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Research Article

Multivariate analysis of Incidence and Risk Factors of Surgical Site Infections in General Surgery: A Retrospective Study from a Tertiary Care Center

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Abstract

Background: Surgical site infections (SSIs) pose a major challenge in surgical care, leading to higher morbidity rates, extended hospitalizations, and increased healthcare expenses. SSI remains a major concern in postoperative care and is the third most frequently reported nosocomial infection**.**

Materials and Methods: A retrospective analysis was carried out over six months in the general surgery department. Data were collected from hospital records, and SSI rates were examined based on infection type, surgical procedure, and whether the surgery was elective or performed in an emergency setting. Results: The study found that the prevalence of SSI in the general surgery department was 12.5%. Among the different types, superficial incisional SSI was the most common, followed by deep incisional and organ/space SSI. The highest rate of SSI was observed in patients undergoing exploratory laparotomy. Emergency surgeries had a significantly higher SSI rate (17.7%) compared to elective procedures (12.5%).

Conclusions: SSIs pose a substantial burden on both patients and healthcare systems. Effective prevention requires a comprehensive strategy addressing preoperative, intraoperative, and postoperative factors. Establishing a culture of patient safety through strong institutional policies, regulatory support, and adherence to infection control measures is essential for reducing SSI rates in healthcare settings.

Keywords: SSI, General surgery, Nosocomial infection and wound infection

Introduction:

Surgical site infections (SSIs) are a critical concern in surgical care, significantly impacting patient outcomes by increasing morbidity, mortality, and healthcare burdens[1]. They represent the most prevalent nosocomial infections among surgical patients and are a leading cause of postoperative complications. SSIs contribute to prolonged hospital stays, delayed recovery, and increased healthcare costs, making their prevention a priority in clinical practice. The incidence of SSIs is notably higher in developing countries compared to developed regions, primarily due to disparities in healthcare infrastructure, infection control measures, and resource availability. Surgical procedures classified as sterile or minimally contaminated reported an alarming 15% SSI incidence in low- and middle-income countries (LMICs)[2]. Patients with SSIs often experience delayed wound healing, prolonged hospitalization, increased pain and discomfort, and, in severe cases, permanent disability or fatal outcomes. Addressing SSIs requires a comprehensive approach, incorporating strict aseptic protocols, appropriate antimicrobial use, and adherence to standardized surgical guidelines

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to improve patient safety and surgical outcomes [3].

Despite advancements in surgical techniques and infection control measures, the incidence of surgical site infections (SSIs) remains a significant public health concern, posing a considerable burden on healthcare systems. SSIs are among the most serious postoperative complications, leading to increased morbidity and mortality. According to the National Nosocomial Infections Surveillance (NNIS) system, SSIs rank as the third most commonly reported hospital-acquired infections, accounting for approximately 12%–16% of all nosocomial infections in hospitalized patients [4]. These infections not only compromise patient recovery but also contribute to extended hospital stays, additional medical interventions, and increased healthcare costs.

Advancements in infection control measures, such as enhanced operating room ventilation, improved sterilization techniques, strict barrier precautions, refined surgical techniques, and the use of antimicrobial prophylaxis, have significantly contributed to reducing the risk of surgical site infections (SSIs) [5]. However, SSIs continue to be a major cause of morbidity and mortality in hospitalized patients. This persistent challenge can be attributed, in part, to the rise of antimicrobial-resistant pathogens, as well as the growing number of surgical patients who are elderly or have chronic, debilitating, or immunocompromised conditions [6]. Additionally, the increasing frequency of prosthetic implant procedures and organ transplant surgeries further complicates infection prevention, necessitating more comprehensive strategies to mitigate SSI risks.

SSIs significantly extend hospital stays, contribute to increased antibiotic usage, and escalate laboratory costs. Patients who develop SSIs are 60% more likely to require intensive care unit (ICU) admission, five times more likely to be readmitted, and have double the mortality rate compared to those without infections. Notably, an estimated 40-60% of these infections are considered preventable through effective infection control measures. This study aims to assess the prevalence of SSIs in the Department of Surgery, providing insights into their incidence and potential strategies for prevention[7,8].

