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Original Article

Comparative Analysis of Surgical Site Infection Rates in Elective and Emergency Abdominal Surgery at a Tertiary Care Hospital

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Abstract

Background: Surgical site infections (SSIs) constitute a significant source of postoperative morbidity and mortality globally. Furthermore, SSIs are associated with elevated healthcare expenditures and extended hospitalizations. This investigation aimed to quantify the incidence of SSIs following elective and emergency abdominal surgical procedures and to evaluate their correlation with various identified risk factors. ***Methods:*** A retrospective cohort study design was employed, utilizing the medical records of 200 patients who underwent general surgery at a tertiary public hospital in South India. The study population comprised two groups: emergency and elective abdominal surgical cases (n=100 per group). Data extraction from the hospital's electronic medical records was performed, and subsequent statistical analysis was conducted using STATA version 14.0. ***Results:*** The study cohort of 200 patients consisted of 57% males, with a mean age of 49.3 years (range: 18-88). Contaminated wounds were present in 122 patients (61%), and 68 patients (34%) exhibited at least one pre-existing comorbidity. The mean duration of postoperative hospitalization was 6.98 days. The overall SSI rate was 11%, with a higher incidence observed in emergency abdominal surgery (13%) compared to elective abdominal surgery (9%). Staphylococcus aureus was identified in 36% of patients diagnosed with SSIs. ***Conclusions:*** The findings indicate a higher SSI incidence following emergency abdominal surgery compared to elective procedures. Advanced age, pre-existing comorbidities, wound contamination, and prolonged postoperative hospital stay were identified as factors associated with an increased risk of developing SSIs.

Keywords: ***Surgical site infection, Morbidity, Mortality, Hospital stay, Post-operative care.***

Introduction

Surgical site infection (SSI) is temporally defined as an infection manifesting within 30 postoperative days in the absence of implanted medical devices, or within one year following the implantation of such a device. The incidence of SSI is generally determined by the complex interplay of four key variables: the bacterial inoculum size, the virulence of the infecting microorganisms, the local tissue microenvironment at the surgical site, and the host's immunocompetence. Surgical procedures characterized by prolonged operative duration and those involving anatomical locations with endogenous microbial flora demonstrate a positive correlation with increased SSI incidence. Furthermore, surgical wounds are classified according to their degree of microbial contamination-namely, clean, clean-contaminated, contaminated, and dirty-a classification system with predictive value for the risk of SSI acquisition [1]. Host-related variables, including extremes of age, malnutrition, diabetes mellitus, tobacco smoking, malignancy, and other immunosuppressing comorbidities, can also increase an individual's susceptibility to SSI development.

Notwithstanding advancements in aseptic practices, antimicrobial prophylaxis, sterile surgical techniques, and postoperative hospital care, surgical site infection (SSI) persists as a significant postoperative complication [2]. Even in healthcare institutions with contemporary infrastructure and standardized protocols for preoperative patient preparation and antibiotic administration, SSIs contribute to elevated healthcare expenditures, increased patient morbidity, and higher mortality rates associated with surgical interventions [3]. Furthermore, SSIs negatively impact patients' health-related quality of life and functional status. The occurrence of SSI is associated with prolonged hospital length of stay, increased diagnostic laboratory costs encompassing microbial identification and antimicrobial susceptibility testing, and escalated antibiotic utilization for therapeutic management. Patients experiencing an SSI demonstrate a fivefold increased risk of hospital readmission for infection-related management, a 60% higher odds ratio for intensive care unit (ICU) admission, and a twofold increase in mortality compared to surgically treated patients without SSI. Importantly, a substantial proportion (40-60%) of these infections is deemed preventable through the implementation of appropriate preventative measures [4].

A reduction in surgical site infection (SSI) rates is associated with improved patient well-being and a decrease in healthcare expenditure within public health institutions. Consequently, SSI incidence functions as a key metric for evaluating the quality of hospital care [5]. Epidemiological data from a World Health Organization (WHO) study demonstrated an inverse correlation between national economic status and SSI prevalence, with high-income nations exhibiting lower rates (ranging from 0.9% in the United States to 2.8% in Australia), while low- and middle-income countries, such as India, consistently reported a higher SSI incidence (within the range of 6.3-9.3%) [6]. The elevated SSI rates observed in these resource-constrained settings are frequently attributed to limited resources, leading to inconsistent guidelines and suboptimal implementation of antibiotic stewardship and infection control protocols. Furthermore, these healthcare facilities often experience challenges such as overcrowding, a deficit of qualified medical personnel and essential supplies, and inadequate surveillance systems, collectively contributing to an increased risk of nosocomial infections [7]. In developing nations like India, SSI represents the most frequently reported category of hospital-acquired infection [8].

