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Surgical Site Infection and Its Risk Factors Following Abdominal Surgery: A Hospital-Based Observational Study

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Abstract

Background: Surgical site infection (SSI) remains one of the most common and costly healthcare-associated infections following abdominal surgery, contributing to prolonged hospitalisation, increased morbidity, and avoidable expenditure. Reported rates are consistently higher in developing-country settings, yet contemporary data from South India are limited. This study aimed to determine the incidence of SSI following abdominal surgery and to identify associated risk factors.

Methods: A hospital-based observational study was conducted among 250 patients undergoing abdominal surgery at Tertiary Care Teaching Hospital. SSI was assessed during the period of admission using the Centers for Disease Control and Prevention (CDC) criteria. Demographic, clinical, and operative variables were recorded prospectively. Descriptive statistics were computed, and associations between potential risk factors and SSI were examined using the chi-square test for categorical variables and the independent-samples t-test for continuous variables, with a significance threshold of $p < 0.05$.

Results: The mean age of the cohort was 49.7 (SD 17.8) years, with near-equal sex distribution (female 50.8%, male 49.2%) and a mean body mass index of 28.7 (SD 5.8) kg/m². SSI occurred in 39 patients, yielding an overall rate of 15.6% (95% CI 11.1–20.1%). SSI was significantly associated with diabetes mellitus (21.8% in diabetics vs 9.9% in non-diabetics; $\chi^2 = 5.86$, $p = 0.015$) and with prolonged operative time (>120 min, 20.4%; $\chi^2 = 8.66$, $p = 0.013$), with a higher mean operative duration among SSI cases (169.7 vs 141.7 min; $t = 3.02$, $p = 0.003$). No significant association was observed with gender, smoking, ASA grade, antibiotic prophylaxis, BMI category, or age.

Conclusion: The SSI rate of 15.6% is consistent with figures reported from comparable Indian settings. Diabetes mellitus and prolonged operative time emerged as the principal identifiable risk factors. The apparent absence of benefit from antibiotic prophylaxis most plausibly reflects confounding by indication in this observational design rather than true ineffectiveness. Glycaemic optimisation and measures to reduce operative duration may help lower the SSI burden.

Keywords: *Surgical site infection; abdominal surgery; diabetes mellitus; operative time; antibiotic prophylaxis; South India.*

Introduction

Surgical site infection (SSI) is among the most frequent and economically burdensome of all healthcare-associated infections, and it remains a persistent challenge in surgical practice worldwide. Defined by the Centers for Disease Control and Prevention (CDC) as an infection occurring at or near a surgical incision within a defined postoperative period, SSI encompasses

superficial incisional, deep incisional, and organ/space categories. Despite substantial advances in aseptic technique, perioperative care, and antimicrobial prophylaxis, SSI continues to complicate a meaningful proportion of operations, contributing to prolonged hospitalisation, repeated interventions, increased antimicrobial consumption, and avoidable healthcare expenditure. Patients who develop SSI experience greater pain, delayed recovery, and a measurably higher risk of readmission, while institutions bear the costs of extended bed occupancy and additional resource utilisation.

Abdominal surgery carries a particular vulnerability to SSI owing to the frequent breach of viscera, the potential for contamination from enteric flora, and the often prolonged and complex nature of intra-abdominal procedures. The wound classification of abdominal operations spans the clean, clean-contaminated, contaminated, and dirty categories, and a considerable share of emergency and gastrointestinal procedures fall into the higher-risk groups. Consequently, abdominal surgery has historically been associated with some of the highest SSI rates across surgical specialties, and it represents an important target for infection-prevention efforts.

A range of patient-related and procedure-related risk factors for SSI has been characterised in the surgical literature. Among patient factors, diabetes mellitus is repeatedly implicated, with hyperglycaemia impairing neutrophil function, microvascular perfusion, and wound healing. Elevated body mass index, advanced age, smoking, and higher American Society of Anesthesiologists (ASA) physical-status grade have likewise been described as contributory. Among procedural determinants, prolonged operative time is one of the most consistently reported predictors, reflecting greater tissue exposure, longer periods of incisional contamination, and increased physiological stress. The appropriate selection and timing of antimicrobial prophylaxis are also recognised as important modifiable elements of perioperative care, although prophylaxis is frequently administered in a manner that does not align with established guidelines. Meta-analytic and multicentre data across orthopaedic, spinal, and urological procedures have reinforced the relevance of these factors, underscoring that the determinants of SSI are partly shared across surgical disciplines while also being modulated by the specific operative context [1].

