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ORIGINAL ARTICLE

Surgical Site Infections in a Rural Teaching Hospital of North India

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ABSTRACT

Aims and objectives: Surgical site infections (SSIs) are one of the most important causes of health care-associated infections. Understanding SSI reduces the social and economic burden of a hospital and society. In this context, we evaluated the various aspects of SSI in our institution, Rohilkhand Medical College & Hospital (RMCH), which is a tertiary care teaching hospital in rural Uttar Pradesh in North India.

Materials and methods: This prospective study was conducted in the Department of General Surgery, RMCH, Bareilly, Uttar Pradesh, India. A total number of 1,498 patients admitted for surgical procedures with effect from November 1, 2016 to December 31, 2016, formed the subjects of the present study. All operated cases during the above period, including major and minor, emergency and elective, laparoscopic and open procedures were included in the present study. Data so obtained were analyzed statistically. The Centers for Disease Control and Prevention, USA criteria were used for defining the wound. Sample swabs were collected from the first dressing and up to 2 to 4 weeks postoperatively. Samples were processed for aerobic and anaerobic flora, and the antibiotic sensitivity of the isolates was also performed.

Results and discussion: The SSI rate in the present study was 8.67%. Significantly higher incidence of SSI was detected with increasing age. The SSI rate in case of emergency surgeries was more (27.7%) as compared with routine/elective surgeries (6.3%). The higher incidence (18.75%) of SSI was detected in patients having preoperative hospital stay of more than 7 days, and the maximum incidence (15.7%) was observed in patients having longer postoperative hospital stay of more than 10 days. Dirty wounds had the highest incidence of SSI (53.45%). The incidence of SSI increased with duration of surgery, order of surgery, and with the increasing duration of postoperative drains. *Staphylococcus aureus* was the commonest isolate (32.30%) followed by *Escherichia coli* (39%).

Conclusion: Though the incidence of SSI in the present study was slightly low as compared with similar reports from other institutions of the country, more rational antibiotic policy and more stringent infection control measures are needed.

Keywords: Centers for disease control and prevention criteria, Hospital stay, Surgical drains, Surgical site infections.

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INTRODUCTION

The Centers for Disease Control and Prevention's (CDC) definition of surgical site infections (SSIs) states that infections occurring only 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] The SSIs are the third most frequently reported nosocomial infections, accounting for 14 to 16% of all the infections,[4] The 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, i.e., based on degree of microbial contamination was developed by the US National Research Council group in 1964.[5] Four classes of wounds, with an increasing risk of SSIs, were described, i.e., clean, clean–contaminated, contaminated, and dirty. Since the introduction of routine prophylactic antibiotic use, infection rates in the most contaminated group have reduced drastically. Infection rates in the US National Nosocomial infection surveillance system hospitals were reported to be clean (2.1%), clean–contaminated (3.3%), contaminated (6.4%), and dirty (7.1%).[6] However, Indian studies consistently show higher rates of SSIs ranging from 4.2 to 30%.[5-9] 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 are responsible for high antimicrobial resistance among pathogens.

AIMS AND OBJECTIVES

The present prospective study was undertaken, as the problem of SSIs remains largely unexplored with lack in adequate basic data for future comparisons, particularly in a tertiary care teaching hospital in a rural setup of North India. Hence, in the larger interest of benefiting patient care, this study was taken up in Rohilkhand Medical College & Hospital (RMCH), Bareilly, Uttar Pradesh, India, which is a teaching hospital providing tertiary level medical care in a rural background of western Uttar Pradesh, North India, with the following objectives:

- To estimate the incidence and pattern of SSIs in this tertiary care rural teaching hospital in the Department of General Surgery.
- To study the various factors that influence SSIs.
- To evaluate the frequencies of various pathogens causing SSIs with their antibiotic resistance patterns.

MATERIALS AND METHODS

The present prospective study was conducted in the Department of General Surgery, RMCH, Bareilly, Uttar Pradesh, India, from November 1, 2016 to December 31, 2016, on all the patients who underwent surgical procedures during this period. The detailed history regarding the personal particulars of the patients, associated comorbid conditions, the type of surgery (emergency/elective), pre- and postoperative hospital stay, duration of surgery, order of surgery, presence of surgical drain and its duration were recorded in the individual 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. The 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 to 10 days and then 2 to 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. One of the swabs was used to make smears, 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 Stokes' disk diffusion method, and antibiotic sensitivity patterns were observed, analyzed, and recorded. Patients were followed up for a period of 30 days after the surgical procedure. The observations were recorded; all the results were tabulated and analyzed by using student's t-test for age, duration of hospital stay, elective *vs* emergency surgery, wound classification (CDC criteria), drainage, order, and duration of surgery.

