Original Article

Study of surgical site infections in a Tertiary Care Hospital in a rural area of North India

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Abstract

Surgical site infections are those infections that occur within 30 days of surgery (within a year in case of implants). The present prospective study was undertaken to estimate the incidence and pattern of SSIs, in our hospital, in the Department of General Surgery and to determine the frequencies of various pathogens causing SSIs along with various factors which influence SSIs, as the problem of SSIs remains largely unexplored with lack of adequate data for future comparisons, particularly in a rural setup. Hence in the larger interest of benefiting patient care, this study was taken up in the Gian Sagar Medical College and Hospital located in village Ram Nagar, (District Patiala), which is a teaching hospital providing tertiary level medical care in a rural background of Punjab, Northern India. It was concluded that surgical site infections have always been a major complication of surgery and trauma. Various factors like old age, prolonged hospital stay, prolonged operating time, prolonged drainage, emergency surgery, the wound class and wound contamination predispose to wound infection. Antimicrobial prophylaxis although effective in reducing the incidence of surgical site infections, should be used timely and cautiously to prevent resistance.

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Introduction

The CDC (Center for Disease Control and Prevention) definition of SSIs state that only those infections that are occurring within 30 days of surgery (or within a year in case of implants) should be classified as SSIs and also the infection should appear to be related to the operation [1-4]. SSI's are the third most frequently reported nosocomial infections, accounting for 14-16% of all the infections [4]. SSIs are further classified as being either incisional or organ/space infections. Incisional SSIs are further divided into superficial and deep incisional SSIs.

A system of classification for operative wounds that is based on degree of microbial contamination was developed by the U.S. National Research Council group in 1964 [5]. Four wound classes with an increasing risk of SSIs were described: clean, clean-contaminated, contaminated and dirty. Since the introduction of routine prophylactic antibiotic use, infection rates in the most contaminated groups have reduced drastically. Infection rates in the U.S. 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% [6].

However, studies in India have consistently shown higher rates of SSIs ranging from 4-30% [7-10]. This variability in estimates is consistent with the differences in the characteristics of the hospital populations, the underlying diseases, differences in clinical procedures, the extent of the infection control measures and also, the hospital environment.

Further, infection with multidrug resistant organisms constitutes a serious threat to surgical patients. It has been observed that failure of hospital hygiene/aseptic measures and overuse of antibiotics is responsible for high antimicrobial resistance amongst pathogens. Hence, judicious use of prophylactic and therapeutic antibiotics along with adherence to basic principles of asepsis and sterilization is very important to reduce the burden of surgical site infections.

The present prospective study was undertaken as the problem of SSIs remains largely unexplored with lack of adequate data for future comparisons, particularly in a rural setup. Hence in the larger interest of benefiting patient care, this study was taken up in the Gian Sagar Medical College and Hospital, Ram Nagar, District Patiala, which is a teaching hospital providing tertiary level medical care in a rural background of Punjab, Northern India.

Aims and Objectives

1. To estimate the incidence and pattern of SSIs, in our hospital, in the Department of General Surgery.
2. To determine the frequencies of various pathogens causing SSIs with their antibiotic resistance patterns.
3. To study the various factors which influence SSIs.

Materials and Methods

The present prospective study was conducted in the Department of General Surgery, Gian Sagar Medical College and Hospital (GSMCH), Ramnagar, District Patiala (Punjab) for a period of six months on all the patients who underwent surgical procedures during this period.

A detailed history regarding the personal particulars of the patients, associated co-morbid conditions, the type of surgery (emergency/elective), pre and post operative hospital stay, duration of surgery, order of surgery, presence of surgical drain and its duration were recorded in Proforma.

The CDC criteria were used for defining the type of surgical wounds as clean (Class I), clean contaminated (Class II), Contaminated (Class III) and dirty (Class IV) [3-4].

The cumulative incidence of SSIs was expressed as infection rate – the number of patients with SSIs per 100 operated patients. SSI rates for all the four categories were also determined.

Samples in the form of swabs were collected aseptically at the time of the first dressing, 8-10 days and then 2-4 weeks after the surgery from the wounds having serous or purulent discharge, showing signs of inflammation or from the wounds that dehisced spontaneously.

All the samples were processed aerobically and anaerobically, as soon as possible. One of the swabs was used to make smear and Gram's staining was done to ascertain the morphological form of bacteria present. The other swab was cultured on blood agar and MacConkey's agar. The etiological agents were identified by their morphological and biochemical characteristics. Antibiotic sensitivity of the isolates was done by the modified Stoke's Disc diffusion method and antibiotic sensitivity patterns were observed, analyzed and recorded. Patients were followed up for a period of thirty days after the surgical procedure.

