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Evaluate the spectrum of surgical site infections in general surgery patients admitted at tertiary care centre of north India

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ABSTRACT

Background

Surgical site infections (SSIs) are infections present in any location along the surgical tract after a surgical procedure. SSIs involve postoperative infections occurring at any level (incisional or deep). With this knowledge we hope to reduce the incidence of this problem in our institution and the burden borne by the patient. We also hope to sensitize other health care professionals to this problem.

Aim

To evaluate the spectrum of surgical site infections in general surgery patients

Methodology

This study included all patients admitted for surgery in the department of General Surgery at Christian Medical College and Hospital, Ludhiana between 1st November 2010 to 1st November 2011. Each patient was followed up from the time of admission till discharge from the hospital and also for 30 days postoperatively. The patients were assessed preoperatively and postoperatively. Swabs obtained from the infected wounds were processed aerobically and anaerobically by standard methods.

Results

In this study from 1st November 2010 to 1st November 2011, a total of 1041 surgeries were performed. There were 1008 major surgeries and 33 minor surgeries performed during the study period. Only inpatients were included in this study. Out of 1041 surgeries performed, surgical site infection (SSI) was detected in 47 (4.51%) patients. Escherichia coli was the predominant organism 15/27 (55.56%). Patients were divided into two arms (SSI group and Non SSI group). Patients who developed SSI were clubbed together in SSI group and those who did not develop SSI following operation were put in Non SSI group. Following observations were made and analysis was concluded accordingly. Data has also been tabulated.

Conclusion

It was found that males are more prone to develop surgical site infection. The length of preoperative hospitalization of more than 1 day was found to have direct relation with developing SSI. There was increased incidence of SSI in the patients in whom postoperative hospitalization was > 7 days. There was more risk of developing SSI in patients, who had serum albumin < 3.5 g/dl. There was increased incidence of SSI in patients in whom duration of surgery was >2 hours. There was increased incidence of SSI in patients in whom open drain was used. There was increased incidence of SSI in contaminated cases as compared to clean, clean contaminated and dirty cases. Pre-operative shaving as a method of hair removal increases the risk of developing SSI. There was increased risk of developing SSI in patients getting post-operative antibiotics for < 10 days than in patients getting post-operative antibiotics for more than 10 days. Escherichia coli (E. coli) was the commonest isolate for the postoperative wound infections.

Keywords: SSI, Surgery, Surgical site infections.

INTRODUCTION

Surgical site infections (SSIs) are infections present in any location along the surgical tract after a surgical procedure. SSIs involve postoperative infections occurring at any level (incisional or deep). SSIs are divided into incisional superficial (skin, subcutaneous tissue), incisional deep (fascial plane and muscles), and organ/space related (anatomic location of the procedure itself).[1]The CDC definition[19] describes three levels of SSI:1.*Superficial incisional*, affecting the skin and subcutaneous tissue. These infections may be indicated by localised (Celsian) signs such as redness, pain, heat or swelling at the site of the insicion or by the drainage of pus.2. *Deep incisional*, affecting the fascial and muscle layers. These infections may be indicated by the presence of pus or an abscess, fever with tenderness of the wound, or a separation of the edges of the incision exposing the deeper tissues.3. *Organ or space infection*, which involves any part of the anatomy other than the incision that is opened or manipulated during the surgical procedure, for example joint or peritoneum. These infections may be indicated by the drainage of pus or the formation of an abscess detected by histopathological or radiological examination or during re-operation. The surgical wound classification system includes four categories: Class I: Clean. Class II: Clean-contaminated. Class III: Contaminated. Class IV: Dirty or infected. The development of an SSI depends on contamination of the wound site at the end of a surgical procedure and specifically relates to the pathogenicity and inoculum of microorganisms present, balanced against the host's immune response. The microorganisms that cause SSIs are usually derived from the patient (endogenous infection), being present on their skin or from an opened viscus. Rarely, microorganisms from a distant source of infection, principally through haematogenous spread, can cause an SSI by attaching to a prosthesis or other implant left in an operative site. Surveillance of SSI provides data that can both inform and influence practice to minimize the risk of SSI, as well as communicate more clearly the risks of infection to patients.[24]The risk of SSI is increased by factors that increase the risk of endogenous contamination (for example, procedures that involve parts of the body with a high concentration of normal flora such as the bowel), increase the risk of exogenous contamination (for example, prolonged operations that increase the length of time that tissues are exposed) and diminish the efficacy of the general immune response (for example, diabetes, malnutrition, or immunosuppressive therapy with radiotherapy, chemotherapy or steroids) or local immune response (for example, foreign bodies, damaged tissue or formation of a hematoma).