Materials and Methods

A retrospective study was undertaken on patients admitted to general surgery units at the Department of General Surgery, at Major S.D. Singh Medical College & Hospital,a tertiary-level hospital located in Kalol, Ahmedabad. The study period was one year. A total of 175 elective surgical patients and 52 emergency surgical patients were included in the study. The elective surgical procedures included cholecystectomy, hernioplasty, gastrectomy, mastectomy, resection anastomosis of bowel, hemorrhoidectomy, fistulectomy, parotidectomy, thyroidectomy. The commonly performed surgeries under emergency conditions were exploratory laparotomy and resection anastomosis of bowel. During the time period of the study, a retrospective chart review was conducted from the hospital database. In this retrospective chart review, existing data that had been recorded for reasons other than research was studied. It was referred as “chart reviews” because the data source was the medical record of the patient. Details that were recorded included the type of surgery by wound class, type and duration of operation, antimicrobial prophylaxis if given, drain used, preoperative and total hospital stay. Each patient’s data was assessed from the time of admission till discharge from the hospital and also on follow up visits which extended up to 30 days.

Surgeon or attending physician based on clinical signs and symptoms. SSIs were classified into three categories: superficial incisional SSI, which involves only the skin and subcutaneous tissue; deep incisional SSI, affecting deeper soft tissues such as fascia and muscle; and organ/space SSI, which extends into organs or body cavities manipulated during surgery. The diagnosis was established if the infection occurred within 30 days postoperatively for superficial and deep incisional SSIs (unless an implant was present, extending the period to one year for deep SSIs) or if there was evidence of organ/space infection within the same timeframe. Stitch abscesses were excluded from the study.

Criteria were used to diagnose different types of surgical site infections (SSIs) in the study [9, 10]:

Superficial Incisional SSI: Infection limited to the skin and subcutaneous tissue. Diagnosis required: Purulent drainage from the superficial incision, Organisms isolated from a culture obtained from the incision, Presence of pain, tenderness, localized swelling, redness, or heat, with deliberate reopening of the incision by the surgeon (unless culture-negative).

Deep Incisional SSI: Infection involving deeper soft tissues such as fascia and muscle. Diagnosis was confirmed by: Purulent drainage from the deep incision, Organisms identified in a culture from deep tissue, Symptoms including pain, swelling, and redness, leading to the surgeon reopening the incision, Detection of an abscess or other evidence of infection during reoperation, histopathological examination, or radiological imaging.

Organ/Space SSI: Infection affecting internal organs or anatomical spaces manipulated during surgery. Diagnostic criteria included: Purulent drainage from a drain placed in the organ/space, Microorganisms identified in a culture obtained from fluid or tissue in the affected area, Detection of an abscess or infection through direct examination, reoperation, histopathological, or radiological findings.

The institute followed a standard protocol to prevent infections during all elective surgical procedures. Preoperative patient preparation included hair removal (if it interfered with the incision site) immediately before the operation, ensuring adequate control of serum blood glucose levels in diabetic patients, an antiseptic bath, and skin preparation with antiseptic agents. The surgical team adhered to universal precautions throughout the procedure. Prophylactic antibiotics were prescribed to all patients, typically administered intravenously. Intraoperatively, standard sterilization and disinfection guidelines were strictly followed. Postoperatively, patients were discharged as early as possible to minimize the risk of surgical site infections (SSIs).

