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ASSESSMENT OF SURGICAL SITE INFECTIONS IN SURGERIES AT TERTIARY CARE HOSPITALS IN SOUTHERN PUNJAB, PAKISTAN; A RETROSPECTIVE STUDY

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ABSTRACT

Background: Surgical Site Infections (SSIs) constitute a significant cause of postoperative morbidity and mortality across global healthcare systems. These infections not only exacerbate clinical outcomes but also contribute substantially to increased healthcare expenditures and extended durations of hospitalization. In the context of developing nations such as Pakistan, the burden of SSIs is further compounded by infrastructural limitations, variability in perioperative practices, and constrained infection control protocols. This study was designed to evaluate the incidence of SSIs following elective and emergency general surgical procedures and to explore the association between SSIs and key predisposing factors.

Methodology: A retrospective cohort study was conducted across multiple tertiary care hospitals situated in the southern region of Punjab, Pakistan. The study analyzed clinical records of 284 patients who underwent general surgical interventions, with almost equal representation from elective and emergency surgical cohorts. Patients' clinical data, including demographic characteristics, comorbidities, wound classification, microbial culture results, and duration of hospital stay, were extracted from institutional electronic medical records. Statistical analysis was performed using STATA version 14.0, with multivariate logistic regression employed to evaluate potential associations between SSI occurrence and relevant clinical variables.

Results & Findings: An overall SSI rate of 9.15% (26/284) was observed. Emergency surgeries exhibited a higher SSI incidence (13%) compared to elective surgeries (9%), although this difference lacked statistical significance ($p = 0.366$). The risk of SSIs increased significantly with advancing age, contaminated wound class ($p < 0.001$), and presence of comorbidities such as diabetes and hypertension ($p = 0.008$). Despite universal administration of antibiotic prophylaxis, no significant protective effect was demonstrated, underscoring concerns about timing and appropriateness of antibiotic use. Staphylococcus aureus (36.37%) and Escherichia coli (31.82%) were the predominant pathogens isolated from infected wounds. Patients with SSIs had significantly longer hospital stays

(mean 10.25 days) compared to uninfected patients (mean 6.98 days), indicating prolonged hospitalization as a potential risk factor.
Conclusions: SIs remain a significant postoperative complication in tertiary hospitals of Southern Punjab, influenced by patient age, wound contamination, comorbid conditions, and hospitalization duration. Effective SSI prevention requires timely and judicious use of antibiotic prophylaxis, improved perioperative care, and stringent infection control protocols. Addressing these factors can reduce SSI incidence, improving patient outcomes and optimizing healthcare resource utilization.

Key words: Surgical Site Infections (SSIs), General Surgery, Postoperative Complications, Tertiary Care Hospitals, Infection Control

INTRODUCTION

Surgical Site Infections (SSIs) represent one of the most prevalent and challenging complications in postoperative patient care, significantly contributing to morbidity, prolonged hospitalization, increased healthcare expenditure, and, in severe cases, mortality [1]. According to the Centers for Disease Control and Prevention (CDC), an SSI is defined as an infection that occurs within 30 days following a surgical procedure, or within one year if a prosthetic implant is placed and the infection is related to the operative procedure [2]. SSIs are further classified into superficial incisional, deep incisional, and organ/space infections, depending on the depth and anatomical location of the infection. The incidence of SSIs is multifactorial, arising from a complex interplay between microbial, host, procedural, and environmental determinants. Four key factors have been identified as critical in the development of SSIs: (i) microbial inoculum at the surgical site, (ii) virulence or pathogenicity of the colonizing organisms, (iii) the local physiological and anatomical characteristics of the surgical site (including tissue perfusion, oxygenation, and contamination status), and (iv) the patient's immune competence. Surgical procedures of extended duration and those that breach mucosal barriers or enter anatomical sites with endogenous microbial flora such as the gastrointestinal or genitourinary tracts are inherently associated with higher infection risk. Wound classification systems, such as the CDC's surgical wound classification, categorize surgical sites into clean, clean-contaminated, contaminated, and dirty/infected wounds. These classifications serve as a predictive tool for SSI risk stratification, with infection rates escalating significantly from clean (typically <2%) to dirty wounds (potentially exceeding 40%) [3,4].
Host-related risk factors that predispose patients to SSIs include extremes of age (neonates and geriatrics), malnutrition, obesity, diabetes mellitus, immunosuppression (due to HIV, malignancy, chemotherapy, or corticosteroid use), smoking, and chronic conditions such as renal or hepatic insufficiency [5]. Furthermore, intraoperative factors such as inadequate sterilization, breaks in aseptic technique, improper skin preparation, use of drains, and perioperative hypothermia also contribute to increased susceptibility [6]. Despite the significant advancements in surgical technique, infection control practices, perioperative antimicrobial prophylaxis, and hospital sterilization protocols, SSIs continue to be among the most frequently encountered healthcare-associated infections (HAIs), particularly in low- and middle-income countries (LMICs). The continued burden of SSIs in modern surgical practice underscores the need for enhanced adherence to evidence-based practices and comprehensive infection prevention strategies [7]. Globally, SSI rates vary widely across healthcare systems. In high-income countries (HICs), where adherence to standardized surgical safety protocols and surveillance mechanisms is typically robust, SSI incidence ranges from 0.9% in the United States to 2.8% in Australia [8]. Conversely, LMICs including South Asian nations such as India and Pakistan report substantially higher SSI rates, estimated between 6.3% and 9.3%, as per WHO assessments [9]. This discrepancy is attributable to systemic barriers including, but not limited to, infrastructural inadequacies, inconsistent implementation of infection control policies, inappropriate or irrational antibiotic prescribing practices, limited access to sterile surgical equipment, overcrowded wards, and a shortage of trained healthcare personnel. These constraints collectively undermine surgical outcomes and elevate the risk of nosocomial infections. SSIs impose significant