The Guideline for Prevention of Surgical Site Infection, 1999, provides recommendations concerning reduction of surgical site infection risk. Each recommendation is categorized on the basis of existing scientific data, theoretical rationale, and applicability. However, the previous CDC system for categorizing recommendations has been modified slightly. Postoperative Surgical site infections remain a major source of illness and a less frequent cause of death in the surgical patient. They are the third most commonly reported nosocomial infections and account for 14-16% of all nosocomial infections among hospital inpatients.[3]

Since SSIs are a universal problem which increase the mortality and morbidity of surgical patients, a thorough knowledge of this subject is essential for a surgeon. Moreover, knowledge of the incidence of the problem in a healthcare institution and the organisms involved and their sensitivity will greatly aid in the management of the problem. There are very few studies in the Indian setting that have addressed this problem and hence we felt the need to identify the incidence and scope of the problem in our institution. With this knowledge we hope to reduce the incidence of this problem in our institution and the burden borne by the patient. We also hope to sensitize other health care professionals to this problem.

AIM AND OBJECTIVES

To evaluate the spectrum of surgical site infections in general surgery patients.

MATERIALS AND METHODS

This study included all patients admitted for surgery in the department of General Surgery at Christian Medical College and Hospital, Ludhiana between 1st November 2010 to 1st November 2011. Each patient was followed up from the time of admission till discharge from the hospital and also

for 30 days postoperatively. The patients were assessed preoperatively and postoperatively. Swabs obtained from the infected wounds were processed aerobically and anaerobically by standard methods.

Surgical wound was inspected at the time of discharge and at one month thereafter. Wound infection was diagnosed with any one of the following criteria being fulfilled: pus discharged from the wound, serous or non-purulent discharge from the wound with signs of inflammation (oedema, redness, warmth, raised local temperature, fever >38°C, tenderness, Induration) and wound deliberately opened up by the surgeon due to localized collection. The wound infection was treated in the standard manner by the treating doctor. The files of the patients were checked from the medical records at Christian Medical College and Hospital.

Statistical Analysis

All the data was compiled on Microsoft Excel Computer program and was subjected to chi-square analysis.

RESULTS AND ANALYSIS

In this study from 1st November 2010 to 1st November 2011, a total of 1041 surgeries were performed. There were 1008 major surgeries and 33 minor surgeries performed during the study period. Only inpatients were included in this study. Out of 1041 surgeries performed, surgical site infection (SSI) was detected in 47 (4.51%) patients. 37 (3.55%) patients developed Superficial Incisional SSI, 9 patients (0.86%) developed Deep Incisional SSI whereas 1 patient (0.09%) developed Organ space related SSI. Out of 47 patients who developed SSI, 37 patients (78.72%) developed Superficial Incisional SSI, 9 patients (19.15%) developed Deep Incisional SSI and 1 patient (2.13%) developed Organ space related SSI. Out of 1041 cases, SSI rates in different groups were: Clean (1.53%), Clean-contaminated (0.28%), Contaminated (2.68%) and dirty (0.86%). Out of 47 patients who developed SSI, 4 patients (8.51%) expired. All patients who expired had undergone a major surgery.

Among 47 patients with clinical SSI, in 41 patients cultures were sent, out of which 27(57.45%) had positive culture. Escherichia coli was the predominant organism 15/27 (55.56%). This was followed by Staphylococcus Aureus 4/27(14.81%).

Patients were divided into two arms (SSI group and Non SSI group). Patients who developed SSI were clubbed together in SSI group and those who did not develop SSI following operation were put in Non SSI group. Following observations were made and analysis was concluded accordingly. Data has also been tabulated.

Table 1: Distribution of subjects according to age

	SSI Group		Non SSI Group		Total
Age (years)	**No.**	**%age**	**No.**	**%age**	
Up to 40	14	3.58	376	96.42	390
>40	33	5.06	618	94.35	651
Total	47		994		1041
Chi square:1.238 ; p = 0.2658 ; Not Significant					

Out of 390 patients up to 40 years of age, 14 Patients (3.58%) developed SSI while out of 651 patients who were >40 years of age, 33 Patients (5.06%) developed SSI. In Non SSI group 376 patients were up to 40 years of age and 618 patients were above 40 years of age.

