Section: Microbiology

Original Research Article

FROM SCALPEL TO SEPSIS: RISK PROFILES OF SURGICAL SITE INFECTIONS IN INDIAN TERTIARY CARE

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Received : *05/11/2025*
Received in revised form : *16/12/2025*
Accepted : *02/01/2026*

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DOI: 10.70034/ijmedph.2026.1.100

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 569-573

ABSTRACT

Background: Surgical site infections (SSIs) are significant hospital-acquired complications with major implications for patient morbidity, mortality and healthcare resource utilization. This study describes the incidence patterns and risk factors of SSIs in a tertiary care hospital setting in India.
Materials and Methods: A non-interventional prospective study was conducted from November 2024 to October 2025. All patients who underwent surgical procedures (appendectomy, laparotomy, debridement, amputation, fixation, cholecystectomy, thyroidectomy, and herniorrhaphy) and subsequently developed clinical features of postoperative wound infection were evaluated. Microbiological culture and identification were performed using standard laboratory methods. Data on demographic variables, comorbidities, operative factors and antimicrobial prophylaxis were recorded.
Results: Among 150 patients with suspected postoperative wound infections, 98 (65·33%) tested positive on culture. Male predominance was observed (98 males, 52 females). Diabetes mellitus was identified in 32 patients (40% of those with recognized risk factors). Deep incisional infections (37·8%) and organ/space infections (35·2%) were more common than superficial infections (25·5%). Laparotomy accounted for the highest number of infections (56 patients, 37·33%), followed by debridement procedures (28 patients, 18·67%). Gram-negative bacilli predominated among isolated organisms. Despite 92·7% of patients receiving prophylactic antibiotics, high SSI rates persisted.
Conclusion: SSIs in this cohort were significantly associated with male sex, age 41-50 years, diabetes, hypertension, smoking, presence of drains, major abdominal and orthopedic procedures, and operative duration exceeding two hours. Structured prevention bundles incorporating risk-adjusted surveillance, optimized perioperative glycemic control, evidence-based antimicrobial prophylaxis, and targeted interventions for high-risk patients are essential to reduce SSI burden.
Keywords: Surgical site infections; risk factors; tertiary care; antimicrobial resistance; infection prevention.

INTRODUCTION

Surgical site infections are infections involving the incision or operative field that arise after a surgical procedure that occurs near the surgical site within 30 days following surgery (or up to 90 days following surgery where an implant is involved)and are typically categorized as superficial incisional, deep incisional, or organ/space infections according to established criteria.[1] They are consistently reported as one of the most frequent hospital-acquired infections, and they have major implications for morbidity, mortality and resource utilization across a wide range of surgical specialities.[1-7] Large surveillance programs and systematic reviews have demonstrated that SSI rates vary widely by wound class, procedure type and patient risk profile, with risk-adjusted indices such as the National Nosocomial Infections Surveillance (NNIS)-based models and Surgical Site Infection Risk Score (SSIRS) providing useful benchmarks for comparing performance between institutions and over time.[1]

Multiple interrelated factors shape SSI risk. Patient-related factors include age, nutritional status, diabetes, obesity, smoking, immunosuppression and the burden of chronic disease, with older adults and those with multiple comorbidities experiencing higher rates of infection.[8] Procedure-related and perioperative factors—such as wound classification (clean, clean-contaminated, contaminated, dirty), urgency (elective versus emergency), duration of surgery, presence of prosthetic material, use of drains and surgical technique—also strongly influence SSI probability.[2] In addition, antimicrobial prophylaxis practices, local microbiological ecology and antimicrobial resistance patterns contribute significantly to variation in SSI epidemiology and outcomes.[3]

Despite improvements in operating room ventilation, sterilization, barrier precautions and guideline-driven prophylaxis, SSIs remain a prominent cause of prolonged hospitalization and readmission, and they are a growing concern in an era of escalating multidrug resistance.[3] Multicentric data and risk-adjusted models have consistently demonstrated that emergency surgery, higher wound classes, longer operative duration, increased age, comorbid conditions such as diabetes and suboptimal antimicrobial practices are key drivers of SSI.[1] Against this background, the present study sought to describe the incidence pattern and risk factors of SSIs in a tertiary care hospital cohort of patients with suspected postoperative wound infections, and to interpret these findings in the context of existing regional and international literature.

