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Surgical Site Infection: Risk Factors Analysis

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ABSTRACT

Introduction:
Surgical site infections (SSIs) are the most common hospital-acquired infections (HAI). They lead to prolonged stay, long-term disability, antimicrobial resistance, the additional financial burden to the healthcare system, the excessive cost for patients and their families and, unnecessary death. Several factors in a patient's journey during surgery can affect the SSI incidence rate. In this research, we have studied various factors which can influence the SSI rate. This will help in the minimization of the SSI incidence rate.

Materials and Methods:
In this prospective observational analytical study, 104 patients posted for surgery were included. The demographic, clinical and relevant laboratory data were documented. SSI was diagnosed by noting down sign and symptoms like local pain, discomfort, type of discharge from the incision site and daily temperature Chart. Postoperative follow-up was done till 1 month. SPSS v21 was used for analysis of data and Microsoft Excel to generate graphs and tables. Logistic regression analysis, Fisher exact test and Chi-square tests were used for statistical analysis. p-value < 0.05 was considered statistically significant.

Results:
In this study, 20 patients developed SSI. Socio-economic condition, type of wound, emergency vs. elective, pre-operative and post-operative stay had significant relationship with SSI while gender, age duration of surgery did not have significant effect. Among laboratory findings, urea and total leucocyte count have significant effect while haemoglobin and protein does not have.

Conclusion:
Risk factors having significant effect on incidence rate of SSI should be addressed before surgical procedure to minimize SSI.

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Introduction

Surgical site infections (SSIs) are infections of the incision or organ or space that occur after surgery (1). It is the most common hospital acquired infection (HAI), accounting for 31% of all HAI among hospitalized patient (2). It affects around one third of patients who had surgeries and it is the most surveyed and most frequent health-care-associated infection in LMICs.[3] Impacts of SSI can be seen in terms of prolonged stay, long term disability, and antimicrobial resistance, additional financial burden to health-care system, excessive cost for patients and their family and, unnecessary death. The overall incidence of SSI in India ranges from 3.38%-30.7% (4-6).

Several factors in the patient's journey through surgery contribute to the risk of SSI.[3] Incidence of SSI depends on both patient and procedure related factors. Risk of SSI can be host related, surgical factors related and, microbial factors related (7).

Table 1: SSI risk factors (8).

Host factors	Older age, Metabolic factors (Diabetes mellitus, Renal failure, Malnutrition), Peripheral vascular disease, Anaemia, Chronic conditions (inflammatory process, skin disease, staphylococcus carrier stage) Immunosuppression, Radiation, Recent operation, Smoking, Prolonged preoperative hospital stays
Surgical factors	Surgical factors (Emergency compared to elective surgery, type of wound, Open compared to laparoscopic surgery, Poor skin preparation, Contamination of instruments, Inadequate antimicrobial prophylaxis, Prolonged procedure, Local tissue necrosis, Blood transfusion, Hypoxia, Hypothermia
Microbial factors	Prolonged hospitalization (leading to nosocomial organisms), Toxin secretion, Resistance to clearance (e.g. capsule formation)

In India, risk of SSI is very high as compared to developed countries. Still prevention of SSI has not been given due importance. Moreover, surveillance data are scanty in this field. This data will help in formulation of evidence based guideline which will increase patient safety, decrease additional health care cost and improve health care quality. In this study we have determine incidence of SSI and analysed its associated factors at PT. J.N.M. Medical College, a tertiary care 700 bedded hospital in Raipur, Chhattisgarh, Central India.

Materials and Methods

We conducted an observational, prospective analytical study in the Department of Surgery of PT. J.N.M. Medical College, a tertiary care 700 bedded hospital in Raipur, Chhattisgarh, Central India for a year after obtaining clearance from Institutional ethics committee. The objective of study was to determine incidence of SSI and to analyse factors associated with this.

Subjects

Patients aged more than 18 years undergoing surgery and willing to give informed consent were included in the study. Participants with diabetes mellitus and symptomatic infection at distant site, were excluded from this study. Immuno-compromised, pregnant and lactating women, smokers, patients with drug allergy history and receiving antimicrobials for any reason were also excluded from this study.

