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Unveiling the burden of surgical site infections (SSI) and its determinants in tertiary care centre

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ABSTRACT

Background: Surgical site infections (SSIs) are prevalent hospital-acquired infections that pose a significant risk to patients, often leading to complications and even death. The incidence of SSIs can vary among different hospitals due to various factors that influence their development.
Objectives: The objective of this study was to examine the occurrence and determine the factors associated with Surgical Site Infections (SSI).
Materials and Methods: From August 2021 to July 2022, our tertiary care center conducted a retrospective observational study. The surgical sites were carefully assessed and categorized, and infected wounds underwent culture and sensitivity testing. The collected data was then analyzed using SPSS 13 software
Results: Among the 360 patients studied, 78 (22%) developed surgical site infections (SSI). Risk factors for SSI included age, gender, BMI, diabetes, blood transfusion, and longer preoperative waiting time. Staphylococcus aureus was the predominant pathogen, and resistance to tetracycline was common.
Conclusion: Surgical site infections (SSI) are prevalent, indicating a high incidence. Among the contributing factors, gender, extremes of BMI, diabetes mellitus, and blood transfusion emerge as influential risk factors associated with the occurrence of SSI.

1. Introduction

Surgical site infections (SSIs) pose a significant challenge in healthcare settings, particularly within tertiary hospitals. These infections occur following surgical procedures and can lead to complications, prolonged hospital stays, increased healthcare costs, and even mortality. Understanding the impact of SSIs on patient outcomes is crucial for improving surgical practices and reducing the associated burden. Various factors contribute to the development of these infections, including patient-related factors (such as age, underlying medical conditions, and immune status), surgical factors (such as duration of surgery, surgical technique, and wound classification), and hospital-related factors (such as infection control practices and antibiotic prophylaxis protocols). SSIs have a profound effect on patient outcomes in tertiary hospitals.[1,2] They can result in prolonged hospital stays, increased readmission rates, additional surgical interventions, and higher healthcare costs. Moreover, SSIs contribute to patient discomfort, pain, and psychological distress. In severe cases, they can lead to life-threatening complications and even mortality, especially among immunocompromised individuals and older adults. Efforts to mitigate the impact of SSIs in tertiary hospitals involve a multidisciplinary approach. Infection prevention and control measures,

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including strict adherence to aseptic techniques, proper sterilization of instruments, and effective hand hygiene protocols, play a crucial role. Preoperative assessment and optimization of patients, appropriate antibiotic prophylaxis, and enhanced postoperative wound care are essential strategies to prevent SSIs.[3,4] Additionally, continuous monitoring, surveillance, and feedback systems help identify areas for improvement and promote best practices.

Surgical site infections significantly impact patient outcomes in tertiary hospitals. Their occurrence prolongs hospital stays, increases healthcare costs, and poses a threat to patient well-being. By implementing comprehensive preventive measures and adopting evidence-based interventions, healthcare professionals can reduce the incidence of SSIs, improve patient outcomes, and enhance the overall quality of care in tertiary hospitals. Continued research and advancements in infection control practices are vital for further reducing the burden of SSIs and ensuring safer surgical experiences for patients. The study's aim and objectives encompass investigating the frequency of Surgical Site Infections (SSIs) and identifying the factors that contribute to their development.[5,6]

2. Materials and Methods

From August 2021 to July 2022, our tertiary care center conducted a retrospective observational study. This study focused on patients who underwent diverse surgical procedures. The inclusion criteria consisted of patients who underwent elective surgeries and remained hospitalized for at least seven days post-operatively. Conversely, patients with grossly contaminated or infected wounds/procedures were excluded from the study. In order to assess the surgical sites, examinations were conducted on the third day following the procedure and subsequently every three days. Cultures were obtained from all infected wounds or as clinically indicated, providing valuable insights into the presence of infections and facilitating appropriate treatment decisions. Wound monitoring was performed with great care. Wounds categorized as Grade 3 or 4 were classified as infected. Additionally, wounds exhibiting physical signs of infection, such as fever and inflammation, were also considered infected if a positive culture was obtained. To evaluate the sensitivity patterns of organisms, an antibiogram was prepared based on the culture sensitivity reports. Various demographic characteristics, including age and sex, were recorded. In order to compare the infected and non-infected groups, variables such as BMI, co-morbid conditions, prophylactic antibiotic use, blood transfusion, and preoperative waiting period were examined. The study employed suitable descriptive statistical analysis utilizing SPSS software. The study protocol obtained approval from the ethical committee.