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Table 2: Distribution of subjects according to sex

	SSI Group		Non SSI Group		Total
Sex	**No.**	**%age**	**No.**	**%age**	
Male	31	5.79	504	94.21	535
Female	16	3.16	490	96.83	506
Total	47		994		1041
Chi square: 4.983 ; p=0.0256 ; Significant					

There were 535 males and 506 females in this study. Out of 535 male patients, 31 Patients (5.79%) developed SSI while out of 506 female patients, 16 Patients (3.16%) developed SSI. In Non SSI group there were 504 males and 490 females.

.**Table 3: Distribution of subjects according to co-morbidities**

Co-morbidities	SSI Group		Non SSI Group		Total
	No.	%age	No.	%age	
Obesity	2	5.88	32	94.11	34
Alcoholism	8	5.44	139	94.55	147
Cardiovascular disorder	12	5.10	223	94.89	235
Any Coexistent infection	1	3.12	31	96.87	32
Total	23		425		448

Out of 1041 patients, 448 patients (43.03%) were having co morbidities while 593 patients (56.96%) were having no co morbidities. There were 34 obese patients, 147 patients were alcoholics, 235 patients had cardiovascular disorder while 32 patients had some coexistent infection elsewhere in the body. Out of 34 obese patients, 2 patients (5.88%) developed SSI. Out of 147 alcoholic patients, 8 patients (5.44%) developed SSI. Out of 235 patients who were suffering from cardiovascular disorder, 12 patients (5.10%) developed SSI. Out of 32 patients who had some co existent infection elsewhere in the body, 1 patient (3.12%) developed SSI

Table 4: Distribution of subjects according to preoperative use of antibiotics

Antibiotics	SSI Group		Non SSI Group		Total
	No.	%age	No.	%age	
No	26	4.08	611	95.91	637
Yes	21	5.19	383	94.80	404
Total	47		994		1041
Chi square: 0.715 ; p=0.3979 ; Not Significant					

In 637 patient's pre-operative antibiotics were not given, whereas in 404 patients, pre-operative antibiotics were given. Out of 404 patients who received antibiotics preoperatively, 21 patients (5.19%) developed SSI whereas out whereas 637 patients who did not receive pre-operative antibiotics, 26 patients (4.08%) developed SSI. In Non SSI group, 383 patients received antibiotics preoperatively whereas 611 patients did not receive pre-operative antibiotics.

Table 5: Distribution of subjects according to method used for hair removal

Methods	SSI Group		Non SSI Group		Total
	No.	%age	No.	%age	
Shaving	27	3.86	671	96.13	698
Clipping	20	11.83	149	88.16	169
Not done	-	-	174	100	174
Total	47		994		1041
Chi square: 16.840 ; p<0.0001 ; Significant					

In 698 patients shaving was done as a method of hair removal and In 169 patients clipping was done as method of hair removal. Out of 698 patients in whom shaving was done as a method of hair removal, 27 patients (3.86%) developed SSI while out of 169 patients in whom clipping was used as a method of hair removal, 20 patients (11.83%) developed SSI. In Non SSI group 671 patients shaving was used as a method of hair removal whereas in 149 patients clipping was used as a method of hair removal.

Table 6 : Distribution of subjects according to time of antibiotic prophylaxis given

Time	SSI Group		Non SSI Group		Total
	No.	%age	No.	%age	
More than 2 hrs prior surgery	7	2.82	241	97.17	248
0-2 hrs prior surgery	39	5.20	710	94.79	749
After skin incision	1	2.27	43	97.72	44
Total	47		994		1041
Chi square: 2.407 ; p=0.1208 ; Not significant					

Out of 749 patients in whom prophylactic antibiotics were given 0-2 hours prior to surgery, 39 patients (5.20%) developed SSI whereas out of 248 patients in whom prophylactic antibiotics were given more than 2 hours prior to surgery, 7 patients (2.82%) developed SSI. 44 patients got prophylactic antibiotic after skin incision and 1 patient (2.27%) among this group developed SSI.

Table 7 : Distribution of subjects according to Random Blood sugar

RBS	SSI Group		Non SSI Group		Total
	No.	%age	No.	%age	
Up to 200	33	5.51	565	94.48	598
>200	06	4.61	124	95.38	130
Not Done	8	2.55	305	97.44	313
Total	47		994		1041
Chi square: 0.172 ; p=0.6786 ; Not significant					

There were 598 patients who were having RBS up to 200 mg/dl, 130 patients were having RBS > 200 mg/dl and in 313 patients RBS was not done. Out of 598 patients who had RBS up to 200 mg/dl, 33 patients (5.51%) developed SSI whereas out of 130 patients who had RBS >200 mg/dl, 6 patients (4.61%). In Non SSI group, 565 Patients had RBS up to 200 mg/dl and 124 patients had RBS >200 mg/dl.

