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Prospective Study to Determine Peri-Operative Risk Factors of Surgical Site Infection (SSI) in Abdominal Surgeries

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Abstract
Surgical Site Infections (SSIs) is defined by the Centers for Disease Control and Prevention as a wound infection that occurs within 30 days of an operative procedure or within a year if an implant is left in place and the infection is thought to be secondary to surgery. This was a single center hospital based Prospective Observational Study conducted on patients who underwent Surgery in SIMS and RC. Ethical committee clearance was obtained prior to the study and a total of 478 patients who underwent abdominal surgery were included in the study. All post-surgical patients were surveilled on POD-3, 7, 14-18 and POD 25-30. The study period being from February 2021 to August 2022. Out of 478 patients, 46 patients developed SSI (9.62%). Gender distribution was 26 males (60.6%) and 20 females (39.3%).23.76% of patients undergoing Emergency Surgeries developed SSIs ($p<0.05$) and 5.83% undergoing elective surgery developed SSI. Majority of the patient developing SSIs belonged to Contaminated or Dirty wound ($p<0.05$). 12.46% of patients undergoing open surgeries developed SSI whereas, 3.36% of patients undergoing laparoscopic surgeries developed SSI ($p<0.05$). in 33.33% patients, organism isolated was E. coli. Diabetes (34.78%) and Smoking (21.74%) were found to be the major risk factors for developing SSI.

INTRODUCTION

Prior to the evolution of germ theory and antisepsis, occurrence of infection in the surgical wound was the rule rather than the exception, which prevented early surgeons from attempting complex procedures due to the frightfully high incidence of morbidity and mortality due to postoperative infections. Ignaz Semmelweis's hypothesis that puerperal fever was caused by putrid material carried on the examining fingers of physicians was later substantiated by Louis Pasteur's Germ Theory. Semmelweis's simple measure of washing hands thoroughly in chlorine water and Joseph Lister's use of dressings saturated with carbolic acid were the pioneering measures of infection control[1,2].

Surgical site infection (SSIs) is defined by the Centers for Disease Control and Prevention as a wound infection that occurs within 30 days of an operative procedure or within a year if an implant is left in place and the infection is thought to be secondary to surgery[3,4].

They are classified as:

- Superficial incisional SSIs.
- Deep incisional SSIs.
- Organ-space SSIs.

Do not Report the Following Conditions as SSI:

- Stitch abscess (minimal inflammation and discharge confined to the points of suture penetration).
- Infection of an episiotomy or newborn circumcision site.
- Infected burn wound.
- Incisional SSI that extends in to fascial and muscle layers.

SSIs are universally present in developed, middle-income and developing nations. Globally around 2 million cases of SSIs occur annually. The World Health Organisation describes these as one of the major infectious diseases having significant economic impact, increasing the cost by healthcare by $20,842 per admission[5].

The prevalence of SSIs varies widely from region and hospital, grossly it ranges between 5-16%. In India the prevalence of SSI is between 5% and 24%[6].

MATERIALS AND METHODS

Patients of Sapthagiri Institute of Medical Sciences and Research Centre, who underwent surgery under the Department of General Surgery and who had given informed written consent were included in this study.

All post-surgical patients were surveilled on Post Operative Day 3 (PoD), PoD 7, PoD 14-18 and PoD 25-30 and evidence of surgical site infection, in accordance with the CDC definition of SSI, were be examined for.

Patients, if diagnosed with SSI, then underwent a detailed evaluation and details such as: history of the patient, general physical examination, systemic examination, antibiotic prophylaxis, operation performed, operative duration, mode of operation, wound classification, surgical site classification, isolate and resistance pattern were be recorded in a study proforma.

Study Period: February 2021 to August 2022.

Study Design: Prospective Observational Study.

Sample Size: 478 Abdominal Surgery patients.

Inclusion Criteria:

- All Abdominal Surgery patients in General Surgery.
- Patients who gave written informed consent.

Exclusion Criteria: Patients who got Discharged Against Medical Advice, or failed to follow up within 30 days of operation.

Statistical Analysis: The data collected was entered into Microsoft Excel Worksheet 2010 and data was taken into IBM SPSS Statistics for Windows, Version 24 software for calculation of frequency, percentage, mean, standard deviation and Probability value.

RESULTS AND DISCUSSIONS

In the present study, 478 cases were enrolled out of which 46/478(9.62%) developed Surgical Site Infection during the study period.

Among the 278 cases enrolled in the study 296 (61.9%) were male, 182 were female. Out of the 46 cases with SSI, 26(60.6%) were male and 20(39.4%) were female.

The mean age of the patients were 38.16 years-with average age of patient's developing SSI was 37.29 years and the mean age of patient's who did not develop SSI was 38.29 years and the majority of patients were in 20-20 years age group.

