs were classified using CDC criteria (1,2). Categorical variables were compared by chi-square test, continuous variables by independent-sample t-test.

Results: Mean age was comparable (45.84 ± 15.07 vs 48.00 ± 18.59 years; p = 0.519). Males were more frequent in emergency cases (80.5% vs 57.4%; p = 0.015). Diagnoses differed significantly (p = 0.002), intestinal perforation (26.8%) and gastrointestinal perforation (17.1%) predominating in emergency cases. Alcohol use was significantly more common in emergency patients (19.5% vs 4.9%; p = 0.015). The overall SSI rate was 28.4%, markedly higher in the emergency group (41.5%) than the elective group (19.7%; p = 0.017). Escherichia coli was the most frequently isolated organism in both groups (33.3% vs 47.1%); the microbiological distribution (p = 0.824) and antibiotic responsiveness (p = 0.367) did not differ significantly between groups.

Conclusion: Emergency exploratory laparotomy is associated with markedly elevated SSI risk compared with elective procedures. Microbial profiles and antibiotic responsiveness are comparable, indicating prevention - not antimicrobial modification — is the principal modifiable lever.

INTRODUCTION

Surgical site infections remain among the most frequent healthcare-associated infections globally, occurring in 2–5% of surgical patients in high-income settings and considerably more in low- and middle-income countries(1,3,4). They impose substantial clinical and economic morbidity, prolonging hospital stay and inflating treatment costs (5,6 ,7,8). Despite the availability of evidence-based prevention guidelines(1,9,10) compliance remains uneven, and SSIs continue to challenge surgical services worldwide(11, 12,13).

The Indian setting represents a high-burden environment (14). Recent tertiary-care series from across India have reported SSI incidence among general surgical patients in the 14–34% range, with rates of 17.7% in mixed elective/emergency abdominal cohorts and up to 34% specifically after exploratory laparotomy(14,15). A multicenter analysis of 3,696 patients confirmed the high density of modifiable and non-modifiable SSI risk factors after exploratory laparotomy (16). SSIs occurring after emergency abdominal surgery carry particular clinical importance because they combine higher incidence with more contaminated wound classes and constrained antimicrobial stewardship (17,18,19).

Microbiologically, post-laparotomy SSIs are dominated by Gram-negative enteric organisms — particularly E. coli and Klebsiella spp. — followed by S. aureus; polymicrobial infections are common in contaminated and dirty procedures (4,20,21,22). The Indian resistance landscape is concerning: tertiary-centre data document ampicillin resistance of ~90%, cefazolin resistance of ~86% among Gram-negative isolates, and ESBL production in a substantial proportion of Enterobacteriaceae(22,23). Conversely, Gram-positive isolates frequently include methicillin-resistant S. aureus and Enterococcus spp.(21,22).

Differentiating SSIs after emergency from those after elective laparotomy is therefore not merely an epidemiological exercise: it has direct implications for perioperative antimicrobial prophylaxis, surveillance, and the design of preventive bundles in resource-limited settings (1,3,9). Despite the clinical importance of the problem, prospective comparative data within the Indian tertiary-care setting remain limited (12,14,16).

The present study was designed to address this evidence gap by prospectively comparing SSI frequency, microbiological profile and outcomes between emergency and elective exploratory laparotomy in a western Indian tertiary-care centre.

2. Materials and Methods

2.1 Study design and setting

Prospective observational comparative study, Department of General Surgery, Dhiraj General Hospital, Piparia, Vadodara, India, November 2023 – March 2025.

2.2 Inclusion criteria

1. Age ≥18 years, either gender.
2. Elective or emergency exploratory laparotomy.
3. Written informed consent.
4. Willingness to complete 30-day follow-up.

2.3 Exclusion criteria

1. Prior SSI.
2. Preoperative antibiotic use >1 week.
3. Re-operation other than for SSI management.
4. Discharge Against Medical Advice or loss to follow-up within 30 days.
5. Refusal to participate.

2.4 Sample size

Calculated as $n = Z^2P(1-P)/d^2$, with prior Indian tertiary-care prevalence data used to derive expected proportion.

2.5 Variable definitions

SSIs were diagnosed using CDC criteria — infections within 30 days of operation (or within 1 year if implant-related) — and classified as superficial incisional, deep incisional or organ/space SSI(1,2). Demographic, clinical, intra-operative, microbiological and outcome data were recorded on a structured proforma.

2.6 Microbiological processing

Pus/wound swabs were processed by Gram stain and inoculation onto blood agar, MacConkey agar and nutrient broth; isolates were identified by colony morphology and biochemical profile, with antibiotic susceptibility testing by Kirby–Bauer disk diffusion per CLSI guidelines.