A prevailing perception suggests a higher incidence of surgical site infections (SSIs) in emergency compared to elective surgical procedures; however, the existing literature offers limited definitive evidence to either support or refute this hypothesis [9]. This investigation aims to determine and compare the prevalence of SSIs in elective and emergency general surgical interventions within a tertiary healthcare facility in South India. The selection of South India as the study setting is predicated on its representation of a distinct healthcare ecosystem characterized by a heterogeneous patient demographic and a substantial volume of surgical cases. By elucidating the specific challenges and epidemiological features of SSIs within this geographical context, the findings of this study are anticipated to inform the development and implementation of targeted preventative strategies by healthcare professionals, thereby contributing to a reduction in SSI rates and an improvement in patient outcomes.

Methods

This was a hospital record-based, retrospective study. Hence no new data were collected from the patients and a waiver of consent was obtained from the institution. The data from the case records of patients who underwent abdominal surgery in the tertiary care centre between 2022 and 2024 were collected. Only those patients, above 18 years of age, who had undergone abdominal surgery under general or regional anaesthesia and had completed the 30 days of follow-up before August 2022 were included in the study. Patients who have had a previous abdominal surgery, immuno-compromised patients, patients on chemotherapy, and patients who came to the emergency in a state of septic shock were excluded from the study.

Assuming the difference between the incidence of SSIs in elective and emergency abdominal surgery to be 15% (lower in elective surgeries,[10] and to achieve this with 80% power and an alpha error of 0.05, the data of a total of 200 patients were required with 100 in each category (emergency and elective). The case sheets of the patients were collected from the hospital's medical records department to compile data regarding patient parameters like age, gender, dates of admission, surgery and discharge as well as presence of comorbidities. Details of the surgery like wound class, diagnosis, surgical procedure done, duration of hospital stay and antibiotic prophylaxis were also collected.

Generally, in a hospital, patients are monitored by their primary physician for signs of SSIs for up to 30 days following the surgery. This study was based on the data recorded by physicians that attended the patients during their follow up visits. A patient was considered positive for an SSI if any one of the signs of inflammation like redness, warmth, swelling, pain or tenderness had appeared at the surgical site or there was purulent discharge or a positive bacterial culture in a swab or fluid collected from the surgical site.

Analysis of the data was done using STATA version 14.0. The various categorical variables are summarized as proportions or percentages. Continuous variables are represented as means with standard deviation or medians with interquartile range depending on the normality of the data.

Results

The general characteristics of the study population are given in (Figure 1 & Table 1). The mean age of the study group was 49.3 years (range 18 to 88 years). The overall surgical site infection rate was 11%. Emergency surgeries reported a higher incidence of SSIs (13%) than elective ones (9%). The Chi-square test value is 0.8172 and the p value is 0.366 which is not significant as p is greater than 0.05. Out of the 22 cases that were positive for post-operative infections, abscess drainage and diabetic foot debridement accounted for about 36.4% of the infections.

