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ORIGINAL ARTICLE

A prospective study of surgical site infections in a teaching hospital in Goa

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Abstract

Introduction Surgical Site Infections contribute significantly to increased health care costs in terms of prolonged hospital stay and lost work days. The problem was largely unexplored in an apex medical institute in Goa.

Aims and Objectives To estimate the incidence, and study the bacteriology and the factors associated with SSI in the study setting.

Settings and Design Prospective study in the surgical wards of an apex medical teaching hospital in Goa.

Materials and Methods Clinico-bacterilogical follow-up of 114 post-operative cases to the development of SSI, as per the CDC criteria (1991). Incidence was expressed as the infection rate per 100 operations. Antibiotic sensitivity testing was done using the disc diffusion method.

Statistical Analysis Association was tested by applying the Student *t*-test and the Chi-square test of significance, and the strength of association expressed as the Odd's Ratio.

Results The overall SSI rate was estimated to be 30.7%; 5.4% for clean, 35.5% for clean-contaminated, and 77.8% for contaminated operations. Seventy-nine per cent of the isolates were gram-negative and almost 64% demonstrated polyantimicrobial resistance.

Conclusions The study emphasizes the need for the evidence-based infection control and antibiotic prescription policies in the hospital.

Keywords Chi-square test · Student *t*-test · Surgical site infections

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Introduction

Surgical Site Infection (SSI) is considered as a surgeon's nightmare [1]. This complication while seemingly infrequent and almost never lethal, adds morbidity, delays incisional healing and thereby generates large marginal care expenses when measured in aggregate. With an extra hospital stay of 6–14 days at as much as US$ 180 per day, a septic surgical wound is considered "a remarkably expensive luxury" [1]. A study by Wasek et al in India in 1961–1962 estimated an overall loss of 12 patient-days for each episode of SSI [2].

While the global estimates of SSI have varied from 0.5–15% [3–10] , studies in India have consistently shown higher rates ranging from 23–38% [11–12]. The 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 in addition the hospital environment. The issue was largely unexplored in an apex teaching medical institution in Goa.

A prospective observational study was thus undertaken to elucidate the extent of the problem and provide the baseline estimates for subsequent comparisons. The study objectives were to estimate the cumulative incidence of SSI, and study the bacteriology and the factors associated with the occurrence of SSI in the General Surgery wards of the hospital.

Material and methods

One hundred and fourteen patients, newly admitted to the study wards during June-July 2005, and consented to participate in the study were followed up clinico-bacteriologically for the evidence of SSI. SSI was diagnosed as per the guidelines issued by the centre for Disease Prevention and Control (CDC, Atlanta-1991) [13]. An 'operation' was defined as any procedure involving skin incision, undertaken in an operation theatre under anesthesia. The operations were classified, depending on the degree of contamination, as Clean, Clean-Contaminated, and Contaminated employing the American College of Surgeons' Committee for Control of Surgical Infections guidelines [7]. The 'Order' of the operation indicated the sequence in which the operations were undertaken during the session.

The patients less than 12 years of age, and those with open wounds for desloughing were excluded from the study. The Cumulative Incidence of SSI was expressed as Infection Rate – the number of patients with SSI per 100 operated patients.

All the reported bacterial isolates were counted once, regardless of their isolation in pure or mixed culture. Antibiotic sensitivity was tested by disc-diffusion method. Among the other variables included in the study were age; sex; duration of pre- and post-operative stay; duration, order and type of operation; type of anesthesia; presence of surgical drain and its duration; and the laboratory data including the fasting blood Sugar Level (FBSL), serum creatinine and haemoglobin.

Statistical analysis

The data was processed in the Statistical Package for Social Sciences (SPSS) software for windows, version 12. The association was tested using the test of statistical significance for the difference between the two proportions—the chi-square test, and for the difference between the two means—the Student *t*-test, at 5% level of significance. The strength of association was expressed as the Odd's Ratio with 95% Confidence Interval (Wolff's method) [14].

Results

Thirty five operations, out of 114, showed an evidence of post-operative wound sepsis yielding an infection rate of 30.7% (22.08–39.32%). Table 1 shows the factors associated with the occurrence of SSI. The description of the quantitative variables and its association with SSI is presented in Table 2. The frequency and antibiotic sensitivity of the sixty one isolates obtained from 35 cases of SSI is presented in Table 3.