MATERIALS AND METHODS

This non-interventional prospective study was conducted in a tertiary care hospital from November 2024 to October 2025. All patients who underwent operations such as appendectomy, laparotomy, debridement, amputation, fixation, cholecystectomy, thyroidectomy and herniorrhaphy and subsequently developed clinical features suggestive of postoperative wound infection were included. Patients with clear evidence of pre-existing infections or non-surgical wounds were excluded. Institutional approval was obtained from the respective Head of Department and Dean.

For each enrolled patient, data were collected on age, sex, diabetes mellitus, hypertension, smoking status, presence of drains, duration of preoperative hospital stay, type of surgery (elective or emergency), type of procedure, type of anesthesia, duration of surgery, and key operative characteristics. These variables mirror factors that have been incorporated into SSI risk indices such as the NNIS and SSIRS. Where possible, procedures were classified by wound class (clean, clean-contaminated, contaminated, dirty) and American Society of Anesthesiologists (ASA) physical status was recorded.

From each suspected postoperative wound infection, swab specimens were collected from the depth of the wound or from purulent discharge, taking care to avoid surface contamination. Samples were promptly transported to the microbiology laboratory and processed using standard methods, including Gram staining and culture on appropriate media, such as blood agar and MacConkey agar, followed by incubation and reading at 24 to 48 hours to detect growth. Isolates were identified by their colony morphology, Gram reaction, and biochemical characteristics, and were categorized as either gram-positive or gram-negative organisms.

SSI was defined and classified according to accepted criteria into superficial incisional, deep incisional and organ/space infection.[1] All culture-positive postoperative wound infections that met these criteria were considered SSIs. Descriptive analysis was undertaken to summarize demographic characteristics, distribution of SSIs by type and procedure, and microbiological profile.

RESULTS

Demographic profile and comorbid conditions

During the 12-month study period, 150 patients with clinically suspected postoperative wound infection were evaluated. Of these, 98 (65.33%) were male and 52 (34.67%) females, indicating a marked male predominance among culture-confirmed SSIs. The highest proportion of culture-positive infections occurred in the 41-50 year age group, followed by patients older than 50 years, with the lowest proportion in those aged 21-30 years. Predisposing factors were documented in 80 of the 150 patients. Among these, diabetes mellitus was present in 32 patients (40% of those with recognized risk factors), hypertension in 14 (17.5 %), drains at the surgical site in 25 (31.25%) and a history of smoking in 09 patients. These observations support a substantial contribution of metabolic and vascular disease, local foreign bodies such as drains, and lifestyle factors to postoperative wound infection.

Antibiotic prophylaxis and surgical site infection type of the 150 patients, 92.7% had received preoperative antibiotic prophylaxis, whereas 7.3% had not been administered any prophylactic regimen. Commonly used agents included combinations such as amoxicillin with or without metronidazole and cephalosporins.

Based on standard criteria, 98 culture-positive cases were classified as SSIs. Among these, 25 (25.5%) were superficial incisional infections, 37 (37.8%) were deep incisional infections, and 36 (35.2%) were organ/space infections. This distribution indicates that the majority of SSIs in the present cohort involved deeper tissues or organ spaces rather than superficial layers alone.

Procedure-related patterns

When SSIs were examined by procedure type, laparotomy accounted for the highest number of postoperative infections, with 56 patients (37.33%) in this group. Debridement procedures contributed 28cases (18.67%), fixation surgeries 17 (11.33%), appendectomy 11(7.33%), herniorrhaphy 14 (9.33%), incision procedures 05 (3.33%), colostomy 08 (5.33%) and thyroidectomy 11 (7.33%). Across these procedure categories, gram-negative organisms were generally more common than gram-positive organisms. This pattern reflects the high risk associated with major abdominal, soft tissue and orthopedic operations, particularly when wounds are clean-contaminated, contaminated or dirty, and when drains and foreign materials are used.