Table 1: Factors related with SSI

	SSI	No SSI	P value
Age group (yrs)			
20 – 30	22	110	<0.000
31- 40	24	50	<0.000
41-50	8	8	<0.000
>51	24	14	<0.000
Gender			
Male	64	156	0.001
Female	14	126	0.001
Comorbid conditions			
Anaemia	Yes 46 No 32	Yes 28 No 254	0.98
Hypertension	Yes 34 No 44	Yes 12 No 270	0.54
Diabetes mellitus	Yes 40 No 38	Yes 8 No 274	<0.001
Preoperative waiting period (Days)			
<2	22	222	
2-7	32	28	0.21
>7	24	32	0.43
Prophylactic antibiotic			
Yes	2	42	0.41
No	76	240	

Table 2: Organism associated with SSI

Organism	Number	Percentage (%)
Staph. Aureus	40	56
Pseudomonas	26	36
Klb. Pneumonia	20	27
Citrobacter	12	17
E.Coli	12	17
Proteus	10	13

Table 3: Antibiotics sensitivity

Antibiotics	No. of Resistance	Percentage (%)
Tetracycline	68	95
Erythromycin	52	72
Ampicillin	44	61
Gentamycin	38	53
Amikacin	40	56
Cotrimoxazole	38	53
Cephalexin	36	50
Ciprofl oxacin	32	45
Norfl oxacin	34	47
Cefotaxime	32	45

3. Result

Throughout the designated study period, a total of 360 patients underwent a diverse range of surgeries within the general surgery department of our institute. The majority of these surgeries (76%) were abdominal procedures, with limb surgeries following closely behind. The "Others" category encompassed neck surgeries, limb surgeries, and other tumor excisions. Among the 360 patients, 78 individuals experienced surgical site infections, resulting in a cumulative incidence rate of 22%. Out of the 78 SSIs recorded, 40 were classified as grade 3 infections and successfully responded to changes in antibiotic treatment. Additionally, 38 patients developed grade 4 infections, with some exhibiting constitutional symptoms such as fever. The age range of the study participants spanned from 20 years to 70 years. A significant majority (65%) fell within the 20-30 years age group. Within this age group, out of 232 patients, 22 individuals (10%) experienced infections. Among the 38 patients who were over 50 years old, a notable 24 individuals (63%) developed surgical site infections. The findings revealed a statistically significant increase in the frequency of SSIs with advancing age, as demonstrated in Table 1. Out of the total participants, 220 (61%) were male, and among them, 64 individuals (29%) experienced infections. Among the 140 female participants, 14 individuals (10%) developed surgical site infections. This difference in incidence between males and females was found to be statistically significant. The majority of the study subjects (266 individuals, 74%) had a normal BMI, and among them, 20 individuals (8%) developed SSIs. Out of the 48 underweight patients, a significant majority of 36 individuals (75%) developed SSIs. Among the 46 overweight patients, 22 individuals (48%) experienced infections in their surgical sites. This disparity was also found to be statistically significant, as indicated in Table 1. The study focused on three comorbid conditions: anemia, hypertension, and diabetes mellitus. For the diagnosis of anemia, hemoglobin levels of 13 g/dL for men and 12 g/dL for women were used as the cutoff points. Among the 37 patients with anemia who underwent surgery, 23 individuals (62.16%) developed surgical site infections. In this study, individuals who were aware of their diabetic and hypertensive status prior to admission were categorized as pre-existing diabetics and hypertensives, respectively. On the other hand, those who were diagnosed with diabetes or hypertension during their hospital stay were classified as newly diagnosed diabetics and hypertensives. A significant majority of the study participants were already aware of their diabetic and hypertensive status before their admission, and most of them were not consistently adhering to medication. This lack of regular medication intake was one of the contributing factors to an extended preoperative waiting period for these individuals. Furthermore, it was observed that a significant majority of the participants had both diabetes and hypertension concurrently. Out of the 24 diabetic patients, 20 individuals (83.33%) developed surgical site infections. Similarly, among the 23 hypertensive patients, 17 individuals (73.91%) experienced SSIs. These findings are summarized in Table 1.