Results

The present study, which included 175 elective surgeries and 52 emergency surgeries conducted from June 2024 to November 2024 revealed a surgical site infection (SSI) rate of 12.5% cases in elective surgeries and 17.7% in emergency surgeries at the Department of General Surgery. Among the three types of surgical site infections (SSIs), superficial incision SSI was the most prevalent, accounting for 5.6 % cases, followed by deep incisional SSI with 4.4% cases, and organ/space SSI with 2.9 % cases (Figure 1). Exploratory laparotomy (34%) was the procedure most commonly associated with SSI followed by colon surgery (21%) and appendectomy (16%). Hernia repair (3%) and Hepato-pancreatico-biliary surgery (4%) were least commonly associated with SSI. The site of the infection was most commonly the incision site (8.2%)

and the microbiological organism most commonly detected were beta hemolytic streptococci and staphylococcus aureus. The surgical procedures most commonly performed, along with the respective SSI rates associated with them, are detailed in Table 1 and Fig.1

Table 1: Common Surgical Procedures and Their Associated SSI Rates	
Surgical procedure	Rate of SSI
Small bowel	27(12%)
Colon	48(21%)
Gastric	11 (5%)
Hepato-pancreatico-biliary	10(4%)
Exploratory laparotomy	77 (34%)
Appendectomy	36 (16%)

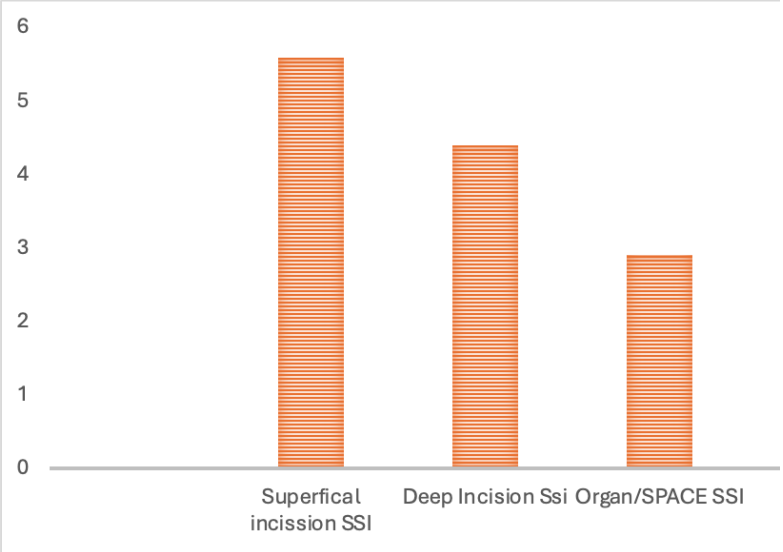

Figure 1: Type of SSI.

In the present study, which included 175 elective surgeries and 52 emergency surgeries, a significant difference in the incidence of surgical site infections (SSIs) was noted between elective and emergency procedures. Table 2 presents baseline data of the patients who underwent these surgeries. The elective surgery group consisted of patients ranging from 11 to 72 years, with a mean age of 56 (±8 years). In contrast, the emergency surgery group had patients aged 16 to 75 years, with a mean age of 44 years. The body mass index (BMI) averaged 22 for elective surgery patients and 24 for emergency surgery patients. Known diabetic patients numberedn38% in the elective surgery group and 23% in the emergency surgery group. Regarding American Society of Anesthesiologists (ASA) classification, 71% of elective surgery patients had ASA status I, 18% had ASA II, and 11% had ASA III. In contrast, 67% of emergency surgery patients were in ASA III status, 22% were in ASA II, 7% were in ASA I, and 4% were in ASA IV. Prophylactic antibiotics were administered to 91% of those undergoing elective surgery, compared to 79% in the emergency surgery group. The data comparing these parameters for elective and emergency surgeries is shown in Table 2.