Table 8 : Distribution of subjects according to type of surgery done

Type of Surgery	SSI Group		Non SSI group		Total
	No.	%age	No.	%age	
Elective	29	4.03	689	95.96	718
Emergency	18	5.57	305	94.42	323
Total	47		994		1041
Chi square: 1.216 ; p=0.2702 ; Not Significant					

In 718 patients elective surgery was done whereas 323 patients underwent emergency surgery. Out of 718 patients who underwent elective surgery, 29 patients (4.03%) developed SSI whereas out of 323 patients who required emergency surgical intervention, 18 patients (5.57%) developed SSI. In Non SSI group, 689 Patients underwent elective surgery whereas 305 patients required emergency surgical intervention.

Table 9: Distribution of subjects according to type of wound

Type of Wound	SSI group		Non SSI group		Total
	No.	%age	No.	%age	
Contaminated	19	5.62	319	94.37	338
Dirty	9	4.61	186	95.38	195
Clean	16	4.03	381	95.96	397
Clean, Contaminated	3	2.70	108	97.29	111
Total	47		994		1041

There were 338 contaminated cases, 195 cases were dirty, 397 cases were clean and 111 cases were clean contaminated. Out of 338 cases which were contaminated, 19 patients (5.62%) developed SSI. Out of 195 dirty cases, SSI was seen in 9 cases (4.61%). Out of 397 clean cases, 16 cases (4.03%) developed SSI and out of 111 clean contaminated cases 3 cases (2.70%) developed SSI. In Non SSI group, 319 patients underwent contaminated surgery, 186 patients underwent dirty surgery. 381 Patients underwent clean surgery and 108 patients underwent clean contaminated surgery.

Table 10 : Distribution of subjects according to duration of surgery

Duration of Surgery (hrs)	SSI Group		Non SSI group		Total
	No.	%age	No.	%age	
Up to 2	11	2.11	508	97.88	519
>2	34	6.53	486	93.46	520
Not Mentioned	2	100	-	-	2
Total	47		994		1041
Chi square: 12.242 ; p=0.0005 ; Significant					

In 520 patients duration of procedure was more than 2 hours while in 519 patients duration of operation was up to 2 hours. Out of 520 patients in whom duration of procedure was more than 2 hours, 34 patients (6.53%) patients developed SSI. Out of 519 patients in whom duration of operation was up to 2 hours, 11 patients (2.11%) developed SSI. In Non SSI group, In 486 patients, duration of procedure was more than 2 hours whereas in 508 patients, duration of operation was up to 2 hours.

Table 11: Distribution of subjects according to time of detection of wound infection (n=47)

Time of Detection (days)	No.	%age
Up to 6	28	59.57
>6	19	40.43
Mean	6.47	
SD	4.02	

In 28 patients (59.57%), wound infection was detected within 6 postoperative days whereas in 19 patients (40.43%) wound infection was detected after 6 postoperative days. Mean time of detection of wound infection was 6.47 days with SD of 4.02.

Table 12: Distribution of subjects according to grade of wound infection (n=47)

Grade of Infection	No.	%age
Incisional Superficial	37	78.72
Incisional deep	9	19.15
Organ space related	1	2.13

Out of 47 patients 37 patients (78.72%) developed Incisional Superficial SSI whereas 9 patients (19.15%) developed Incisional deep SSI and 1 patient (2.13%) developed Organ space related SSI.

Table 13: Distribution of subjects according to the organism grown (N=27)

Oragnism	No.	%age
Escherichia Coli	15	55.56
Staphylococcus aureus	4	14.81
Acinetobacter baumanni	2	7.41
Enterococcus feacalis	2	7.41
Enterobacter aerogenes	2	7.41
Candida Albicans	1	3.70
Klebsiella Pneumoniae	1	3.70

In our study, Escherichia coli (*E. coli*) was the commonest (55.56%) isolate for the postoperative wound infections. Staphylococcus aureus was the second most common (14.81%) isolate. Acinetobacter baumanni, Enterococcus feacalis, Enterobacter aerogenes were seen in 2 wounds each (7.41%).