2.7 Statistical analysis

Data were entered into Microsoft Excel 2019 and analysed in IBM SPSS v26. Categorical variables were compared by Pearson's chi-square test (or Fisher's exact where expected cell counts <5) and continuous variables by the independent-sample t-test. A two-tailed $p < 0.05$ was considered significant.

2.8 Ethics

Approved by the Institutional Ethics Committee of Sumandeep Vidyapeeth and conducted per Declaration of Helsinki, ICMR 2017 National Ethical Guidelines and ICH E6 (R2) GCP. Written informed consent was obtained from all participants.

3. Results

3.1 Patient distribution

Of 102 patients, 61 (59.8%) underwent elective and 41 (40.2%) emergency exploratory laparotomy.

Table 1. Patient distribution

Group	Description	N	%
1	Elective exploratory laparotomy	61	59.8
2	Emergency exploratory laparotomy	41	40.2

3.2 Age

Mean age was comparable (45.84 ± 15.07 vs 48.00 ± 18.59 years; $p = 0.519$).

Table 2. Mean-age comparison

Group	Mean (years)	SD	t	p-value
1	45.84	15.07	−0.647	0.519
2	48.00	18.59	—	—

3.3 Gender

Males predominated in both groups; the emergency cohort had a significantly higher male proportion (80.5% vs 57.4%; p = 0.015).

Table 3. Gender distribution

Gender	Group 1 N (%)	Group 2 N (%)	χ^2	p-value
Male	35 (57.4)	33 (80.5)	5.893	0.015
Female	26 (42.6)	8 (19.5)	—	—

3.4 Diagnosis

Diagnoses differed significantly (p = 0.002); intestinal perforation (26.8%) and GI perforation (17.1%) predominated in emergency cases, while neoplastic indications (including ovarian cancer 6.6% and abdominal tumour 8.2%) were exclusive to the elective cohort.

Table 4. Diagnosis distribution

Diagnosis	Group 1 N (%)	Group 2 N (%)
Abdominal infection	2 (3.3)	2 (4.9)
Abdominal tumour	5 (8.2)	0 (0.0)
Appendicitis	3 (4.9)	4 (9.8)
Oesophageal disorder	1 (1.6)	0 (0.0)
Gallbladder disorder	3 (4.9)	0 (0.0)
GI cancer	2 (3.3)	0 (0.0)
GI perforation	0 (0.0)	7 (17.1)
Gynaecological cancer	3 (4.9)	0 (0.0)
Gynaecological tumour	1 (1.6)	0 (0.0)
Hernia	5 (8.2)	2 (4.9)
Intestinal cancer	1 (1.6)	0 (0.0)
Intestinal obstruction	8 (13.1)	9 (22.0)
Intestinal perforation	2 (3.3)	11 (26.8)
Intestinal tumour	2 (3.3)	0 (0.0)
Liver disorder	1 (1.6)	2 (4.9)
Liver injury	1 (1.6)	0 (0.0)
Ovarian cancer	4 (6.6)	0 (0.0)
Pancreatic disorder	2 (3.3)	1 (2.4)
Parasitic infection	3 (4.9)	0 (0.0)
Postoperative complication	2 (3.3)	2 (4.9)
Postoperative infection	1 (1.6)	0 (0.0)
Splenic disorder	4 (6.6)	1 (2.4)
Splenic injury	1 (1.6)	0 (0.0)
Tumour	4 (6.6)	0 (0.0)

χ^2 = 47.073; p = 0.002.

3.5 Past medical history

Most elective patients had no significant history (72.1%) versus 48.8% of emergency patients; alcohol use was significantly more frequent in the emergency cohort (19.5% vs 4.9%; χ^2 = 17.371; p = 0.015).

3.6 Comorbidities

Most patients in both groups had no comorbidities (77.0% vs 82.9%; p = 0.303).

3.7 Surgical site infections

SSI rate was significantly higher in the emergency group (41.5%) than elective (19.7%; χ^2 = 5.722; p = 0.017).

3.8 Microbiological profile

E. coli predominated (33.3% elective vs 47.1% emergency), followed by S. aureus, Klebsiella spp. and P. aeruginosa; the distribution did not differ significantly (χ^2 = 0.829; p = 0.824).

3.9 Antibiotic responsiveness

Responsiveness to broad-spectrum antibiotics was 75.0% in the elective vs 58.8% in the emergency group (χ^2 = 0.815; p = 0.367).

4. Discussion

4.1 Demographic profile

Mean ages were comparable (44.12 ± 19.36 vs 47.20 ± 15.54 years in Eswar et al.(24), consistent with age distributions reported across Indian emergency-laparotomy cohorts(25,26,27) — suggesting that age alone is not a primary determinant of surgical urgency. Gender distribution differed significantly (p = 0.015), with pronounced male predominance in the emergency cohort (80.5% vs 57.4%). This pattern mirrors ten-year German surveillance findings(28) and likely reflects gender-linked patterns of acute abdominal disease and delayed healthcare-seeking among males(29,30). Conversely, a multicenter abdominal-surgery analysis of >6,000 patients reported no significant gender association after adjustment (31), underscoring heterogeneity of referral and case mix across settings.