The burden of SSI is disproportionately greater in low- and middle-income countries, where reported incidence frequently exceeds that of high-income settings. Constraints in infrastructure, variability in perioperative practices, a higher proportion of emergency presentations, and challenges in implementing standardised infection-control bundles all contribute to this disparity. Indian studies have documented SSI rates that, while heterogeneous across institutions and procedure types, are often higher than international benchmarks, and they have additionally highlighted the problem of inappropriate surgical chemoprophylaxis as a contributor to both infection and antimicrobial misuse [2,3]. Disease-specific surgical conditions prevalent in the region, such as perforated peptic ulcer, further add to the contaminated-wound caseload encountered in South Indian surgical units [4].

Notwithstanding the existence of Indian data, contemporary, setting-specific evidence on the incidence and determinants of SSI following abdominal surgery in South India remains comparatively sparse. Variation in case mix, surgical volume, and perioperative protocols means that institution-level data are valuable for guiding local quality-improvement initiatives. Robust local estimates of SSI incidence and the identification of locally relevant risk factors are prerequisites for designing targeted, context-appropriate prevention strategies. The present hospital-based observational study was therefore

undertaken at a tertiary care teaching hospital in South India to determine the incidence of SSI among patients undergoing abdominal surgery, assessed in accordance with CDC criteria, and to examine the association between SSI and a defined set of patient-related and procedure-related risk factors. By generating locally grounded evidence, this study seeks to inform pragmatic measures to reduce the SSI burden in comparable South Indian surgical settings.

Materials and Methods

Study design and setting

This was a hospital-based observational study, incorporating prospective cohort and cross-sectional elements, conducted in the Department of Surgery at tertiary care teaching hospital in South India. The study was carried out over six months.

Study population

The study enrolled 250 consecutive patients undergoing abdominal surgery during the study period. Inclusion criteria comprised adult patients aged 18 years and above admitted for elective or emergency abdominal surgical procedures who consented to participate and could be followed for the duration of their hospital admission. Exclusion criteria included patients with a pre-existing infection at the operative site at the time of surgery, patients who declined participation, and those for whom complete postoperative follow-up during admission could not be ensured.

Sample size

A sample of 250 patients undergoing abdominal surgery was studied. This sample size was considered adequate to estimate the incidence of SSI with reasonable precision and to permit examination of associations between SSI and the prespecified risk factors within an observational framework.

Outcome definition and assessment

The primary outcome was the occurrence of SSI, defined and classified according to the Centers for Disease Control and Prevention (CDC) criteria. SSI was assessed during the period of hospital admission through systematic clinical examination of the surgical wound, with documentation of the relevant signs of superficial incisional, deep incisional, or organ/space infection as applicable. Assessment was confined to the in-hospital period; SSI occurring after discharge was not captured.

Variables

Data were collected on demographic, clinical, and operative characteristics, including age, sex, body mass index (BMI), presence of diabetes mellitus, smoking status, ASA physical-status grade, operative duration, receipt of antibiotic prophylaxis, and length of hospital stay. These variables were selected on the basis of their established or hypothesised relationship with SSI.

Statistical analysis

Data were summarised using descriptive statistics. Continuous variables were expressed as means with standard deviations, and categorical variables as frequencies and percentages. The overall SSI rate was reported with its 95% confidence interval. Associations between categorical risk factors and SSI were assessed using the chi-square (χ^2) test, and differences in continuous variables between patients with and without SSI were assessed using the independent-samples t-test. A p-value of less than 0.05 was considered statistically significant. Multivariable analysis was not performed; accordingly, all reported associations are unadjusted.

Ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee of [Name of Tertiary Care Teaching Hospital] ([IEC approval number and date]). Informed consent was obtained from all participants prior to enrolment, and patient confidentiality was maintained throughout.

Results

Patient and operative characteristics

A total of 250 patients undergoing abdominal surgery were studied. The mean age was 49.7 (SD 17.8) years, with ages ranging from 18 to 80 years. The cohort was almost evenly distributed by sex, comprising 127 women (50.8%) and 123 men (49.2%). The mean BMI was 28.7 (SD 5.8) kg/m². Diabetes mellitus was present in 119 patients (47.6%), and 122 patients (48.8%) were smokers. The mean operative duration was 146.0 (SD 54.0) minutes. ASA physical-status grades were distributed as grade I in 87 patients (34.8%), grade II in 79 patients (31.6%), and grade III in 84 patients (33.6%). Antibiotic prophylaxis was administered to 118 patients (47.2%) and not given to 132 patients (52.8%). The mean hospital stay was 9.2 (SD 3.7) days. These characteristics are summarised in Table 1.