clinical and economic burdens on patients and healthcare systems. Patients developing SSIs are approximately five times more likely to require hospital readmission, are 60% more likely to necessitate intensive care unit (ICU) admission, and have double the mortality rate compared to patients with uncomplicated postoperative courses [10]. Additionally, SSIs necessitate prolonged use of antimicrobial agents, contributing to the emergence of antimicrobial resistance (AMR) a growing global health crisis. The economic impact is equally substantial, as SSIs lead to increased costs due to extended hospital stays, additional diagnostic evaluations (e.g., cultures and sensitivity testing), reoperations, and loss of productivity. It is noteworthy that approximately 40% to 60% of SSIs are considered preventable through stringent adherence to perioperative infection control measures, such as the use of appropriate antimicrobial prophylaxis (timing, selection, and dosing), rigorous hand hygiene, sterilization and disinfection protocols, environmental sanitation, surgical team discipline, and implementation of surgical safety checklists.

SSIs are widely recognized as a quality-of-care indicator within hospitals and healthcare systems. Their occurrence reflects the effectiveness of infection prevention and control (IPC) practices, hospital hygiene standards, and institutional adherence to surgical safety protocols. Consequently, reducing SSI rates is critical not only for improving individual patient outcomes but also for enhancing the operational efficiency and credibility of healthcare institutions, especially in the context of resource-constrained public sector hospitals. In Pakistan, particularly in under-resourced regions such as Southern Punjab, there is a dearth of systematically collected data on the incidence and determinants of SSIs. Tertiary care hospitals in these areas cater to large and diverse populations, often under significant resource limitations and infrastructural constraints. These institutions face challenges including surgical backlogs, high patient-to-staff ratios, inconsistent antimicrobial stewardship practices, and a lack of routine surveillance systems for SSIs. Additionally, literature on the comparative risk of SSIs in elective versus emergency surgeries remains inconclusive. While emergency procedures are intuitively considered to carry a higher infection risk due to limited preoperative optimization, contamination of the surgical field, and the urgency of the intervention, empirical evidence remains variable and context-dependent. The present retrospective study was undertaken to assess the burden, characteristics, and contributing factors of SSIs in patients undergoing both elective and emergency surgeries at tertiary care hospitals in Southern Punjab, Pakistan. This region presents a unique healthcare landscape marked by socioeconomic disparities, variable access to care, and a high volume of surgical procedures. By evaluating the prevalence and risk profile of SSIs in this setting, the study aims to generate evidence that may guide the formulation and implementation of context-specific infection control interventions, improve surgical care outcomes, and inform regional health policy strategies aimed at reducing postoperative infectious complications.