Study methods

After obtaining clearance and approval from institutional ethics committee study was conducted. Using purposive sampling, 538 patients who were posted for surgery from January 2016-January 2017 were assessed

for eligibility. Out of these 420 were excluded due to presence of exclusion criteria. 14 patients were lost to follow up. 104 patients were included for the study. Written informed consents were obtained from all of them. The demographic, clinical and relevant laboratory data were documented. SSI was diagnosed by noting down signs and symptoms like local pain, discomfort, type of discharge from the incision site and daily temperature chart. Postoperative follow-up was done till 1 month.

Statistical analysis

SPSS v21 was used for analysis of data and Microsoft Excel to generate graphs and tables. Logistic regression analysis, Fisher exact test and Chi-square tests were used for statistical analysis.

The chi-square test for categorical variables was used to determine the significance of association, whereas the multivariate logistic regression model was used to examine independent risk factors for SSI. P-value< 0.05 was considered statistically significant.

Results

In this study we had 104 patients and 20 of them developed SSI. We have used logistic regression and Chi square test (or Fisher's exact test for 2 X 2 contingency tables) to study factors which can influence the likelihood of SSI.

Table 2 shows the result of Chi square test for relationship of SSI with demographic and surgical variables.

Table 2: SSI versus demographic and surgical variable

Demographic details	**P-value**	**Interpretation**
Gender	0.418	Not significant
Age	0.097	Not significant
Urban/rural	0.001	Significant
Surgical variables	P-value	Interpretation
Type of wound (clean, clean-contaminated, contaminated, dirty)	0.001	Significant
Emergency vs elective	0.001	Significant
Preoperative stay (<24, 24-48, >48 hours)	0.004	Significant
Duration of surgery (>2-hour vs < 2-hour)	0.480	Not significant
Postoperative stay (<5, 5-10, 10-15,15-20,>20 days)	0.033	Significant

In our study, majority of patients (63%) underwent gastrointestinal (GI) surgeries which were followed by gastro-urinary surgeries (29%), breast surgeries (3%) and trauma (3%). As per previous literature, gastro-intestinal surgeries have significantly higher SSI rates compared to the other surgeries (9,10). We performed Fisher's exact test to find out the same. The p-value for the test comes out as *0.037 (statistically significant).* Effect of hypertension on SSI incidence rate was calculated using Fisher's exact test, p-value was 0.926 (*statistically not significant*).

In the rest of this section, we have used logistic regression analysis. As urea and creatinine have very high correlation, only one of them is kept in the list of independent variables in the logistic regression. Similar argument is true for protein and albumin.

Table 3 and 4 reports the outcome of logistic regression where log odd ratio of developing SSI is modelled using the independent variables: urea, protein, age, gender and TLC. It can be seen from the table 3 that urea (p-value 0.038) and TLC (p-value 0.001) have significant impact on the likelihood of developing SSI. Protein (p-value 0.543), age (p-value 0.336) and gender (p-value 0.201 for female) do not have significant impact on the likelihood of developing SSI.

Table 4 reports the outcome of logistic regression where log odd ratio of developing SSI is modelled using the independent variables: haemoglobin, creatinine and albumin. Creatinine has significant impact on the likelihood of developing SSI with p-values of 0.009. Haemoglobin (p-value 0.140) and albumin (p-value 0.140) do not have significant impact on the likelihood of developing SSI.

Table 3: Logistic regression-I outcome

	B	Std. error	Wald	Deg. freedom	Significance	Exp(B)
Urea	0.036	0.017	4.314	1	0.038	1.037
Protein	-0.266	0.437	0.371	1	0.543	0.766
Age	0.023	0.024	0.924	1	0.336	1.023
Female	-1.144	0.896	1.632	1	0.201	0.318
TLC	0.396	0.119	11.146	1	0.001	1.486
Constant	-5.426	3.214	2.851	1	0.091	.004

Table 4: Logistic regression-II outcome

	B	Std. error	Wald	Deg. freedom	Significance	Exp(B)
Hb	0.212	0.144	2.178	1	0.140	1.236
Creatinine	1.445	0.550	6.908	1	0.009	4.241
Albumin	-.796	0.647	1.513	1	0.219	0.451
Constant	-3.121	1.904	2.686	1	0.101	0.044