Table 2: Patient Demographics and Clinical Characteristics for Elective and Emergency Surgeries		
Patient Parameters	Elective Surgeries	Emergency Surgeries
Age	56(±8 years)	44 years (±7 years)
Male: Female	0.7	1.5
Body Mass Index	22	24
Diabetics	38%	23%
ASA status	I	III
Prophylactic antibiotics given	91 %	79%
Rate of SSI	12.5 %	17.7%

Various risk factors associated with surgical site infections (SSI) were assessed in this study. Figure 2 presents a comparison of these risk factors, revealing statistically significant differences in the number of SSI cases when antibiotic prophylaxis was administered compared to when it was not used. Additionally, the use of drains was linked to a higher number of SSI cases compared to instances where no drains were used, with this difference also being statistically significant. The impact of surgical site infections (SSI) on healthcare systems was also studied. Overall hospital mortality was 1.8%, with this being reported for patients with organ/space SSI (2 cases). During the postoperative period, re-exploratory surgery was required for 2.7% of organ/space SSI patients and 1.8% of deep incisional SSI patients. The mean duration of postoperative antibiotic therapy was 3-5 days for patients with superficial SSI, 5-7 days for those with deep incisional SSI, and 7-10 days for patients with organ/space SSI. The mean duration of stay in the intensive care unit (ICU) was 2 days (ranging from 0 to 12 days) for patients with deep incisional and organ/space SSI. Patients with superficial SSI were directly transferred from recovery to their respective wards. The mean in-hospital stay for superficial SSI patients was 2 days (ranging from 0 to 8 days), for deep incisional SSI patients was 5 days (ranging from 2 to 11 days), and for organ/space SSI patients was 7 days (ranging from 4 to 18 days).

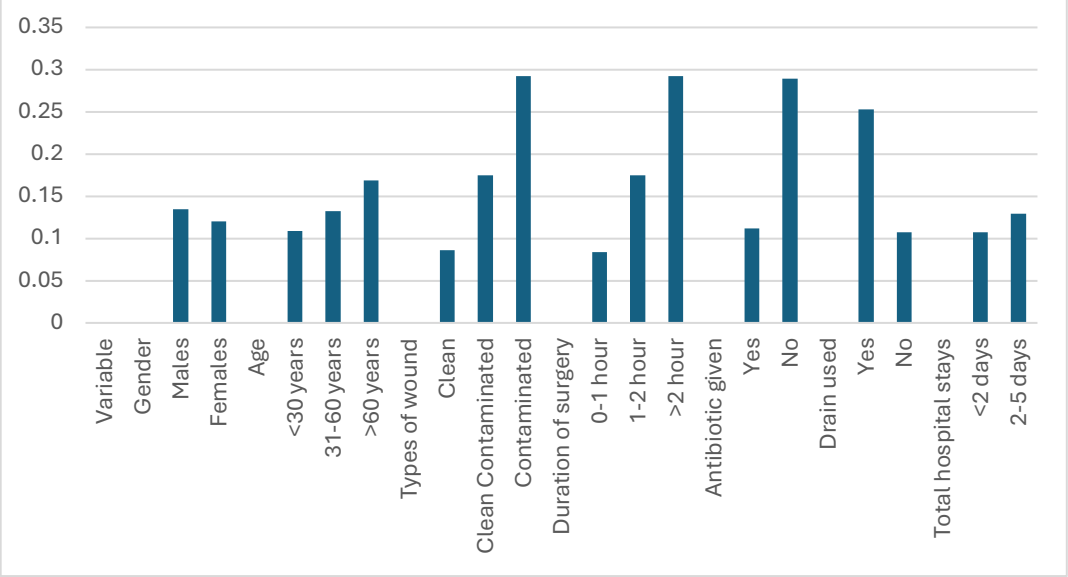

Figure 2: Comparison of various risk factors for SSI.

Discussion

Surgical site infection (SSI) is the most frequently reported complication in surgical patients and is the third most commonly reported nosocomial infection, accounting for approximately a quarter of all nosocomial infections. The present study revealed an SSI rate of 12.5% for elective surgeries and 17.7% for emergency surgeries. Among the three types of SSI, superficial incision SSI was the most prevalent, followed by deep incisional SSI , and finally organ/space SSI. Exploratory laparotomy (34%) was the procedure most commonly associated with SSI, and the infection site was most frequently the incision site (8.2%).