The vast majority of cases were Elective surgeries 377/478 (78.87%) and only 101/478 (21.13%) were emergency cases. Out of the total, 22 (5.83%) of the cases developed SSI. And among the 101 Emergency surgeries performed 24/101 cases (23.76%) developed Surgical Site Infection which is statistically significant ($p<0.05$).

Table 1: Incidence of SSIs

Total cases	**478**
SSI	46
Percentage	9.62

Table 2: Distribution according to Gender among SSI patients

	Total number of cases	**Cases that developed SSI**	**Percentage of SSI among each Gender**
Male	296	26	60.6
Female	186	20	39.4
	482	46	

Table 3: Age Distribution

Category	**Average age in years**
SSI Patients	37.29
All patients	38.16

Table 4: Distribution according to Elective or Emergency Surgery

	Total cases	**Cases that developed SSI**	**Percentage**
Elective	377	22	5.83
Emergency	101	24	23.76
Total	478	46	

Table 5: Distribution of cases based on type of wound

Type of Wound	**Total number of cases**	**Number of cases that developed SSI**	**Percentage of SSI according to type of wound**
Clean	270	16	5.93%
Clean-contaminated	151	16	10.60%
Contaminated	28	8	28.57%
Dirty	29	6	20.69%
Total	478	46	

Table 6: Distribution of cases based on type of Operation

Operation type	**Number of cases**	**Number of cases that developed SSI**	**Incidence of SSI based on type of Operation (%)**
Open	329	41	12.46
Laparoscopic	149	5	3.36
Total	478	46	

Table 7: Organisms Isolated

Organism	**Number of cases**	**Percentage**
E. coli	17	33.33
Pseudomonas Sp.	9	17.65
Klebsiella sp.	7	13.73
Coagulase Negative Staphylococcus	7	13.73
Enterobacter Sp.	3	5.88
Proteus Vulgaris	2	3.92
Non-Fermenting Gram Negative Bacilli	2	3.92
Acinetobacter Sp.	1	1.96
Citrobacter Sp.	1	1.96
Enterococcus Sp.	1	1.96
Streptococcus Sp.	1	1.96
Total	51	

Table 8: Risk factors for SSI

Risk Factors	**Number of case with risk factors**	**Proportion of risk factor in cases that developed SSI**
Diabetes	16	34.78
Smoking	10	21.74
Hypertension	7	15.22
Alcohol	7	15.22
Thyroid Disorder	4	8.70
Immunocompromised state	2	4.35
Malignancy	2	4.35
Tuberculosis	1	2.17
Tobacco chewing	1	2.17
Asthma	0	0
Recent radiotherapy	0	0

Table 9: Anemia among patients who developed SSI

Haemoglobin	**Number of cases**	**Percentage**
Severe<7mg/dl	0	0%
Moderate 7-11mg/dl	14	30.43%
Mild 11-12mg/dl	37	17.39%
>12mg/dl	24	52.17%

Table 10: Serum Albumin levels among patients that developed SSI

Serum Albumin	**Number of cases**	**Percentage**
<3.5g/dl	27	58.69%
>3.5g/dl	20	43.47%

Table 11: HbA1c levels among patients that developed SSI

HbA1c	Number of cases	Percentage of cases
<6	9	19.56%
6-8	8	17.39%
>8	29	63.04%

Table 12: Operative time as a risk factor for development of SSI

Operative time	Number of cases	Percentage
<1 hour	3	6.52%
1-2 hour	11	23.91%
>2 hour	32	69.56%

Based on the type of wounds of the 478 cases, 270/478 (56.49%) were clean cases. 16/270 (5.93%) of the clean cases got infected and developed an SSI, whereas 16/151 (10.59%) out of 151 Clean-Contaminated cases developed an SSI. 28/478 cases were Contaminated, out of which 8/28 (28.57%) developed infection and 6/29 (20.69%) out of 29 Dirty cases developed an SSI. Majority were contaminated or Dirty wounds which is statistically significant (p<0.05).

Majority of the cases were open surgeries 329/478 (68.83%) and 149/478 (31.13%) were laparoscopic procedures. Among the 329 open surgeries 41/329 (12.46%) cases developed an SSI subsequently. Only 5 cases out of the 149 (3.36%) Laparoscopic cases developed an SST. Hence Open surgeries are linked to more percentage of SSIs (p<0.05).

Among the cases that developed SSI, 41/46 cases showed mono microbial grouch and 5:45 cases showed polymicrobial growth. Out of the total 51 isolates, majority 42/51 (82.35%) were gram negative bacilli and 9/51 (17.6%) were gram positive cocci.