A significant majority of the patients, specifically 244 individuals (67.78%), underwent surgery within 36 hours of admission. Out of these patients, 22 individuals (9%) developed surgical site infections. On the other hand, 56 patients (16%) waited for more than a week before undergoing surgery, and among them, 24 individuals (43%) experienced SSIs. These findings indicate a statistically significant difference, as highlighted in Table 1. An interesting observation was made regarding the usage of prophylactic antibiotics in the studied hospital. It was noted that prophylactic antibiotic administration was not a standard practice. Instead, antibiotics were selectively given to patients with existing infections or other identified risk factors. Among the 44 patients who received prophylaxis, only one person developed a surgical site infection. In contrast, out of the remaining 316 patients who did not receive prophylaxis, 76 individuals (25%) developed SSIs. These findings are presented in Table 1. Among the examined parameters, certain factors showed significant statistical significance in univariate analysis. These factors included age, gender, BMI, co-morbid conditions such as anemia, hypertension, and diabetes mellitus, blood transfusion, preoperative waiting period, and prophylactic antibiotic usage. These significant factors were then included in the multivariate analysis. In the multivariate analysis, gender, extreme BMI, diabetes mellitus, and blood transfusion emerged as independent predictors of surgical site infection. On the other hand, anemia, hypertension, and prophylactic antibiotic usage did not exhibit statistically significant associations, as shown in Table 1. Among the 78 cases of surgical site infections (SSIs) examined, 72 of them demonstrated the presence of thriving colonies. The predominant organism identified in the infected surgical sites was Staphylococcus aureus, followed by Pseudomonas and Klebsiella. Interestingly, certain surgical sites presented with mixed infections involving multiple types of microorganisms, as evidenced in Table 2. It is disheartening to note that the organisms isolated from the SSIs exhibited resistance to the entire spectrum of antibiotics commonly employed in our hospital's surgery department. Tetracycline, unfortunately, encountered the highest level of resistance, closely followed by erythromycin and ampicillin (Table 3). This highlights the pressing need for alternative strategies to effectively combat these resistant strains and ensure successful treatment outcomes. Upon the occurrence of a surgical site infection (SSI), a proactive approach was taken by the surgeons, who promptly ordered culture and sensitivity

tests to identify the causative organisms. Based on the test results, appropriate adjustments were made to the antibiotic treatment regimen to ensure optimal effectiveness. In addition to addressing the infection itself, close monitoring was also dedicated to the management of co-morbid conditions such as diabetes and hypertension. Stringent measures were implemented to closely observe and control these conditions, recognizing their potential impact on the healing process and overall patient well-being. Despite the diligent implementation of these measures, only 52 cases (67%) of surgical site infections (SSIs) were fully resolved by the time of discharge. Regrettably, 22 patients (28 %) had to return home with the infection still persisting. In one particular case, a subsequent operation was required to effectively manage the SSI, while sadly, an elderly patient succumbed to septicaemia, highlighting the severe consequences that can arise from such complications.

4. Discussion

Within the realm of surgical procedures, post-operative wound infections persist as a significant source of morbidity, representing the most common form of nosocomial infections. This study delves into the world of elective surgeries, specifically focusing on 360 cases treated at a government tertiary care.[7–12] The surgical landscape primarily comprises abdominal surgeries. The occurrence of surgical site infections (SSI) exhibits substantial variation both across different regions of the world and among different healthcare facilities. Research studies have reported SSI rates ranging from 3 % to 42 %.[4,6–9] In line with these findings, the current study reveals an SSI incidence of nearly 22%, which, although relatively high, aligns with previous research outcomes.

Furthermore, the rate of SSI demonstrates an upward trend with advancing age. In this particular study, a higher proportion of SSI cases was observed among individuals aged 50 years and older. This trend is consistent with findings from other studies. The underlying reasons for this association can be attributed to factors such as diminished immune response, the presence of coexisting medical conditions in elderly patients, and potential challenges in adherence to treatment protocols.[13–16] The current study reveals a notable disparity in the development of surgical site infections (SSI) between males and females. Similarly, a study conducted in Pune demonstrated a slight predominance of SSI among male patients (7.4%) compared to female patients (5.1%).[16] However, in a study conducted in western U. P, a higher proportion of females (27%) exhibited a preponderance of SSI in comparison to males (18%).[17] Nonetheless, Berard F and Gandon J assert that gender does not serve as a definitive determinant of the risk of SSI.[18]

In summary, while the present study highlights a significant proportion of males experiencing SSI compared to females, the observed variations across different studies and locations suggest that gender alone may not be a conclusive factor in predicting the risk of SSI. Further investigations and considerations of additional factors are necessary to comprehensively understand the dynamics of SSI occurrence.