The rate of surgical site infections (SSI) in elective surgeries in the present study is comparable to other studies conducted in developing countries (11, 12). However, the observed incidence rate of 12.5% is higher than the rates reported in developed countries, such as the United Kingdom (3.1%) and the Netherlands (4.3%) [12]. In the Asian context, SSI rates have been reported as high as 34%. In this study, higher SSI incidences were observed in colon surgery (21%) and appendectomy (16%), which are more than two-fold higher than those reported in European studies and by U.S. NNIS reports [13]. This difference in incidence rates could be attributed to the higher standards of care in developed countries. However, it is important to consider the variability in data collection and surveillance methods when comparing these rates. While the infection rates in the present study are higher than those reported in some previous studies, infection rates ranging from 20% to as high as 76.9% have also been documented. The incidence rate of infections was highest for exploratory laparotomy in the present study [14].

The present study reported a higher rate of SSI incidence in emergency surgeries (17.7%) as compared to elective surgeries (12.5%). This is in accordance to previously report studied wherein emergency surgeries have shown higher rate of SSI. In emergency surgeries, the type of wound was more commonly contaminated or clean contaminated; antibiotic prophylaxis was less commonly given and duration of surgery was longer as compared to elective surgeries [15]. The present study showed a higher incidence of surgical site infections (SSI) with increasing age, although no significant difference was noted between the two sexes. Older age is associated with various predisposing factors, such as diabetes and anemia, which could contribute to the trend of increasing SSI incidence with age. Additionally, an increase in SSI incidence was observed when the duration of surgery exceeded 2 hours (19.4%). Prolonged surgery results in increased exposure of the operation site to air, extended trauma, stress from prolonged anesthesia, and sometimes blood loss, all of which may contribute to a higher risk of infection [16].

The most common pathogens associated with surgical site infections (SSI) in the present study were *A beta-hemolytic streptococci* and *Staphylococcus aureus* (SA). *Staphylococcus aureus* has long been recognized as one of the most important pathogens in SSIs worldwide. Colonization of the anterior nares and skin with SA is frequent in humans, with approximately 20% of individuals being persistently colonized in the nares, while another 30-50% are intermittently colonized. Increased carriage rates are seen in patients with underlying co-morbidities, such as diabetes, chronic kidney disease, HIV infection, and chronic dermatitis. The relative risk of SSI is 2-9 times greater in SA carriers than in non-carriers. Moreover, molecular epidemiology has shown that, in 85% of patients, the strain of SA causing a post-operative infection is identical to the strain isolated from the nasal cavity preoperatively [20].

Surgical site infections (SSI) serve as an indicator of the quality of a healthcare system in any hospital. In this study, the impact of three types of SSI on the healthcare system was examined. It was observed that patients with organ/space SSI had the longest ICU and in-hospital stays. These patients also required the longest duration of postoperative antibiotics (7-10 days) and were more frequently subjected to re-exploratory surgery (2.7%). Furthermore, two patients (1.8%) succumbed to their infections due to organ/space SSI. The cost of care for patients with SSIs is nearly three times higher than for patients without SSIs during the first eight weeks after hospital discharge. These infections not only reduce the patients' quality of life but also contribute to 3.7 million excess hospital days and more than $1.6 billion in additional costs annually in the United States. Furthermore, patients who develop SSIs are five times more likely to be readmitted to the hospital, 60% more likely to spend time in the intensive care unit, and twice as likely to die compared to surgical patients without infections [21].

Conclusion

The present study provides valuable insights into the risk factors for surgical site infection (SSI) occurrence in a large population within the general surgery setting in India. It was observed that factors such as increasing patient age, contaminated wounds, prolonged surgery duration, absence of prophylactic antibiotics, use of drains, and prolonged hospital stay are all associated with an increased incidence of SSI. Based on these findings, the following steps are recommended as priorities for the near future: defining an antibiotic prophylaxis policy, reducing the length of hospital stay, and minimizing the duration of procedures through proper staff training in surgical techniques. Additionally, the judicious use of drains should be emphasized, and extra care should be taken in emergency surgeries to lower overall SSI incidence rates.

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