RESULTS AND DISCUSSION

Elective surgery was performed in 1,332 (88.92%) and emergency surgery in 166 (11.08%) patients. A total of 1,498 patients were operated in the Department of General Surgery over the study period. The cumulative infection rate was 8.67% as 130 patients developed SSIs out of a total of 1,498 patients.

Age and Sex

In the present study, 690 (46.1%) were male and 808 (53.9%) were female patients. The male patients who developed 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 the rates of SSIs among 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 four times in patients aged >56 years as compared with the patients between age group 16 and 25 years (Table 1). The results are consistent with the available literature.[10]

Duration of Hospital Stay

Period of pre- as well as postoperative hospital stay were also studied. Duration of preoperative hospital stay was considered only for elective surgeries for obvious reasons. As the duration of hospital stay increased, the rate of SSIs also increased. Patients with preoperative hospital stay of >7 days had more than four times incidence of SSI as compared with those having hospital stay of 1 day; however, the results were not statistically significant ($p > 0.05$) (Table 2). On the contrary, patients having postoperative hospital stay of >10 days had almost five times incidence

Table 1: Age distribution

Age group (years)	*No. of patients (n = 1,498)*	*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)

Table 2: Preoperative hospital stay

Length of stay (days)	*No. of patients (n = 1,332)*	*No. of SSIs*
1	712	30 (4.21%)
1–7	524	36 (6.87%)
>7	96	18 (18.75%)

$p > 0.05$, not significant ($t = 1.7466$; $df = 3$; Standard error of difference = 235.317)

Table 3: Postoperative hospital stay

Length of stay (days)	*No. of patients (n =1,498)*	*No. of SSIs noted (n = 130)*
<2	484	16 (3.3%)
3–5	406	30 (7.39%)
6–10	366	46 (12.57%)
>10	242	38 (15.7%)

$p < 0.05$, very statistically significant (t = 5.6191; df = 5; Standard error of difference = 59.885)

Table 4: Incidence of SSI as per the CDC criteria of classification of surgical wounds

	Total no. of surgeries (n = 1,498)	*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

	Total no. of surgeries (n = 1,332)	*No. of SSIs (n = 84)*
Laparoscopic cholecystectomy	468	8 (1.7%)
Open cholecystectomy	88	10 (11.36%)
Mesh hernioplasty	228	9 (3.95%)
Minor excision-cyst		
Lipomas, lymph nodes, etc.	96	7 (7.29%)
Interval appendectomy	58	6 (10.35%)
Open pyelolithotomy	72	6 (8.33%)
Open ureterolithotomy	34	2 (5.88%)
Open cystolithotomy	22	1 (4.55%)
Pilonidal sinus excision	22	8 (36.36%)
Anal procedures – hemorrhoidectomy, fistulectomy	88	14 (15.91%)
Thyroidectomy	28	1 (3.57%)
Breast surgeries –		
mastectomy fibroadenoma excision	18	1 (5.56%)
Hemicolectomy	12	1 (8.34%)
Gastrectomy	10	2 (20%)
Miscellaneous surgeries – nephrectomy open prostatectomy	88	8 (9.09%)

Table 6: Incidence of comorbidities

Comorbidities	*Total no. (n = 130)*	*%*
Diabetes	38	29.23%
COPD	28	21.54%
IHD and Hypertension	22	16.92%
No comorbidities	42	32.31%

of SSI compared with those of hospital stay of <2 days, and the results were statistically significant ($p < 0.05$) (Table 3). Can we ascribe it to the increased chances of hospital-acquired infections in these patients having longer stay? It is also understandable that patients whose postoperative hospital stay was longer, obviously had more morbidity, as complications and comorbid conditions were seen more in these patients.