METHODOLOGY

Materials and Methods

This retrospective, record-based cohort study was designed to evaluate the incidence and associated factors of Surgical Site Infections (SSIs) among patients undergoing surgical procedures at tertiary care hospitals in Southern Punjab, Pakistan. The study covered a 12-month period, from January 1, 2024, to December 31, 2024. As the study involved secondary data analysis from hospital records with no direct patient contact or intervention, a formal waiver of informed consent was granted. Ethical approval for the study protocol was obtained from the Institutional Review Board (IRB) of the respective tertiary care facility. The study population consisted of 284 adult patients (≥18 years of age) who underwent general surgical procedures under either general or regional anaesthesia within the study period. Only those patients who had completed a minimum of 30 days of postoperative follow-up up to January 31, 2025 were included in the analysis, in line with the Centers for Disease Control and Prevention (CDC) criteria for SSI surveillance in surgeries without implant placement. Patients with a history of previous abdominal surgery, those who were immunocompromised (e.g., individuals receiving chemotherapy or with diagnosed immunodeficiency disorders), and patients who presented in septic shock at the time of surgery were excluded to reduce confounding factors that may independently influence infection risk.

The data were obtained from the hospital's Medical Records Department using a standardized data abstraction form. Demographic variables (age, sex), clinical characteristics (comorbid conditions such as diabetes mellitus, hypertension, malignancy, or obesity), and surgical details (type and urgency of the procedure elective vs. emergency, wound classification based on CDC categories, surgical diagnosis, type of surgical procedure, and operative duration) were systematically recorded. Additional variables collected included details on the administration of prophylactic antibiotics (timing, type), length of hospital stay, and documentation of postoperative complications. Each case was also assessed for ASA (American Society of Anesthesiologists) physical status classification.
SSIs were identified based on documentation by treating surgeons or attending physicians during the 30-day postoperative period. Diagnostic criteria for SSIs included the presence of any of the following at the surgical site: signs of localized inflammation (redness, warmth, swelling, pain, or tenderness), purulent discharge, or a microbiologically confirmed positive culture from wound swabs or aspirated fluid. These criteria adhered strictly to CDC guidelines for standardized SSI surveillance. No additional testing or direct clinical assessments were performed beyond what was already recorded in the patient files.
Data analysis was performed using STATA version 14.0. Descriptive statistics were applied to summarize demographic and clinical characteristics of the study population. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means with standard deviations or medians with interquartile ranges, depending on the distribution assessed via the Shapiro–Wilk test. Comparative analyses between elective and emergency surgery groups were conducted using the Chi-square test or Fisher’s exact test for categorical variables, and the independent samples t-test or Mann–Whitney U test for continuous variables, as appropriate. A p-value less than 0.05 was considered statistically significant.

RESULTS & FINDINGS

he demographic and clinical characteristics of the study participants in a structured format. The age distribution reveals that the majority of patients were in the middle-age to early elderly brackets, with the highest proportion falling within the 45–54 year age group (26.8%), followed by those aged 35–44 years (22.5%) and 55–64 years (17.9%). Participants aged 25–34 years constituted 17.2% of the sample. Younger adults aged 18–24 years accounted for only 4.5%, while older adults aged 65 years and above represented a smaller proportion: 6.7% for those aged 65–74 years, 2.8% for 75–84 years, and 1.4% for those 85 years or older. In terms of gender distribution, males comprised a significant majority, representing 63% (n=179) of the study population, while females accounted for 37% (n=105). Regarding the type of surgical intervention, a slightly higher proportion of patients underwent emergency surgical procedures (52.8%) compared to elective surgeries (47.2%), indicating a substantial representation of urgent clinical scenarios in the dataset.

Table 1: Demographic and clinical details of the study group (n=200).

Characteristics	**N (%)**
Age (in years)	
18-24	13 (4.5)
25-34	49 (17.2)
35-44	64 (22.5)
45-54	76 (26.8)
55-64	51 (17.9)
65-74	19 (6.7)
75-84	8 (2.8)
85 or above	4 (1.4)
Gender	
Male	179 (63)
Female	105 (37)
Surgical procedure	
Emergency	150 (52.8)
Elective	134 (47.2)
Wound class	
Clean	78 (27.5)
Clean-contaminated	89 (31.3)
Contaminated	87 (30.6)
Dirty	30 (10.6)
Comorbidities	
No comorbidities	146 (51.4)
Diabetes mellitus	69 (24.3)
Hypertension	40 (14)
Both	29 (10.2)
Duration of hospital stay (in days)	
0-3	47 (16.5)
4-7	92 (32.4)
8-11	66 (23.2)
12-14	39 (13.7)
15 or more	40 (14)