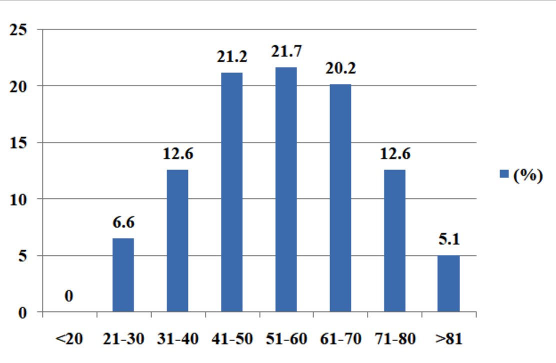

Figure 1 (a) Age wise distribution of the study group

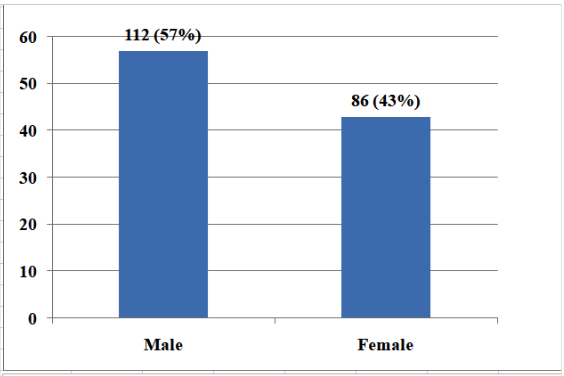

Figure 1 (b) Sex wise distribution of the study group

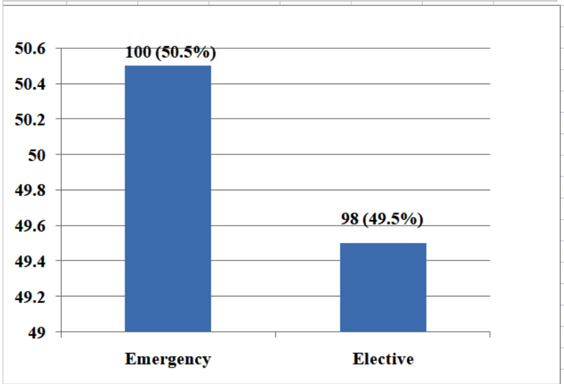

Figure 1 (c) Surgical procedure done of the study group

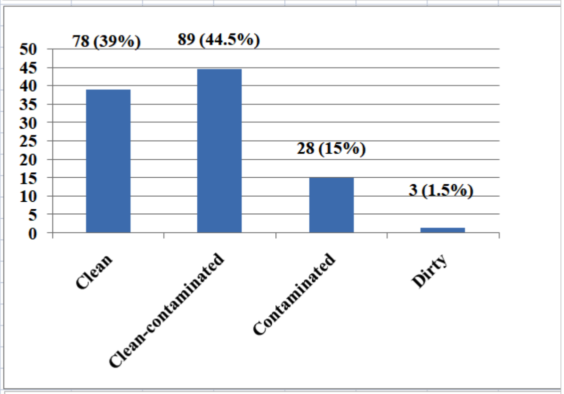

Figure 1 (d) Wound class of the study group

Table 1: Underlying co morbidities and duration of hospital stay of the study group.

Co morbidities	**No (%)**
No comorbidities	132 (66)
Diabetes mellitus	29 (14.5)
Hypertension	20 (10)
Both	19 (9.5)
Duration of hospital stay (in days)	
0-3	47 (23.5)
4-7	92 (46)
8-11	40 (20)
12-14	9 (4.5)
15 or more	12 (6)

The average age of the population which showed signs of an SSI was 57 years. Among those who developed an SSI, almost 59% were above the age of 50 years. Only 3 patients, from a group of 78 with clean surgical sites, developed an SSI (3.84%) while in the remaining 122 patients with contaminated or dirty wounds, 19 of them developed an SSI (15.57%). After analysis, the relative risk came out to be a staggering 4.05 meaning patients with any degree of wound contamination (belonging to wound classes clean-contaminated, contaminated, or dirty) are 4.05 times more prone to develop an SSI than those with clean wounds (**Table 2**).

Table 2: Risk factors associated with SSIs.

Variables	**Patients with SSIs, N (%)**	**Patients without SSIs, N (%)**	**Odds ratio(95%CI)**	**P value**
Surgical procedure				
Emergency	12(6.5)	87(43.5)	1.51(0.61-3.71)	0.366
Elective	8(4.5)	91(45.5)		
Wound class				
Clean	3(1.5)	76(37.5)		
Clean-contaminated	6(3)	83(41.5)	4.61(1.32-16.15)	<0.001
Contaminated	11(5.5)	19(9.5)		
Dirty	2(1)	1(0.5)		
Comorbidities				
No comorbidities	9(4.5)	123(61.5)		
Diabetes mellitus	5(2.5)	24(12)	3.23(1.30-8.00)	0.008
Hypertension	2(1)	18(9)		
Both	6(3)	13(6.5)		

Duration of hospital stay (days)				
<7	6(3)	118(62)	5.24(1.95-14.09)	<0.001
≥7	16(8)	60(30)		

In the 68 patients with comorbidities (hypertension or diabetes or both) nearly 13 people developed an SSI (19.11%) whereas only 9, from a group of 132 patients (6.81%) without any comorbidities, reported an infection at the surgical site. All the patients who developed SSIs were given peri-operative antibiotic prophylaxis. The average duration of hospital stay for the whole group was 6.98 days while for those who developed a wound infection, it was 10.25 days. Staphylococcus aureus accounted for nearly 36.37% of the infections closely followed by Escherichia coli at 31.82% (**Table 3**).