Operative duration emerged as an important feature: patients undergoing operations lasting longer than two hours had a substantially higher likelihood of developing SSI than those with shorter procedures. This is concordant with data from multiple cohorts where increasing duration beyond defined thresholds (often procedure-specific) is a strong independent predictor of SSI and is therefore incorporated into risk indices and benchmark models[1].

Microbiological findings

In this cohort, gram-negative bacilli predominated among SSI isolates, with gram-positive cocci accounting for a smaller but clinically important proportion of infections. Organisms frequently encountered in similar studies include Escherichia coli, Klebsiella species, Pseudomonas aeruginosa, Acinetobacter species and Proteus species, along with Staphylococcus aureus, coagulase-negative staphylococci and Enterococcus species.

Table 1: List of surgical procedures and the bacterial isolates from patients who had post operative surgical site infection

Type of surgical procedure	Patients no(%)	Bacterial isolates		Total isolates no (%)
		Gram positive	Gram negative	
Laparotomy	56 (37.33)	15(34.8)	28(65.11)	43(43.9)
Debridement	28(18.67)	5(31.25)	11(68.75)	16(16.3)
Fixation	17(11.33)	4(57.14)	3(47.85)	7(7.1)
Appendectomy	11(11.33)	6(50)	6(50)	12(12.2)
Herniorrhaphy	14(9.33)	3(50)	3(50)	6(6.1)
Incision	5(3.33)	2(33.33)	4(66.67)	6(6.1)
Colostomy	8(5.33)	1(14.28)	6(85.71)	7(7.1)
Thyroidectomy	11(7.33)	1(50)	1(50)	2(2.0)
Total	150(100)	36(36.73)	62(63.26)	98(100)

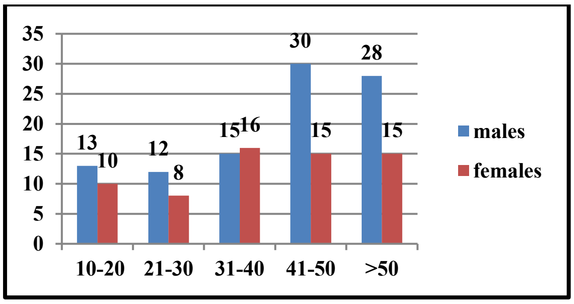

Figure 1: Age Distribution

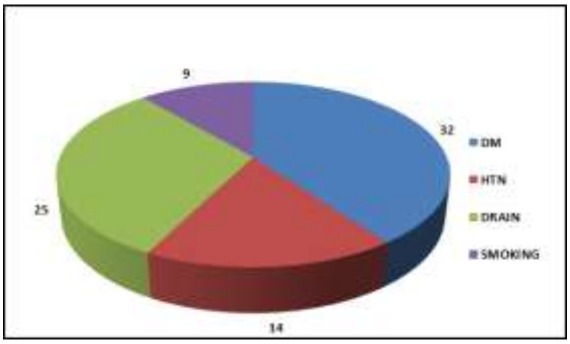

Figure 2: Predisposing factors

DISCUSSION

This prospective tertiary-care cohort demonstrated that SSIs occurred predominantly in male patients and were concentrated in middle-aged and older adults, a pattern consistent with multiple reports showing higher SSI rates in men and in older age groups, especially when comorbidities are prevalent.[8] The highest proportion of infections in the 41-50 year age group likely reflects both exposure to high-risk procedures and accumulation of chronic disease, whereas increased vulnerability in older adults has been attributed to immunosenescence, reduced physiological reserve and a greater burden of comorbidity.[8]