The classification of surgical wounds, based on the degree of contamination, showed a relatively even distribution among the clean-contaminated (31.3%), contaminated (30.6%), and clean (27.5%) wound classes. The least represented category was dirty wounds, accounting for 10.6% of the cases. This distribution suggests that a significant portion of surgeries were associated with potential or actual microbial exposure. Assessment of comorbid conditions revealed that slightly more than half of the patients (51.4%) did not present with any known comorbidities. Among those with comorbidities, diabetes mellitus was the most prevalent (24.3%), followed by hypertension (14%). A combined presence of both diabetes and hypertension was noted in 10.2% of the patients, indicating a clinically relevant burden of chronic illnesses. Finally, the duration of hospital stay varied among participants, with the most common range being 4–7 days (32.4%), followed by 8–11 days (23.2%). Approximately 16.5% of patients were discharged within 0–3 days, while 13.7% stayed for 12–14 days. Notably, 14% of the cases required prolonged hospitalization of 15 days or more. This variation reflects the heterogeneity in patient recovery times and potentially the complexity of their clinical presentations.

Table 2: Risk Factors Associated with Surgical Site Infections (SSIs) among Patients in Southern Punjab, Pakistan (N = 284)

Variables	Patients with SSIs, N (%)	Patients without SSIs, N (%)	Odds Ratio (95% CI)	P value
Age (in years)			2.14 (0.86–5.37)	0.097
< Mean age (≤ 44 years)	10 (3.5%)	90 (31.7%)		
≥ Mean age (> 44 years)	16 (5.6%)	78 (27.5%)		
Surgical procedure			1.78 (0.82–3.85)	0.160
Emergency	15 (5.3%)	103 (36.3%)		
Elective	11 (3.9%)	79 (27.8%)		
Wound class			5.02 (1.55–16.24)	<0.001
Clean	3 (1.1%)	68 (23.9%)		
Clean-contaminated	5 (1.8%)	76 (26.8%)		
Contaminated	14 (4.9%)	25 (8.8%)		
Dirty	4 (1.4%)	13 (4.6%)		
Comorbidities			3.60 (1.48–8.73)	0.004
No comorbidities	10 (3.5%)	110 (38.7%)		
Diabetes mellitus	7 (2.5%)	21 (7.4%)		
Hypertension	3 (1.1%)	16 (5.6%)		
Both	6 (2.1%)	35 (12.3%)		
Duration of hospital stay			5.24 (1.95–14.09)	<0.001
< 7 days	5 (1.8%)	115 (40.5%)		
≥ 7 days	21 (7.4%)	67 (23.6%)		

Thee table 2 presents the relationship between selected risk factors and surgical site infections (SSIs) among 284 patients. SSIs were more common in patients over 44 years, those undergoing emergency procedures, and those with comorbidities, though age and surgical urgency were not statistically significant. Wound classification showed a strong association, with contaminated and dirty wounds significantly increasing SSI risk ($p < 0.001$). Patients with diabetes, hypertension, or both had higher infection rates ($p = 0.004$). Longer hospital stays (≥7 days) were also significantly linked to SSIs ($p < 0.001$), indicating it as a key contributing factor.

Table 3: Microbiological Profile of Surgical Site Infections (SSIs) (n = 22)

Organism	Patients with SSIs, N (%)
Staphylococcus aureus	8 (36.4%)
Escherichia coli	7 (31.8%)
Streptococcus pyogenes	5 (22.7%)
***Klebsiella* species**	5 (22.7%)
***Pseudomonas* species**	4 (18.2%)

The table 3 presents the microbiological profile of 22 culture-positive surgical site infections (SSIs) among 26 patients. Staphylococcus aureus was the most commonly isolated organism, found in 36.4% of cases, followed by Escherichia coli (31.8%). Streptococcus pyogenes and Klebsiella species were each isolated in 22.7% of cases, while Pseudomonas species were identified in 18.2%. The presence of multiple organisms in some patients indicates polymicrobial infections.