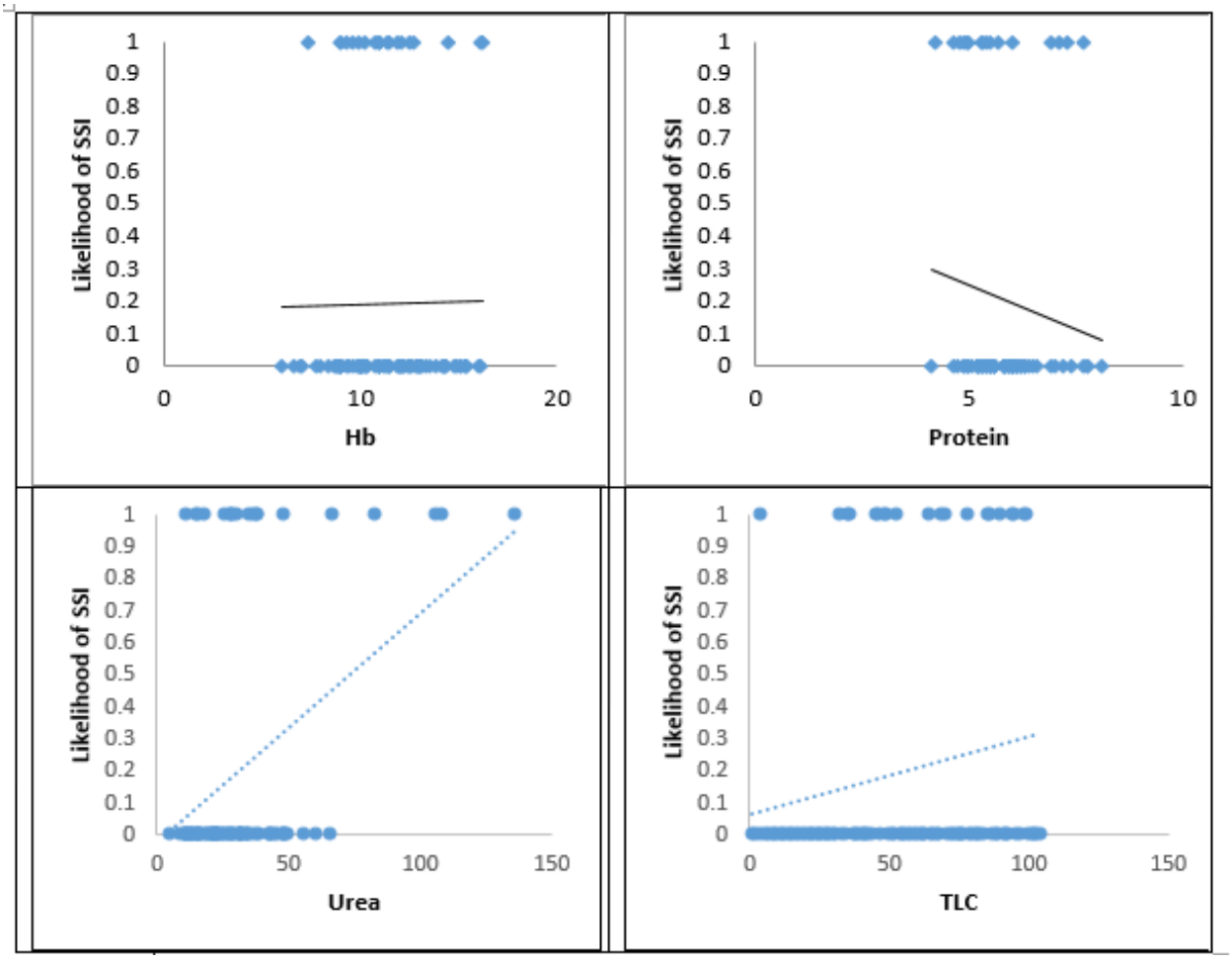

Figure 1: Likelihood of SSI with Hb, protein, urea, TLC

Figure 1 show the impact of haemoglobin, serum protein, serum urea and total leukocyte count on likelihood of SSI using regression analysis.

The regression trend line shows that incidence of SSI does not change with haemoglobin (Hb). The change in SSI with Hb is not significant (p-value 0.140). Regression trend shows that incidence of SSI decreases with protein. The logistic regression output finds a similar trend wherein with a unit increase in protein, odds ratio for SSI decreases by a factor of 0.766. However, relationship was not statistically significant (p-value 0.543).