Table 3: Microbiological profile of SSIs (n=22).

Organisimsm	No (%)
S.aureus	8 (36.37)
E.coli	7 (31.82)
Streptococcuspyogenes	5 (22.73)
Klebsiellasp.	5 (22.73)
Pseudomonassp.	4 (18.18)

Discussion

The aggregate surgical site infection (SSI) incidence of 11% in this context significantly exceeds reported rates in developed nations such as the United Kingdom (3.1%) and the Netherlands (4.3%) [11]. Epidemiological studies within India have demonstrated a wide range of SSI prevalence, varying from 6.1% to 38.7% [10]. Contrary to the common assumption that emergency surgical interventions are inherently associated with a greater SSI risk due to potentially higher microbial bioburden at the surgical site, a study involving 697 patients in Vietnam reported a lower SSI incidence in emergency cases compared to elective procedures (8.7% versus 13.1%), despite a higher proportion of contaminated wounds in the emergency cohort. This observation was attributed to longer preoperative hospitalization duration in elective surgery patients [12]. Similarly, a study of 248 general surgery patients in Malaysia found a higher SSI incidence in elective surgeries (19.4%) compared to emergency surgeries (15.47%) [13]. The authors posited that the increased risk in elective cases was due to a longer mean operative duration compared to emergency procedures.

The observed incidence of surgical site infections (SSIs) was numerically higher in emergency abdominal surgical procedures (13%) compared to elective procedures (9%). However, this difference did not reach statistical significance ($p = 0.366$, $\alpha = 0.05$). The elevated SSI rates in emergency surgeries may be associated with a greater proportion of contaminated or dirty wounds, suboptimal preoperative preparation, and delayed initiation of antimicrobial prophylaxis. In this cohort, only 7% of emergency cases (n=100) presented with clean surgical sites, contrasting with 71% of elective cases. Consistent with these findings, a study by Sriranjani *et al*. in India (n=150) reported a higher SSI prevalence in emergency surgeries (27.11%) compared to elective surgeries (10.29%) [14]. Similarly, another investigation of postoperative infections in an Indian tertiary care center concluded that emergency surgical interventions were associated with a greater risk of SSI acquisition than elective procedures (17.7% versus 12.5%, respectively) [15].

This investigation revealed a positive correlation between advancing patient age and the incidence of surgical site infections (SSIs). The increased susceptibility to SSIs in older individuals is likely multifactorial, encompassing a higher prevalence of underlying chronic conditions such as diabetes mellitus and hypertension, as well as age-related immunosenescence leading to compromised host defense mechanisms. Consistent with these findings, previpus study identified advanced age as the paramount patient-associated risk factor in their hierarchical analysis [16]. Furthermore, a statistically significant association ($p < 0.001$) was observed between SSI prevalence and the degree of surgical site contamination, with infection rates escalating from 3.85% in clean wounds to 66.67% in dirty wounds. Corroborating these observations, an Indian study focusing on abdominal surgeries reported SSI rates of 3.9% in clean wounds compared to 56.7% in dirty wounds [10]. The elevated infection risk in more contaminated wounds is attributed to the direct introduction of pathogenic microorganisms into the surgical field prior to the intervention. However, the subjective nature of surgical wound classification introduces inter-observer variability, limiting its absolute predictive utility for SSI development [17].