Table 1. Patient and operative characteristics (N = 250)

Characteristic	Value
Age, mean (SD), years	49.7 (17.8)
Age range, years	18–80
Female, n (%)	127 (50.8)
Male, n (%)	123 (49.2)
BMI, mean (SD), kg/m²	28.7 (5.8)
Diabetes mellitus, n (%)	119 (47.6)
Smokers, n (%)	122 (48.8)
Operative duration, mean (SD), min	146.0 (54.0)
ASA grade I, n (%)	87 (34.8)
ASA grade II, n (%)	79 (31.6)
ASA grade III, n (%)	84 (33.6)
Antibiotic prophylaxis given, n (%)	118 (47.2)
Antibiotic prophylaxis not given, n (%)	132 (52.8)
Hospital stay, mean (SD), days	9.2 (3.7)

Incidence of surgical site infection

SSI occurred in 39 of the 250 patients, corresponding to an overall SSI rate of 15.6% (95% CI 11.1–20.1%). The remaining 211 patients (84.4%) did not develop SSI during their hospital admission (Table 2).

Table 2. Incidence of surgical site infection (N = 250)

Outcome	n	%	95% CI
SSI present	39	15.6	11.1–20.1
SSI absent	211	84.4	—

Categorical risk factors and SSI

The associations between categorical risk factors and SSI are presented in Table 3. SSI was significantly associated with diabetes mellitus: 21.8% of diabetic patients developed SSI compared with 9.9% of non-diabetic patients ($\chi^2 = 5.86$, $p = 0.015$). No statistically significant association was observed between SSI and gender (male 17.1% vs female 14.2%; $p = 0.65$), smoking status (smokers 16.4% vs non-smokers 14.8%; $p = 0.85$), or ASA grade ($p = 0.63$). Notably, the SSI rate among patients who received antibiotic prophylaxis (13.6%) did not differ significantly from that among patients who did not receive prophylaxis (17.4%; $p = 0.51$). BMI category likewise showed no significant association with SSI ($p = 0.69$), nor did age ($p = 0.53$).

Table 3. Categorical risk factors and surgical site infection

Risk factor	Category	SSI rate (%)	χ^2	p-value
Gender	Male	17.1	—	0.65
	Female	14.2		
Diabetes mellitus	Present	21.8	5.86	0.015
	Absent	9.9		
Smoking	Smoker	16.4	—	0.85
	Non-smoker	14.8		
ASA grade	I / II / III	—	—	0.63
Antibiotic prophylaxis	Given	13.6	—	0.51
	Not given	17.4		

Operative time and continuous comparisons

SSI showed a strong and statistically significant association with operative time when analysed by category: the SSI rate was 6.7% for procedures lasting less than 60 minutes, 5.9% for those lasting 60 to 120 minutes, and 20.4% for those exceeding 120 minutes (χ^2 = 8.66, p = 0.013). Consistent with this, the mean operative duration was significantly higher among patients who developed SSI than among those who did not (169.7 vs 141.7 minutes; t = 3.02, p = 0.003). These findings are presented in Table 4.

Table 4. SSI by operative-time category and continuous comparison of operative duration

Comparison	Group	SSI rate / Mean	Test statistic	p-value
Operative time category	<60 min	6.7%	χ^2 = 8.66	0.013
	60–120 min	5.9%		
	>120 min	20.4%		
Mean operative duration (min)	SSI present	169.7	t = 3.02	0.003
	SSI absent	141.7		

Discussion

In this hospital-based observational study of 250 patients undergoing abdominal surgery at a tertiary care teaching hospital in South India, the overall SSI rate was 15.6% (95% CI 11.1–20.1%). Two factors emerged as significantly associated with SSI: diabetes mellitus and prolonged operative time [1]. Patients with diabetes had more than double the SSI rate of those without (21.8% vs 9.9%; p = 0.015), and procedures exceeding 120 minutes carried a markedly higher infection rate than shorter operations (20.4% vs 6.7% and 5.9%; p = 0.013), with a significantly greater mean operative duration among infected cases (169.7 vs 141.7 minutes; p = 0.003). Other examined factors — gender, smoking, ASA grade, BMI category, and age — were not significantly associated with SSI in this cohort.The observed SSI rate of 15.6% sits within the range reported from comparable Indian and other developing-country settings, which characteristically exceed the lower rates documented in many high-income contexts. A four-year prospective study at a private tertiary care hospital in Mumbai documented the incidence and microbial aetiology of SSI and reaffirmed that SSI remains an ongoing concern even in well-resourced Indian institutions [2]. Studies of orthopaedic trauma surgery in a tertiary care centre in India have similarly described meaningful SSI burdens and adverse downstream outcomes [3], while procedure-specific analyses internationally — for example, the relatively low

rates following laparoscopic urological procedures [4] — illustrate how operative approach and case mix substantially influence infection risk. The comparatively higher rate seen in abdominal surgery, with its frequent enteric contamination and longer operative times, is consistent with the present finding and with the recognised regional caseload of contaminated abdominal pathology such as perforated peptic ulcer [5].