Diabetes mellitus emerged as a major risk factor in this cohort, being present in 40% of patients with identified predisposing factors, alongside hypertension, smoking and the presence of drains. This is in agreement with a wide body of evidence demonstrating that diabetes, poor glycemic control and perioperative hyperglycemia significantly increase SSI risk across surgical specialties.[9] Meta-analyses and cohort studies have demonstrated that elevated perioperative glucose levels are independently associated with higher SSI rates, reinforcing the recommendation for careful glycemic management during the perioperative period.[9] The impact of corticosteroids and other immunosuppressants on postoperative infection risk, documented in orthopedic and other surgical populations, further underscores the importance of

reviewing chronic steroid use and implementing tailored perioperative strategies for such patients.[10]
From a procedural perspective, the predominance of infections following laparotomy, debridement, fixation surgeries and other major operations is consistent with reports that extensive abdominal and orthopedic procedures, especially when performed in emergency settings or in higher wound classes, are associated with the greatest SSI burden.[2] Numerous studies have demonstrated that emergency operations, contaminated or dirty wounds and major procedures involving prolonged tissue handling and foreign materials confer a higher risk than elective, clean surgeries[2]. Operative duration is a particularly robust predictor: surgeries lasting more than procedure-specific thresholds exhibit significantly higher SSI rates and are explicitly incorporated into widely used risk indices and benchmark tools such as the basic SSI risk index and SSIRS.[1]
The microbiological pattern in this study, with predominance of gram-negative bacilli and a significant presence of S. aureus and other gram-positive organisms, mirrors findings from Indian and international series investigating postoperative wound flora.[3] The prominence of gram-negative organisms, including E. coli, Klebsiella, Pseudomonas and Acinetobacter, and the frequent detection of multidrug-resistant strains highlight the need for targeted infection-control practices, rational antibiotic use and stringent stewardship to limit resistance proliferation.[3] At the same time, the consistent involvement of S. aureus and other gram-positive cocci in SSIs supports continued emphasis on skin preparation, hand hygiene and device-related aseptic measures.[3]
The observation that a large majority of patients with SSI had received prophylactic antibiotics is consistent with prior work demonstrating that prophylaxis alone is insufficient when timing, agent selection and duration are suboptimal, or when local resistance patterns are unfavourable.[3] Studies from India, Ethiopia and other low- and middle-income settings have highlighted inappropriate prophylactic regimens and prolonged postoperative use as common practice, which may contribute to both persistent SSI and rising resistance.[3] Adherence to evidence-based guidelines and periodic audits of antibiotic use are therefore critical components of SSI prevention.[11]
Risk-adjusted models and surveillance systems have proven particularly valuable in benchmarking SSI rates and identifying high-risk subsets. Work from multicentric and single-centre studies has demonstrated that models incorporating wound class, ASA score, duration and procedure type can provide meaningful predictions of SSI risk and guide targeted interventions.[1] Discordance in ASA classification between surgeons and anesthesiologists, which has been linked to differences in predicted and observed outcomes, further emphasizes the need for consistent and accurate preoperative risk assessment.[12] Embedding such risk indices into routine surveillance, and feeding results back to clinical teams, can help design tailored prevention bundles for high-risk procedures and populations.

CONCLUSION

In this prospective tertiary-care cohort, SSIs were most frequent among male patients and individuals in the 41-50 year age group, and were strongly associated with diabetes, hypertension, smoking, presence of drains, major abdominal and orthopedic procedures and longer operative durations. These findings are consistent with the broader literature, which identifies age, comorbidity, wound class, emergency status and prolonged surgery as key SSI determinants. Gram-negative organisms predominated among isolates, with important contributions from S. aureus and other gram-positive cocci, and high SSI rates occurred despite widespread use of prophylactic antibiotics, reflecting the combined effects of resistance and imperfect prophylaxis practices.
To reduce SSI burden in similar settings, infection-control programs should prioritize robust surveillance with risk adjustment, regular departmental feedback, optimization of perioperative care (including strict glycemic control and careful management of immunosuppression), evidence-based antibiotic prophylaxis and focused preventive bundles for high-risk combinations of patient factors, procedures and wound classes. Such a structured, data-driven approach offers a realistic pathway to lowering SSI rates and improving surgical outcomes in high-volume Indian tertiary hospitals.

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