DISCUSSION

Postoperative Surgical site infections remain a major source of illness and a less frequent cause of death in the surgical patient. Since SSIs are a universal problem which increase the mortality and morbidity of surgical patients, a thorough knowledge of this subject is essential for a surgeon. The present study is focused on incidence and spectrum of the problem in a healthcare institution so as to reduce the incidence of this problem in our institution and the burden borne by the patient as well as to sensitize the health care professionals to this problem. In this one year study, out of 1041 surgeries performed, 47 patients (4.51%) developed surgical site infection. 37 patients (78.72%) developed Superficial Incisional SSI. 9 patients (19.15%) developed Deep Incisional SSI and 1 patient (2.13%) developed Organ space related SSI. Patients were divided into two arms (SSI group and Non SSI group) on the basis of development of surgical site infection. Patients who developed SSI were clubbed together in SSI group and those who did not develop SSI following surgery were put in Non SSI group.

Age has been found to be a predictor for developing surgical site infections. One prospective observational study using logistic regression to analyze data collected from 142 medical centers identified age as an independent risk factor for SSI.[42] Of 163624 patients who were included in the study, 7035 developed SSI within 30 days of surgery. Patients aged over 40 had a statistically significantly increased risk of developing SSI compared with those less than 40 years. In past studies, males have been reported to have a higher risk of developing wound infections.[90-92] in our study there were 535 males and 506 females in this study. The reason for this disadvantage is not entirely clear. One of the possible confounders may be smoking. Because most smokers from the studied generations tended to be male, the effect of gender may be confounded with the effect of smoking on tissue repair. In our study, all the patients received prophylactic antibiotic dosage. Antibiotic Prophylaxis in clean operations has been shown of value in the areas of surgery such as trauma[66] and vascular surgery[34,35] whereas two trials showed no significant decrease in wound infections with intravenous antibiotic prophylaxis in case of clean surgery like hernia repair.[67,87] Antibiotic prophylaxis is most effective in preventing surgical site infections when administered 0 to 2 hours before the start of surgery Our study showed that development of SSI does not depend upon the time of administration of antibiotic prophylaxis. Surgical wound classification has long been established as an important predictor of the postoperative surgical

site infections. Since the introduction of routine prophylactic antibiotic use, infection rates in the most contaminated groups have reduced drastically. Infection rates in US National Nosocomial Infection Surveillance (NNIS) system hospitals were reported to be: clean 2.1%, clean-contaminated 3.3%, contaminated 6.4% and dirty 7.1%.[32] In our study, Out of 338 cases which were contaminated, 19 patients (5.62%) developed SSI. Out of 195 dirty cases, SSI was seen in 9 cases (4.61%). Out of 397 clean cases, 16 cases (4.03%) developed SSI and out of 111 clean contaminated cases 3 cases (2.70%) developed SSI. In Non SSI group, 319 cases (34.00%) were contaminated, 186 cases (18.71%) were dirty, 381 cases (38.33%) were clean and 108 cases (10.86%) were clean contaminated. There was increased incidence of developing SSI in contaminated cases as compared to dirty, clean and clean-contaminated cases but the difference was not statistically significant. In our study, in 27 patients (57.45 %) there was positive growth seen. Whereas in 14 patients (29.79%) no organism growth was seen. In general, *S. aureus*, coagulase-negative staphylococci, *Enterococcus* species and *Escherichia coli* (*E.coli*) are the most frequently isolated pathogens in SSIs and the presence of each is determined primarily by the anatomical location and inherent contamination of the surgical site.[38] Entry into hollow viscera exposes surrounding tissue to gram-negative bacilli such as *Escherichia coli*, gram-positive organisms such as enterococcus, and, occasionally, anaerobes such as *Bacillus fragilis.*[16] *In our study, Escherichia coli* (*E. coli*) was the commonest (55.56%) isolate for the postoperative wound infections. Staphylococcus aureus was the second most common (14.81%) isolate. Acenitobacter baumanni, Enterococcus feacalis, Enterobacter aerogenes were seen in 2 wounds each (7.41%). E.coli being the most common isolate can be attributed to the fact that most of the surgeries involved the gut.

Surgical site infection has been a burden on the patient in addition to the trauma incurred by the surgical procedure. Therefore it becomes very necessary for the health professionals to be aware of the predictors of surgical site infections as well as the appropriate methods to prevent these infections.

CONCLUSIONS

To conclude, it was found that males are more prone to develop surgical site infection. The Length of preoperative hospitalization of more than 1 day was found to have direct relation with developing SSI There was increased incidence of SSI in the patients in whom post-operative hospitalization was > 7 days , who had serum albumin < 3.5 g/dl , in whom duration of surgery was >2 hours , in whom open drain was used , in whom pre-operative Shaving as a method of hair removal is used and in patients getting Post-operative antibiotics for < 10 days than in patients getting post-operative antibiotics for more than 10 days. *Escherichia coli* (*E. coli*) was the commonest isolate for the postoperative wound infections.

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