Elective *vs* Emergency Surgery and CDC Criteria

Incidence of SSIs was also found to be more in emergency surgeries [46 (27.7%)], as compared with routine/elective surgeries [84 (6.3%)]. The incidence of SSI also increased from clean to dirty wounds; however, the results were not statistically significant ($p > 0.05$) (Table 4). A total of 1,332 (88.91%) patients underwent elective surgery, whereas 166 patients (11.09%) underwent emergency surgery (Table 5). Among the 166 emergency surgeries performed, 94 were exploratory laparotomies, and SSI was observed in 24 (25.53%) of these patients. Number of patients who underwent emergency appendectomies was 72, and out of these, 22 (30.55%) patients developed SSI. Incision and drainage of abscesses and debridement/amputation done in emergency were excluded from this category, since these were considered to be dirty surgeries.

Various comorbidities were also found and studied in our patients (Table 6). Of the 130 patients who developed SSIs, 38 (29.23%) were diabetic (diabetes mellitus type II). A total of 10 (26.31%) diabetic patients who entered in our study developed SSIs; 28 (21.54%) patients who developed SSIs had coexistent chronic obstructive pulmonary disease (COPD); 22 (16.92%) patients who developed SSIs had coexisting ischemic heart disease (IHD)/hypertension. Only 42 (32.31%) patients having no comorbid conditions developed SSI.

Duration and Order of Surgery

There was a statistically significant increased incidence ($p < 0.01$) of SSI in patients having longer duration of surgery ($p < 0.01$) (Table 7) and increasing order of surgery ($p < 0.05$) (Table 8). 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 the emergency surgeries, for the obvious reasons.

Table 7: Duration of surgery

Duration of surgery (hours)		
<1	402	14 (3.48%)
1–2	504	36 (7.14%)
>2	592	80 (13.51%)

$p < 0.05$, significant (t = 6.6484; df = 3; Standard error of difference = 71.346)

Table 8: Order of surgery

Order of surgery in elective OT	*Total no. of surgeries (n = 1,332)*	*Total no. of (n = 84)*
First	406	22 (5.42%)
Second	388	23 (6.85%)
Third	336	23 (6.85%)
>Third	202	16 (7.92%)

$p < 0.05$, significant (t = 5.6869; Standard error of difference = 54.570)

Table 9: Duration of drainage

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

$p < 0.05$, significant (t = 1.9552; df = 3; Standard error of difference = 35.973)

Table 10: Antibiotic sensitivity analysis

Isolates	*Total no. (n = 130)*	*Resistant to cefoperazone/ sulbactum*	*Resistant to ciprofloxacin*	*Resistant to amikacin*
S. aureus	42	18 (42.86%)	25 (59.52%)	9 (21.43%)
Enterococci	27	14 (51.85%)	11 (40.74%)	6 (22.23%)
E. coli	31	9 (29.03%)	12 (38.71%)	5 (16.13%)
Pseudomonas	19	7 (36.84%)	11 (57.89%)	4 (21.05%)
Klebsiella	9	1 (11.11%)	5 (55.56%)	0 (–)
Proteus	2	0 (–)	1 (50%)	0 (–)

Postoperative Drains

Postoperative drains were placed in 268 (17.89%) patients, of which 58 (21.64%) patients developed SSIs. Drains were not placed in 1,230 (82.1%) patients, of which 72 (5.85%) patients developed SSIs. Hence, patients with postoperative drains developed more SSIs compared with those in whom drains were not placed. Further, the incidence of SSI exceeded more than five times for patients in whom drains were kept for >7 days as compared with the patients with drainage for 1 to 3 days (Table 9). The results so observed were found to be statistically significant ($p < 0.05$), and one of the plausible reasons could be the drain acting itself as a cause of infection.

Culture and Sensitivity

A single etiological agent was identified and isolated in all the 130 cases of SSIs among a total number of 1,498 surgeries. The most commonly isolated organisms was *Staphylococcus aureus* in 42 (32.3%) patients followed by *Escherichia coli* in 31 (23.84%), *Enterococcus faecalis* in 27 (20.77%), *Pseudomonas aeruginosa* in 19 (14.61%), *Klebsiella* in 9 (6.93%), and *Proteus* in 2 (1.54%) patients (Table 10). Gram-negative bacteria were found in 61 (46.93%) isolates and Gram-positive bacteria were found in 69 (53.07%) isolates. Many of the bacteria isolated were multidrug resistant, but none was found to be resistant to all the antibiotics, for which tests were done (Table 10).