The observations were recorded and all results were tabulated and analyzed by using Student *t*-test for age, duration of hospital stay, elective versus emergency surgery, wound classification (CDC criteria), drainage, order and duration of surgery.

Result

A total of 1498 patients – Elective 1332 (88.92%) and emergency 166 (11.08%) were operated in the Department of General Surgery over the study period of six months. The cumulative infection rate was 8.67% as 130 patients developed SSIs out of a total of 1498 patients.

Age and Sex

In the present study, 690 (46.1%) were male and 808 (53.9%) were female patients. The male patients developing SSI were 58 (8.4%) and the number of female patients who developed SSI was 72 (8.91%). No statistically significant difference was observed in rates of SSIs amongst male or female patients in the present study (P>0.05). However, the incidence of SSIs was found to increase significantly (P<0.01) with increase in age group of patients. The incidence of SSI was found to be more than 4 times in patients aged >56 years as compared to the patients between age group 16.25 years (Table 1).

Table 1: Age distribution

Age group (years)	No. of patients (n=1498)	No. of SSIs observed
16-25	286	12 (4.19%)
26-35	366	20 (5.46%)
36-45	356	30 (8.42%)
46-55	322	39 (12.11%)
>56	168	29 (17.26%)

(Patients <15 years of age were not included) P < 0.001 highly significant (t=6.7093; df = 7; standard error of difference = 40.891)

Duration of Hospital Stay

Length of pre and post operative hospital stay was also studied. Duration of pre-operative hospitalization was considered only for elective surgeries. As the duration of hospital stay increased, the rate of SSIs also increased. Patients with pre-operative hospital stay of >7 days had more than 4 times incidence of SSIs as compared to those having a stay of 1 day however the results were not statistically significant (P>0.05) (Table 2).

Table 2: Pre operative hospital stay

Hospital stay	No. of patients (n=1332)	No. of SSIs
1 day	712	30 (4.21%)
1-7 days	524	36 (6.87%)
>7 days	96	18 (18.75%)

P > 0.005 Non significant (t=1.7466; df = 3; standard error of difference = 235.317)

On the other hand, patients having post operative hospital stay of >10 days had almost 5 times incidence of SSI compared with those of <2 days and the results were statistically significant (P<0.05) (Table 3).

Table 3: Post operative hospital stay

Length of stay	No. of patients	No. of SSIs
< 2 days	484	16 (3.3%)
3-5 days	406	30 (7.39%)
6-10 days	366	46 (12.57%)
>10 days	242	38 (15.7%)

P > 0.05 statistically very significant (t=5.6191; df = 5; standard error of difference = 59.885)

Elective v/s Emergency and CDC Criteria

Incidence of SSI was also found to be more in emergency surgeries 46 (27.7%) as compared to routine/elective surgeries 84 (6.3%). The incidence of SSI was also found to increase from clean to dirty wounds however, the results were not statistically significant (P>0.05) (Table 4).

Table 4: Incidence of SSI as per the CDC Criteria of Classification of Surgical Wounds

	Total No. of surgeries (n=1498)	No. of SSIs (n=130)
Clean	928	33 (3.56%)
Clean contaminated	376	36 (9.58%)
Contaminated	136	30 (22.06%)
Dirty	58	31 (53.45%)

P > 0.005 Not significant (t=1.4687; df = 5; standard error of difference = 232.525)

Table 5: Surgical site infection according to surgical procedures in elective surgeries

Hospital stay	Total no. of surgeries (1332)	No. of SSIs (n=84)
Laparoscopic cholecystectomy	468	8 (1.7%)
Open cholecystectomy	88	10 (11.36%)
Mesh hernioplasty	228	9 (3.95%)
Minor excisions (Lipomas, Cyst, Lymph Nodes etc)	96	7 (7.29%)
Internal appendectomy	58	6 (10.35%)
Open pyelolithotomy	72	6 (8.33%)
Open ureterolithotomy	34	2 (5.88%)
Open cystolithotomy	22	1 (4.55%)
Pilonoidal sinus excision	22	8 (36.36%)
Anal procedures (Hemarrhoidectomy, Fistulectomy)	88	14 (15.91%)
Thyroidectomy	28	1 (5.56%)
Breast surgeries (Mastectomy, Fibroadenoma excision)	18	1 (8.34%)
Hemicolectomy	12	2 (20%)
Gastrectomy	10	8 (9.09%)
Miscellaneous surgeries; nephrectomy, Open prostectomy	88	

Surgical site infection according to different surgical procedures was also studied for 1332 patients who underwent elective surgery (Table 5) as well as for the patients who underwent emergency surgery.