Our investigation revealed a statistically significant positive correlation between the presence of comorbidities and the risk of surgical site infection (SSI) ($p = 0.008$). The observed SSI incidence rates were 17.24% in patients with diabetes mellitus, 10% in patients with hypertension, and 31.58% in patients with both diabetes mellitus and hypertension. The heightened susceptibility to SSI in diabetic individuals can be attributed to compromised immune function and hyperglycemia, which provides a conducive environment for bacterial proliferation. This likely explains the highest SSI incidence observed in diabetic foot debridement procedures within this study cohort. In hypertensive patients, peripheral vasoconstriction leading to reduced perfusion of the surgical site may impair tissue oxygenation and nutrient delivery, thereby increasing SSI susceptibility. Prior research demonstrated a strong association between wound infections and comorbid conditions. Furthermore, Khan *et al*.[18] elucidated the utility of the Charlson Comorbidity Index (CCI) and the American Society of Anesthesiologists (ASA) physical status classification system as predictive tools for SSI risk stratification based on the quantification of comorbidity burden.

While numerous investigations have demonstrated the efficacy of antibiotic prophylaxis in reducing surgical site infection (SSI) rates, our study did not establish a statistically significant association between prophylactic antibiotic administration and SSI prevention. Notably, all patients in our cohort who developed a surgical wound infection had received prophylactic antibiotics. The intended mechanism of antibiotic prophylaxis is the reduction of the microbial load at the surgical site, thereby preventing overwhelming of host immune responses. However, the injudicious use of these agents can elevate the risk of infection with antimicrobial-resistant organisms. Contemporary research indicates that the temporal administration of prophylactic antibiotics, ideally within 120 minutes prior to surgical incision, can substantially decrease SSI incidence [19]. Nevertheless, antibiotic prophylaxis should be restricted to clinically indicated scenarios. A study conducted by Fehr *et al*. in a rural African healthcare setting reported a 22% SSI rate among patients receiving preoperative antibiotic prophylaxis, with 60% of the isolated pathogens exhibiting antimicrobial resistance [20].

Our microbiological analysis of surgical site infections revealed Staphylococcus aureus as the predominant isolate (36.37%), closely followed by Escherichia coli (31.82%). These findings align with the microbial etiology reported in a prior investigation of SSI risk factors in emergency surgical procedures [21]. The mean length of hospital stay for the entire cohort was 6.98 days, whereas patients who developed a surgical wound infection exhibited a significantly prolonged mean stay of 10.25 days. This observation suggests a positive correlation between the duration of hospitalization and the risk of SSI. This increased risk is likely attributable to extended exposure to the nosocomial environment, potentially facilitating colonization and subsequent infection with antimicrobial-resistant microorganisms. Consistent with these findings, two independent studies conducted in Pakistan on postoperative infections also demonstrated a significant association between increased hospital stay and SSI incidence, positing that prolonged hospitalization promotes patient skin colonization with hospital-acquired bacterial flora, particularly those exhibiting antibiotic resistance [22,23].

This study is subject to several limitations. Firstly, the modest sample size may have limited the statistical power to detect significant associations for certain investigated variables. Secondly, the retrospective design, relying on pre-existing medical records, constrained data analysis to documented parameters. Consequently, potentially relevant variables such as body mass index (BMI), surgical duration, drain utilization, and blood transfusion could not be comprehensively evaluated as potential risk factors for surgical site infections (SSIs). Thirdly, the inherent limitations of a non-randomized design introduce the potential for confounding bias, as the study and control cohorts exhibited baseline differences in variables beyond the primary comparison points.

Conclusion

Surgical site infections (SSIs) remain a significant source of postoperative morbidity. The findings indicate a higher SSI incidence following emergency abdominal surgery compared to elective procedures. The findings of this study also demonstrate a strong association between patient age, surgical wound classification, pre-existing comorbidities, and the length of preoperative hospital stay with the incidence of SSI development. While prophylactic antibiotic administration can mitigate the risk of surgical wound infections, its efficacy is contingent upon judicious utilization. Complete eradication of postoperative infections may not be achievable; however, the implementation of appropriate preventative strategies can substantially reduce infection rates, thereby decreasing patient morbidity and mortality and optimizing healthcare resource allocation.

Declarations

Ethical Approval

Not applicable

Consent for publication

Not applicable

Data availability

Upon request to the corresponding author.

Funding

Nil

Conflict of interest

None declared

Authors contributions

All authors made substantial contributions to the reported work, including in the areas of conception, study design, execution, data collection, analysis, and interpretation. They participated in drafting, revising, and critically reviewing the article, gave final approval for the version to be published, agreed on the journal for submission, and accepted responsibility for all aspects of the work.

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