The strong association between SSI and diabetes mellitus is biologically coherent and concordant with the wider literature. Hyperglycaemia impairs leucocyte chemotaxis and phagocytosis, compromises microvascular perfusion, and delays collagen synthesis and wound healing, collectively predisposing diabetic patients to incisional infection. Diabetes has been identified as a contributory factor in pooled analyses of SSI risk across surgical disciplines, including meta-analytic data for spinal surgery [4]. In a population such as the present one, in which nearly half of patients were diabetic, this association assumes considerable clinical and public-health importance and points directly to perioperative glycaemic control as a modifiable target.

Prolonged operative time was the other principal determinant identified. The graded increase in SSI rate with longer operations, culminating in a 20.4% rate beyond 120 minutes, mirrors the consistent finding across the literature that extended operative duration heightens infection risk through prolonged tissue exposure, greater contamination, increased physiological stress, and potential lapses in the maintenance of an optimal antimicrobial tissue concentration. The concordant continuous analysis, demonstrating a near 28-minute longer mean operative time in infected cases, strengthens the inference. Operative duration has been repeatedly implicated as a risk factor in multivariable analyses of SSI in other surgical settings [6], lending external coherence to the present observation.

The finding that antibiotic prophylaxis was not associated with a lower SSI rate — indeed, the rate was numerically lower among those who did not receive it (13.6% with prophylaxis vs 17.4% without; $p = 0.51$) — warrants careful interpretation and must not be read as evidence that prophylaxis is ineffective. In an observational design, prophylaxis is preferentially administered to patients perceived to be at higher risk, including those undergoing longer, more complex, or contaminated and dirty procedures. This confounding by indication can obscure or even reverse the true protective effect, since the very patients most likely to receive prophylaxis are also those most predisposed to infection. The robust evidence base supporting appropriate antimicrobial prophylaxis is well established, and Indian data have specifically drawn attention to the prevalence of inappropriate surgical chemoprophylaxis and its relationship with SSI and antimicrobial misuse [7]. The present result is therefore best understood as a manifestation of the limitations of unadjusted observational analysis rather than as a refutation of prophylactic benefit, and it underscores the need for guideline-concordant selection, timing, and dosing of perioperative antibiotics[8].

From a prevention standpoint, the findings carry several practical implications for comparable South Indian surgical units. First, optimisation of perioperative glycaemic control in diabetic patients is a high-yield, modifiable intervention[9]. Second, deliberate measures to reduce operative time — through meticulous planning, appropriate case selection, team efficiency, and surgical expertise — may attenuate the infection risk associated with prolonged procedures. Third, ensuring appropriate antimicrobial prophylaxis, administered in accordance with established guidelines and stewardship principles, remains an essential component of SSI prevention even where unadjusted observational data appear

paradoxical. Embedding these measures within structured infection-prevention bundles is likely to be the most effective route to lowering the SSI burden[10].

Limitations

Several limitations merit acknowledgement. The study was observational in design, and multivariable analysis was not performed; consequently, all reported associations are unadjusted and may be subject to confounding, most notably confounding by indication for antibiotic prophylaxis. The single-centre setting limits the generalisability of the findings to other institutions and case mixes. SSI was assessed only during the period of hospital admission, so infections developing after discharge may have been missed, potentially underestimating the true incidence. Finally, the synthetic nature of certain study-level details required the use of bracketed placeholders for institutional and regulatory specifics.

Conclusion

In this hospital-based observational study of patients undergoing abdominal surgery at a tertiary care teaching hospital in South India, the SSI rate was 15.6%, consistent with figures reported from comparable Indian settings. Diabetes mellitus and prolonged operative time (>120 minutes) were the two significant, identifiable risk factors for SSI, whereas gender, smoking, ASA grade, BMI category, age, and antibiotic prophylaxis showed no significant association. The apparent lack of protective effect from prophylaxis most plausibly reflects confounding by indication inherent to the observational design rather than true ineffectiveness. Targeted measures — perioperative glycaemic optimisation, reduction of operative duration, and guideline-concordant antimicrobial prophylaxis — offer practical avenues to reduce the SSI burden in similar South Indian surgical settings.

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