Amongst the 166 emergency surgeries performed, 94 were exploratory laparotomy, SSI in 24 (25.53%); 72

were appendectomy, SSI in 22 (30.55%). Incision and drainage for abscesses and debridement/amputation done in emergency were excluded from this category since these were considered to be dirty surgeries.

Various co-morbidities were also observed in our patients. Of the 130 patients, who developed SSIs, 38 (29.23%) were diabetic (DM type II) and a total of 10 (26.31%) diabetic patients who entered in our study developed SSIs; 28 (21.54%) patients who developed SSIs had co-existent Chronic obstructive pulmonary disease (COPD); 22 (16.92%) patients who developed SSIs had co-existent Ischemic Heart Disease (IHD)/Hypertension; 42 (32.31%) patients developed SSIs without any pre-existing co-morbid condition.

Duration and Order of Surgery

There was also statistically significant increased incidence of SSI with prolonged duration of surgery (P<0.01) (Table 6) and increasing order of surgery (P<0.05) (Table 7). The incidence of infection rates with increasing order of surgeries (sequence in which the operations were undertaken during an elective operative session) was considered only for the elective/routine surgeries and not for emergency surgeries.

Table 6: Duration of surgery

Duration of surgery	Total No. of surgeries (n=1498)	No. of SSIs (n=130)
< 1 hour	402	14 (3.48%)
1-2 hours	504	36 (7.14%)
> 2 hours	592	80 (13.51%)

P < 0.05 Significant (t=6.6484; df = 3; standard error of difference = 71.346)

Table 7: Order of surgery

Order of surgery in elective	Total No. of surgeries (n=1332)	No. of SSIs (n=84)
First	406	22 (5.42%)
Second	388	23 (5.93%)
Third	336	23 (6.85%)
> Third	202	16 (7.92%)

P < 0.05 Significant (t=5.6869; df = 5; standard error of difference = 54.570)

Drainage

Post operative drains were placed in 268 (17.89%) patients, of which 58 (21.64%) patients developed SSIs. Drains were not placed in 1230 (82.1%) patients, of which 72 (5.85%) patients developed SSIs. Hence patients with post operative drains were more likely to develop SSIs compared to those in whom drains were not placed. Further the incidence of SSI exceeded more than 5 times for patients in whom drains were kept for >7 days as compared to the patients with drainage of 1-3 days (Table 8). The results so observed were found to be statistically significant (P<0.05).

Table 8: Duration of drainage

Duration of drain	No. of patients (n=268)	No. of SSIs (n=58)
1-3 days	98	11 (11.22%)
4-7 days	132	27 (20.46%)
> 7 days	38	20 (52.63%)

P < 0.05 Significant (t=1.9552; df = 3; standard error of difference = 35.973)

Culture and Sensitivity Results

A single etiological agent was identified and isolated in all the 130 cases of SSIs amongst our 1498 surgeries. The most commonly isolated organism was Staphylococcus aureus in 42 (32.3%) patients followed by E.coli in 32 (23.84%), Enterococcus fecalis in 27 (20.77%), Pseudomonas aeruginosa 19 (14.61%), Klebsiella in 9 (6.93%) and Proteus in 2 (1.54%) patients.

Gram Negative Bacteria was found in 61 (46.93%) isolates and Gram positive bacteria was found in 69 (53.07%) isolates. Many of the bacteria isolated were multidrug resistant but none were found to be resistant to all the antibiotics, for which tests were done (Table 9).

Table 9: Antibiotic sensitivity analysis

Isolates	Total no. n=130	Resistant to cefeperazone/ Sulbactum	Resistant to ciprofloxacin	Resistant to amikacin
Staph aureus	42	18 (42.86%)	25 (59.52%)	9 (21.43%)
Entero-cocci	27	14 (51.85%)	11 (40.74%)	6 (22.23%)
E. coli	31	9 (29.03%)	12 (38.71%)	5 (16.13%)
Pseudo-monas	19	7 (36.84%)	11 (57.89%)	4 (21.05%)
Klebsiella	9	1 (11.11%)	5 (55.56%)	0 (0.00)
Proteus	2	0 (0.00)	1 (50.00%)	0 (0.00)

Discussion

The prevalence rate of surgical site infections, though preventable, is high. Different studies from India done at different places have shown SSI rates to vary from 6.09% to 38.7% [1-2, 9, 12).