DISCUSSION

The present study evaluated the burden and contributing factors of surgical site infections (SSIs) among patients undergoing surgical procedures in tertiary care hospitals in Southern Punjab, Pakistan. An overall SSI incidence of 9.15% was observed, which, although lower than previously reported rates from some regions of South Asia, remains significantly higher than that reported in developed healthcare systems such as the United Kingdom (3.1%) and the Netherlands (4.3%) [11]. Comparative regional data from India reflect considerable variability in SSI rates, ranging between 6.1% and 38.7% depending on institutional practices and case-mix complexity [10]. Our data revealed a higher incidence of SSIs in emergency surgeries (13%) as compared to elective procedures (9%), although this difference was not statistically significant ($p = 0.366$). This aligns with existing literature indicating that emergency procedures tend to present with a greater proportion of contaminated or dirty wounds, and are often performed without optimal preoperative preparation or timely administration of prophylactic antibiotics [14,15]. In this study, only 7% of emergency surgeries were categorized as clean, compared to 71% in elective cases, supporting the notion that wound classification significantly impacts infection risk. While some studies, such as those from Vietnam and Malaysia, report higher SSI rates in elective cases due to prolonged pre-operative stays and surgical durations [12,13], the local context here points to infrastructural limitations and delayed interventions in emergencies as major risk amplifiers. A strong correlation was observed between age and the risk of SSIs, consistent with Dominioni et al.'s hierarchy of patient-related risk factors [16]. Elderly patients often present with diminished immune competence and a higher prevalence of comorbidities such as diabetes and hypertension, both of which were found to be significant contributors to SSI development in our cohort ($p = 0.008$). Notably, 31.58% of patients with both diabetes and hypertension developed SSIs, reinforcing findings from Khan et al., who demonstrated the predictive utility of comorbidity indices such as the Charlson Comorbidity Index and ASA scores in estimating SSI risk [18]. Wound classification was also significantly associated with SSI incidence ($p < 0.001$). The infection rate ranged from 3.85% in clean wounds to 66.67% in dirty wounds, echoing prior evidence from abdominal surgery studies in India, where a similar gradient was observed [10]. The subjective nature of wound classification remains a limitation in clinical prediction, but the direct relationship between wound contamination and microbial inoculation is well established [17]. Interestingly, while antibiotic prophylaxis was universally administered among infected cases, our study did not demonstrate a statistically significant protective effect. This finding resonates with growing concerns about the misuse and mistimed administration of antibiotics. Optimal prophylaxis—typically within 60 to 120 minutes prior to incision—has been shown to significantly reduce SSI risk [19]. However, indiscriminate or poorly timed administration may contribute not only to reduced efficacy but also to increased resistance patterns, as noted by Fehr et al., who reported that 60% of SSI isolates in their African cohort were resistant strains [20].

The microbiological profile of SSIs in our study revealed Staphylococcus aureus as the predominant pathogen (36.37%), followed by Escherichia coli (31.82%), Streptococcus pyogenes, Klebsiella spp., and Pseudomonas spp. This spectrum is broadly consistent with reports from similar tertiary settings, where Gram-positive cocci and enteric Gram-negative bacilli are commonly implicated [21]. These organisms, particularly in prolonged hospital stays, may reflect nosocomial colonization and biofilm-associated persistence on surgical wounds. Moreover, the average length of hospital stay for infected patients was significantly longer (10.25 days) compared to the overall study population (6.98 days), suggesting that extended hospitalization itself is a risk factor for infection. Prolonged inpatient exposure increases the likelihood of contact with resistant hospital flora, as corroborated by local studies from Pakistan indicating a strong relationship between hospital stay duration and the incidence of resistant SSIs [22,23].

LIMITATIONS OF THE STUDY

This study, despite its meaningful findings, has some limitations. The retrospective design restricted data availability to pre-recorded clinical information, thus excluding potential risk factors such as BMI, duration of surgery, intraoperative blood transfusion, and postoperative drain use. Furthermore, the modest sample size limited the statistical power of certain subgroup analyses. Potential confounding factors may have biased the observed associations, given the non-randomized comparison of study groups.

CONCLUSION

Surgical site infections remain a significant postoperative complication in tertiary care settings of Southern Punjab, Pakistan. Our findings highlight the role of advanced age, wound classification, comorbid conditions, and hospital stay duration in increasing SSI risk. Although antibiotic prophylaxis remains a cornerstone of prevention, its judicious and timely use is essential to avoid resistance and ensure effectiveness. Standardizing surgical protocols, optimizing perioperative care, and enhancing surveillance practices are critical for reducing infection rates, improving surgical outcomes, and preserving healthcare resources in resource-constrained settings.

CONFLICT OF INTEREST

Authors declared no conflict of interest.

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