The presence of co-morbid conditions such as anemia, diabetes, and hypertension emerged as noteworthy risk factors for surgical site infections (SSI). Among these, diabetes remained a significant predictor according to the results of multivariate analysis. These findings align with the report by the National Academy of Science, which also documented a higher infection rate in patients with diabetes mellitus, mirroring our study.[13] Similar results have been reported in various studies encompassing diverse surgical procedures.[14,19]

In essence, the current study underscores the significance of co-existing medical conditions, particularly anemia, diabetes, and hypertension, as substantial risk factors for the development of SSI. Notably, diabetes emerged as a significant predictor of SSI in the multivariate analysis, consistent with the findings of the National Academy of Science. These findings provide further support to existing research that has consistently identified these co-morbidities as influential factors in the occurrence of SSI across various surgical procedures.

The current study revealed a significant dose-response relationship between blood transfusion and the occurrence of surgical site infections (SSI). It was observed that the majority of transfusions took place during the intraoperative or perioperative period. This finding aligns with a study conducted by Tang et al., which identified blood transfusion as a crucial risk factor contributing to the development of SSI.[20] The immunosuppressive effects associated with allogeneic blood transfusion further predispose patients to postoperative infections.[21]

The study findings highlight a clear association between blood transfusion and the incidence of SSI, demonstrating a dose-response relationship. Notably, the majority of transfusions occurred intraoperatively or perioperatively, further emphasizing their potential impact on SSI development. This aligns with the results of a study conducted by Tang et al., which also identified blood transfusion as a significant risk factor for SSI. Moreover, the immunosuppressive effects associated with allogeneic blood transfusion further heighten the susceptibility to postoperative infections.

In summary, the current study underscores the dose-response relationship between blood transfusion and the likelihood of developing SSI. It emphasizes the importance of intraoperative or perioperative transfusions as potential risk factors. The immunosuppressive nature of allogeneic blood transfusion further contributes to the increased susceptibility to postoperative infections. A prolonged

preoperative hospital stay, coupled with exposure to the hospital environment, has been identified as a significant risk factor for surgical site infections (SSI).[6] The present study yielded comparable findings, corroborating the research conducted by Anvikar A.R. and Lilani S.P., which also reported a higher incidence of SSI among patients with extended preoperative hospital stays.[6,7] Extended stays in the hospital prior to surgery contribute to the colonization of antimicrobial-resistant microorganisms and directly impact a patient's susceptibility to infection. This can occur through the reduction of host resistance or by providing an increased opportunity for bacterial colonization.[8] In summary, the present study, along with previous research conducted by Anvikar A.R. and Lilani S.P., emphasizes the significance of a prolonged preoperative hospital stay as a risk factor for surgical site infections. This extended stay fosters the colonization of antimicrobial-resistant microorganisms, thereby heightening the susceptibility to infection. It is crucial to mitigate the potential risks associated with prolonged hospitalization to reduce the incidence of SSIs. In essence, the significance of pre-operative antibiotics in reducing the incidence of surgical site infections (SSI) is well-established. Nonetheless, the studied hospital did not adopt a routine practice of prophylactic antibiotic usage. Instead, antibiotics were selectively prescribed to patients with existing infections or other risk factors. This selective approach resulted in a substantial proportion of patients (24%) developing SSI when prophylaxis was not employed, highlighting the importance of broader implementation of preventive measures to minimize the risk of SSI.[20–25] In the present study, Staphylococcus aureus emerged as the predominant organism isolated from surgical sites, followed by Pseudomonas and Klebsiella. Other organisms such as E.coli, Citrobacter, and Proteus were also identified in cases of surgical site infections (SSI). Similar findings were reported by Lilani et al. and Mahesh et al., who observed a higher prevalence of Staphylococcus aureus and Pseudomonas in SSIs. Numerous studies have consistently identified Staphylococcus aureus as the most common pathogen associated with postoperative wound infections. It is worth noting that the presence of Staphylococcus aureus is often attributed to its abundance in the normal flora of the skin and nails,[25] which explains its frequent occurrence in SSIs. On the other hand, the higher incidence of gram-negative organisms in postoperative wound infections can be attributed to the acquisition of these bacteria from the patient's endogenous microflora.

5. Conclusion

The study revealed a relatively high incidence of surgical site infections (SSI). Various factors, including age, gender, body mass index (BMI), co-morbidities such as anemia, hypertension, and diabetes mellitus, as well as blood transfusion, pre-operative waiting period, and prophylactic antibiotic usage, were identified as potential risk factors for SSI development. However, upon thorough analysis, only gender, extreme BMI, diabetes mellitus, and blood transfusion emerged as significant predictors of SSIs. Staphylococcus aureus was the predominant microorganism associated with SSIs, and a notable proportion of SSIs exhibited resistance to multiple antibiotics, indicating the presence of multidrug-resistant strains.

6. Source of Funding

None.

7. Conflict of Interest

None.

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