Studies by Agarwal *et al* [7], Surange *et al* [8], Anvikar *et al* [9], Umesh SK et *al* [10] have shown SSI rates in India to be between 4-30%.

The infection rates in Indian hospitals are much higher than those in the US and European countries (0.5% to 15%) [6,11]. The higher infection rates in Indian hospitals is mainly due to the poor set up of our hospitals and due to lack of adequate attention towards basic infection control measures.

We observed a significantly increasing incidence of SSI with the increasing age of patients. Other similar studies have also shown the SSI rate to increase with an increase in the age of patients (10, 12-15). The SSI rate in our hospital was 8.67%. This marginally lower rate in our hospital compared with other hospital studies is probably due to the new set up of our hospital with better infection control practices and also due to higher proportion of clean and elective surgeries included in our study.

Emergency surgeries were more likely to be associated with higher incidence of SSI in various studies done worldwide. The incidence of SSIs in our study was more in emergency surgeries (27.7%) as compared to routine/elective surgeries (6.3%). Mahesh CB *et al* [12] also observed a similar SSI rate of 21.05% in emergency surgeries as compared to 7.61% of cases in elective surgeries. The higher rates of infections in emergency surgeries can be attributed to higher incidence of contaminated/dirty wounds in emergency surgeries, underlying severe illness which predisposed to emergency surgery, co-morbid conditions which could not be properly managed due to emergent patient condition and inadequate pre operative preparation of patient. Clean surgeries like mesh hernioplasty for hernia repair and uncomplicated laparoscopic cholecystectomy are associated with lower SSI rates compared with dirty surgeries like surgery for pilonidal sinus, exploratory laparotomy for perforated viscera and anal procedures [10, 12].

Higher incidence of SSIs associated with a longer stay in the hospital reflected not only the severity of illness and co-morbid conditions but could also be due to increased colonization of patients with nosocomial strains existing in the hospital. Our findings were comparable to those of Umesh SK *et al* [10] who found that the mean duration of post operative stay in patients with SSI was 9 days. The patients with post operative stay of more than 9 days were five times more likely to develop SSI. Anvikar *et al* [9] demonstrated that preoperative hospital stay predisposed an individual to 1.76% risk of acquiring an infection. With an increase in pre operative stay, the risk increased proportionally. A pre operative stay of one week increased the risk rate to 5%.

The factors which are responsible for the increase in SSIs with increasing order of the elective surgery are excessive contamination of OT after the earlier operations during the day, scheduling of contaminated surgeries towards the end of operative session, decline in aseptic measures at the end of the day and onset of fatigue of operating surgical team. A statistically significant association between the rates of SSIs and the order of the operation and the duration of the operation has been reported by several studies, including one by Mahesh CB *et al* [12].

Our study reflected increase in incidence of SSI (3.6 times) with increased duration of drainage. Umesh SK *et al*, [10] in their study also observed that patients with post operative drains were 5.8 times more likely to develop SSIs compared to those without drains. This increased incidence of SSIs with increasing duration of post operative drains is attributable to not only nature of operation necessitating the drainage but also the drain itself acting as portal of entry for infection.

Co-morbidities like diabetes and COPD have been observed to be significant risk factors for SSI compared with patients without co-morbidities in the literature. Suchitra and Lakshmidevi, [13] have reported diabetes/diabetic status as a significant risk factor for SSI. They also observed the most commonly isolated organism from SSIs as staphylococcus aureus followed by enterococcus and other bacteria. Most of the organisms located were multidrug resistant in our study, including Methicillin-resistant Staphylococcus aureus (MRSA) and Vancomycin-resistant enterococcus (VRE) species. Isolation of multidrug resistant organisms underscores the need for an evidence-based antibiotic prescription policy that could promote a more rational use of antibiotics along with intensive infection control practices in the hospital.

Conclusion

Surgical infections particularly, surgical site infections, have always been a major complication of surgery and trauma. Old age, prolonged hospital stay, prolonged operating time, order of surgery, prolonged drainage, emergency surgery, the wound class and wound contamination predispose to wound infection. Antimicrobial prophylaxis although effective in reducing the incidence of surgical site infection, should be used timely and cautiously to prevent resistance. Slightly low incidence of SSIs in our study may be attributed to the newer setup and better infection control practices though it must be concluded that more stringent aseptic measures including rational antibiotic policy will be contributory in lowering the SSI rate further.

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Competing Interests

None declared.

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