Furthermore, regression trend line shows that incidence of SSI increases with urea. The logistic regression output indicates that the change in SSI with urea is statistically significant (p-value .038). The odds ratio for SSI increases by a factor of 1.037 with every unit increase in urea.

The regression trend line shows that likelihood of SSI increases with total leukocyte count (TLC). Further, the logistic regression output indicates that the change in SSI with TLC is statistically significant (p-value .001). The odds ratio for SSI increases by a factor of 1.486 with every unit increase in TLC

Discussion

As per WHO incidence of SSI is three to five times higher in low and middle-income countries (LMIC) like ours's than high income countries (11). The pooled SSI rate was 11.8 per 100 surgical patients undergoing surgical procedures (95% CI: 8.6-16.0%). Furthermore, in South-East Asia rate of SSI was 7.8 (95% CI: 6.3-9.3) (12).

In our study incidence rate of SSI was 19% which is much higher than the expected rate. Increased SSI incidence leads to prolonged stay, long-term disability, antimicrobial resistance, the additional financial burden to the healthcare system, the excessive cost for patients and their families and, unnecessary death (13). This can be curtailed by taking care of risk factors associated with SSI. There are several modifiable and non-modifiable risk factors for SSI. In our study we have analysed these risks factors and classified them into demographic, surgical and individual risk factors.

Age, gender and rural vs urban were demographic variable considered in our study. We found using fisher exact test that gender and age which are non-modifiable risk factors have no significant effect on SSI (Table 2). This finding is in accordance with study done by Cheng et al.(14). However rural vs. urban factor demonstrated significant effect on SSI. A study conducted in Central India has also reported higher incidence of SSI which has been attributed to rural set up of study (15). This might be due to better awareness about hygiene and early medical interventions in urban people.

Surgical factors including type of surgery, type of wound, duration of surgery, preoperative and postoperative stay were analysed. In our study majority of patients (63%) had undergone gastrointestinal surgeries. If we compare gastrointestinal surgery vs. rest of the surgeries, p-value is 0.037 which is statistically significant. For wound classification, we have used NRC classification. Wounds were classified into clean, clean-contaminated, contaminated and dirty wound. P-value was 0.001 which was significant. Similar finding has been observed in other studies also.[16] Duration of surgery was categorized into < 2 hours and > 2 hours, as duration of surgery more than 2 hours is a risk factor. We found no significant relationship between duration of surgery and SSI (p-value 0.4808). Postoperative stay was categorized into less than 5 days, between 5-10 days, 11-15 days, 16-20 days and more than 20 days in our study. Using Chi-square test p-value was 0.033 (significant). This may be due to the prolonged stay in patients who develop SSI.

We found statistically significant relationship with likelihood of SSI in case of factors including gastrointestinal vs. other surgeries, emergency or elective surgery, preoperative stay, and type of wound. In our study majority of dirty wounds were among gastrointestinal surgery categories. They are mostly emergency in nature and needs urgent intervention. This leads to shorter preoperative stay for them. And this explains the reason for significant relationship between them. In SENIC index which is used for risk factor stratification, gastrointestinal surgery and dirty wounds are counted as determinants of SSI (17). Similar findings have been seen in study by Cheng et al.(14).

Lastly, we have analysed individual factors which can affect SSI incidence rate. Figure 1 demonstrates the relationship between Hb,

protein, and urea and TLC with likelihood of SSI. We found that statistically significant relationship is present between TLC and urea with SSI. No significant relationship was seen with albumin & protein level, which is contradictory to various studies (18,19). It might be due to small sample size in our study. This is in accordance with the other literatures (14,20).Preventing surgical site infections (SSIs) is important for successful surgical outcomes (21). It ought to be a multifaceted strategy that considers all the SSI-causing factors. Several measures have been proposed by WHO to minimize the incidence rate of SSI. Negative pressure wound therapy, maintaining normothermia, using chlorhexidine gluconate along with alcohol-based skin preparation agents, decolonization with intranasal antistaphylococcal agents, and using antistaphylococcal skin antiseptics for high-risk procedures can all help lower the incidence of surgical site infections (22). These strategies should be used in conjunction with the individual SSI-causing factors, such as excessive urea, a protracted postoperative stay, and an elevated WBC count. These actions will improve patient safety, boost confidence in physicians, and alleviate the financial load on both patients and the health system.

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