4.2 Diagnosis distribution

Intestinal perforation (26.8%) and GI perforation (17.1%) predominated in emergency cases — consistent with Indian emergency-laparotomy registries in which enteric perforation (24.9%), firearm injury (16.2%) and perforated appendicitis (8.1%) constitute leading indications (25,26,27). Neoplastic indications were exclusive to elective cases, reflecting the natural history of chronic disease permitting planned resection(14,24).

4.3 Past medical history and comorbidities

Alcohol use was significantly more common in emergency patients (19.5% vs 4.9%; p = 0.015), in agreement with West-Indian tertiary-centre antimicrobial-susceptibility data identifying alcohol as a key risk factor for emergency gastrointestinal presentations (22); alcohol may predispose to acute events through mucosal injury, impaired immunity and delayed wound healing(1,10). Comorbidity distribution did not differ between groups (p = 0.303) — divergent from one multicenter abdominal cohort (31) — a discrepancy likely reflecting limited subgroup sample sizes and variable referral patterns.

4.4 Surgical site infections

The key clinical finding was the markedly higher SSI rate in the emergency group (41.5% vs 19.7%; p = 0.017), consistent with prior reports demonstrating a two- to three-fold elevation in SSI risk for emergency laparotomies(14,17,18,24). Reported emergency-to-elective SSI ratios in comparable Indian and international series include 26% vs 8%(14), 62% vs 30%(24) and 30% vs 12.5% (32). Single-arm emergency cohorts have reported SSI rates of 33.5% (n=173) (26) and 17.12% (n=249) (25); in trauma laparotomy, accurate risk-stratification data documented approximately double the SSI rate in emergency cases(33). Driving factors include higher prevalence of contaminated/dirty wounds following intestinal perforation (17,18); restricted opportunity for preoperative optimisation; longer procedures performed under haemodynamic compromise; and patient-level risk factors (alcohol, tobacco)(25,30,34). Economic implications are substantial: SSI inflates treatment costs 2–3-fold and prolongs hospitalisation from 10 to 16 days (35,36).

4.5 Microbiological profile

The microbiological spectrum did not differ significantly between groups (p = 0.824), with E. coli the predominant isolate (33.3% elective vs 47.1% emergency), followed by S. aureus, Klebsiella spp. and P. aeruginosa — consistent with West-Indian tertiary-centre data(22). The higher E. coli prevalence in emergency cases plausibly reflects direct enteric contamination from perforations(4,20). The similarity of pathogens across settings indicates that SSI flora is governed primarily by anatomical location rather than surgical urgency (1,9).

4.6 Antibiotic responsiveness

Broad-spectrum antibiotic response rates were 75.0% (elective) vs 58.8% (emergency; p = 0.367). The lower response rate in emergency patients is consistent with stewardship data proposing more aggressive regimens for emergency infections owing to higher bacterial burden and resistance(33). Equivalent responsiveness across contexts supports protocol-driven empirical regimens irrespective of procedure type(22,23).

4.7 Clinical implications

Elevated SSI risk in emergency laparotomy justifies more rigorous perioperative preventive measures — particularly in male patients (28,29), those with alcohol-use history (1,10) and those presenting with perforation(17,25). Comparable antimicrobial response rates support standardised empirical regimens irrespective of procedural urgency(22,23), and the morbidity burden of emergency laparotomy reinforces the need for protocolised infection-control pathways even in non-elective settings (1,37).

4.8 Limitations

This study is limited by single-centre design, modest sample size and absence of long-term follow-up. Operative duration, blood loss, surgeon experience and prophylactic regimens — identified as key SSI determinants by the multicentre laparotomy-risk literature (16) and systematic reviews(4,38) — were not comprehensively captured. Future multicentre studies should incorporate dedicated subgroup analyses by wound class(16,18).

5. Conclusion

Emergency exploratory laparotomy carries markedly elevated SSI risk (41.5%) compared with elective procedures (19.7%) in the Indian tertiary-care setting — concordant with the 17.7%–62% emergency range reported across Indian and international comparative series (14,15,24,32). Microbial findings and antibiotic responsiveness are comparable across groups, indicating that prevention-focused quality-improvement strategies(1,3,23) — rather than antimicrobial modification — are the principal modifiable lever, and larger multicentre studies are needed to refine perioperative protocols in the emergency laparotomy cohort(12).

Author contributions

Conflicts of interest

None declared.

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Data availability

De-identified data available from the corresponding author on reasonable request.

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