The prevalence rate of SSIs, though preventable, is yet quite high. Different studies from India done at different places have shown SSI rates to vary from 4 to 30%.[1,2,7-9,11-13] The SSI rates in Indian hospitals are much higher than those in the US and European countries (0.5–15%).[14,15] The higher infection rates in some Indian hospitals may be mainly due to the not very good setup of these hospitals and the inadequate attention toward basic infection control measures, including lack of ethical antibiotic policy of individual hospitals. We observed a significantly increasing incidence of SSI with the increasing age of patients, which is consistent with the other available reports from the country.[8,10,14-17] The SSI rate in this hospital, in the present series, was 8.67%. This marginally lower rate in our hospital compared with studies from other Indian hospitals may be due to the better setup and better and strict infection control practices being followed in this hospital. This could also be due to higher proportion of clean and elective surgeries in the present study.

Emergency surgeries are associated with higher incidence of SSIs in various studies done worldwide. Similarly, the incidence of SSIs in our study was more in emergency surgeries (27.7%) as compared with routine/elective surgeries (6.3%). Mahesh et al[11] also observed a similar SSI rate of 21.05% in emergency surgeries as compared with 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, underlying pathology which also precipitates the underlying comorbid conditions, which probably could not be properly managed due to emergent nature of surgery. Inadequate preoperative preparation of these emergency patients could also be a contributory factor. Clean surgeries like mesh hernioplasty for hernia repair and uncomplicated laparoscopic cholecystectomy are associated with lower SSI rates as compared with dirty surgeries like surgery for pilonidal sinus and anal procedures,[8,11] as was observed in the present study also (Table 5).

Higher incidence of SSIs associated with a longer stay in the hospital reflects not only the severity of illness and comorbid conditions, but also probably increased colonization of patients with nosocomial strains existing in the hospital. Our findings were comparable with those of Kamat et al,[8] who found that the mean duration of postoperative stay in patients with SSI was 9 days. The patients with postoperative stay of more than 9 days were five times more likely to develop SSI. Anvikar et al[7] demonstrated that preoperative hospital stay predisposed an individual to 1.76% risk of acquiring an infection. With an increase in preoperative hospital stay, the risk increased proportionally. A preoperative stay of 1 week increases the risk rate to 5%. The probable factors that have been implicated in the increase in SSIs with higher order of the elective surgery are excessive contamination of operating theater after the earlier operations during the day, scheduling of contaminated surgeries toward the end of operating 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 have been reported by several studies, including one by Mahesh et al.[11] Results of the present series (Tables 2 and 3) matched the reported inferences. Present study reflected increase in incidence of SSI (3.6 times) with longer duration of drainage. Kamat et al,[8] in their study, also observed that patients with postoperative drains were 5.8 times more likely to develop SSIs compared with those without drains. This increased incidence of SSIs with increasing duration of postoperative drains may be attributed to not only the nature of operation necessitating the drainage, but also the drain itself acting as portal of entry for infection. Comorbidities like diabetes and COPD have been observed to be significant risk factors for SSI compared with patients without comorbidities. Suchitra and Lakshmidevi[16] have reported diabetes as a significant risk factor for SSI. Similar results are obtained in the present series.

Most of the organisms located were multidrug resistant in our study, including methicillin-resistant *S. aureus* and vancomycin-resistant *enterococcus* species (Table 9). Various authors[18-21] have also observed that most common isolated organism in SSI is *S. aureus* followed by *enterococcus* and other bacteria.[19-22]

CONCLUSION

The SSIs have always been a major and worrying complication of surgery and trauma adding to further morbidity and draining of the already limited resources. Factors studied in the present study as old age, comorbidity, prolonged hospital stay, prolonged operating time, order of surgery, prolonged drainage, emergency surgery, the wound class, and wound contamination all contribute to SSI. Isolation of multidrug-resistant organisms underscores the need for an evidence-based antibiotic prescription policy that could promote an ethical and rational use of antibiotics along with intensive infection control practices in the hospital. Slightly low incidence of SSI in our study may be attributed to the better setup and better infection control practices, although it must be emphasized that more stringent aseptic measures including rational antibiotic policy along with adherence to basic principles of asepsis and sterilization will be helpful in lowering the SSI rate further.

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