In this study, among the patients that developed SSI 34,8% were diabetic with an average HbAlc of 9,91+2.7. 15.2% were hypertensive. There was one patient with tuberculosis. Four patients (8.7%) had a thyroid disorder. 10 patients were smokers (21.74%) and 7 (15.22%) were alcoholics. Only one patient regularly chewed tobacco. There were 2 cases with malignancy and 2 patients in immunocompromised state. Out of the patients that developed SSI, the mean Haemoglobin was 12.29+0.6g/dL. On average the Serum Albumin level was 3.42+/-0.7 g/dL. The mean Scrum Total Bilirubin was 1.26+/-0.8 mg/dL.

Pre operative Complete Blood Count was done in all 46 patients. The mean Haemoglobin was 12.29+/-0.6g/dL. None of the patients had a haemoglobin less than 7mg/dL, therefore no cases of severe anemia were present in this study. 14/46 (30.43%) cases had a Hb between 7mg/dl to 11 mg/dL. Some patients 8/46 (17.39%) had mild anemia. The majority 32/46(69.5%) of cases had a haemoglobin greater than 11mg/dl.

Liver Function Test was measured pre-operatively. The mean S. Alb in the study population was 3.42+/-0.7 g/dL. 8/37 (21.62%) cases had a Serum Albumin level <3.0g/dl. 12/37(32.43%) cases had a S. Alb level between 3.0-3.5g/dl. 16/37(43.24%) patients had S. Alb greater than 3.5g/dl.

The HbA1c were collected peri-operatively and tabulated. 9/46 (19.56%) cases that developed SSIs were non-diabetic. 8/46 (17.39%) of the patients were borderline diabetics. Majority of the cases, i.e. 29/56 (63.04%) were diabetic which was statistically significant with p<0.05.

The duration of procedure was analysed and tabulated. Of the 46 cases, only 3 were completed within 1 hour. 11/46 cases were completed within 2 hours. And among the cases that developed SSI (69.56%), the operative time exceeded 3 hours which was statistically significant with P<0.05.

In the present study, we observed that Surgical Site Infections were predominant in males as compared to females, of the 46 patients were enrolled with surgical site infection 56.5% were male while 43.5% were female. Similar findings were also observed by Chad CKR[5]

In the present study we observed that SSIs were common in surgeries performed under emergency setting rather than those performed electively. Out of the 377 elective cases in our study, 39 developed SSI (6.11%) and among the 79 emergency cases 22 developed SST (21.78%). In a study by Saxena A *et al.,* 2013, study the infection rate was 16.48% in patients operated in emergency setting while in patients operated electively the rate was 13.39%30 Similar findings were also observed by Khairy GA *et al.,* 14.28% of the patients operated in emergency setting developed SSIs while only 3.37% operated in the elective setting developed SSIs.35 This is the case as surgeries performed under emergency lack routine pre-op optimisation and preparation such as management of comorbidities, control of diabetes, hypertension, nutrition, etc and emergency operations involve contaminated areas like bowel and the perianal region[6,7].

Diabetics are at a higher risk of infections, uncontrolled diabetics are at an even higher risk. This is because of impaired micro-circulation and sugar rich plasma acting as a media for bacterial growth. In the present study, among the 46 patients that developed SSI, 16 (34.78%) were diabetic and the mean HbAlc was 8.91+/-ee2.7 %. 63.04% of the cases that developed an

SSI had an HbAlc greater than 8%., indicating a large portion of the study population had uncontrolled diabetes. In the study by Chada CKR *et al.,* 39% patients had uncontrolled diabetes while 27% patients had controlled diabetes. 31 Saxena A *et al.,* observed that the incidence of SSIs was 24.13% in diabetics while the same was 13.28% in non-diabetics.

Both extremes of nutrition are risk factors for development of SSI. Mahutrition, which can be measured using Serum Albumin, has been shown to be a cause of impaired wound healing, reduced immunity and increased morbidity. 49 In the present study 27/46 (58.7%) of the patients that developed SSI, had a S. Alb less than 3g/dL. In a study by Huda F et at the mean S. Alb of patients that developed SSI was 3.68+0.7, as compared to 3.92÷0.6. However this was not statistically significant. In a meta-analysis of 13 studies with a total of 112,183 patients showed that an albumin level less than 3.5g dL had an 2.5 fold increase in risk of SSI[8].

CONCLUSION

The mean age of the patients was 38.3 years. Most of the patients were in the age group of 20-40 year age group. Surgical Site Infections were common in surgeries performed under emergency setting rather than those performed electively.

SSIs were common in contaminated wound (28.6%) followed by dirty wound (20.7%). SSIs were common in open surgeries (14%) and we observed a reduced incidence in laparoscopic procedures at only 3.3%.

In the present study, the incidence of Gram Positive Cocci was (17.6%) and Gram Negative Bacilli was 82.3%. Coagulase Negative Staphylococcus was the most common GPC isolate and E. Coli, Pseudomonas and Klebsiella Pneumonia were the common GNB isolates.

In this study it was noted that Diabetes, Smoking and Obesity were the main risk factors in developing SSI.

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