Discussion

The infection rate in this study is comparable to that in other studies in India. A study by Subramanian et al in AIIMS [12] estimated an infection rate of 24.8%. Similar study by Ganguly et al in Aligarh [11] reported an infection rate of 38.8%. The incidence , however, is much higher than that in other countries; for instance in USA the SSI rate is estimated to be 2.8%, and 2–5% in European countries [15]. A recent study in Tehran also estimated an infection rate of 8.4% [9]. The higher infection rate in Indian hospitals reflects poor consciousness about the health care associated infections, and dismal infection control practices.

Length of hospitalization and duration of post-operative stay was significantly associated with the SSI (Tables 1 and 2). The median duration of post-operative stay in patients with SSI was 9 days. The patients with the post-operative stay of more than 9 days were five times more likely to develop SSI than otherwise, OR = 5.2 (2.16–12.43). Similar results were obtained by other researchers in India and worldwide [9, 11, 12, 15, 16]. Longer stay results in prolonged exposure to the potentially infective hospital environment, and consequently, the higher infection rate. Moreover, prolonged hospital stay may be a consequence of SSI. The exact cause-effect relationship between the hospital stay and the incidence of SSI is difficult to deduce.

Clean-contaminated operations were 9.72 (2.64–43.3) times more likely, and Contaminated operations were 61.83 (14.76–282.83) times more likely to get infected compared to Clean operations. This finding is in close agreement with the findings of the other researchers [2, 6, 7]. The operations on head, face, neck and back were less likely to be infected. Considering 'back' as a reference, the OR was 9.04 (1.37–200.89) for abdominal, 32 (1.06–97.95) for thoracic and perineal, and 208 (12.15–4573.63) for operations involving the limbs. A similar finding is recorded by Subramanian et al, and is attributed to the rich blood supply of the tissues of the head, face and neck enabling early mobilization of body's defence mechanisms and lower

Table 1 Factors associated with the Surgical Site Infections (categorical variables)

Characteristics	SSI/Total	(%)	χ^2	p
Gender:				
Male	26/77	(33.8)	1.047	0.306
Female	9/37	(24.3)		
Age (years)				
16–25	5/19	(26.3)		
26–35	5/25	(20.0)	5.996	0.307
36–45	5/21	(23.8)		
46–55	10/29	(34.5)		
56–65	7/15	(46.7)		
66–75	3/5	(60.0)		
Length of stay				
<5 days	4/25	(16.0)		
6 to 10	12/54	(22.2)	19.84	0.003
11 to 15	7/17	(41.2)		
16 to 20	5/9	(55.6)		
>20	7/9	(77.7)		
Type of operation				
Clean	3/56	(5.4)		
Clean-Contaminated	11/31	(35.5)	45.305	0.000
Contaminated	21/27	(77.8)		
Site of operation				
Back	1/17	(5.9)		
HFN	3/40	(7.5)		
Abdomen	13/36	(36.1)	46.864	0.000
Thorax	2/3	(66.7)		
Perineal	2/3	(66.7)		
Limbs	13/14	(92.9)		
Others*	1/1	(100.0)		
Duration of drain				
1 to 3	6/13	(46.2)		
4 to 7	8/10	(80.0)	18.181	0.000
>7	1/1	(100.0)		
Operation theatre				
Emergency	22/56	(39.3)		
Routine	13/58	(22.4)	3.812	0.051
Order of operation†				
1	4/36	(11.1)		
2	6/17	(35.3)	9.478	0.024
>2	3/5	(40)		

*Others include incision and drainage of breast abcess
†Applicable to 58 cases of elective operations only

infection rate [11]. Further, most operations on head, face, neck and back were clean, and thus, less likely to be infected.

The patients with post-operative drain were 5.8 (2.33–14.66) times more likely to develop SSI compared to those without the drain. While the proportion of those with post-operative drain acquiring SSI was 62.5% (15/24), it was 22.2% (20/90) among those without the drain ($c2$ = 14.448, p = 0.000). Further, the infection rate increases with the increasing duration of the drain (Tables 1 and 2). Similar observations were made in other studies on SSI, and could be attributed to the nature of operation necessitating the drainage, the drain acting as the portal of entry, or the effect of the drain itself [9, 11, 12, 17].

Of the 30 smokers enrolled in the study 17 developed the SSI (56.3%), while only 18 of the 84 (21.4%) non-smokers developed SSI ($c2$ = 12.901, p = 0.000). Smokers were 2.3 (1.21–10.77)-times more at risk of SSI than non-smokers. This is on account of local and systemic vasoconstriction causing tissue hypoxia which delays primary wound healing. Similar observation is made in other studies worldwide [9, 18].

The infection rate increased with the order of operation. The order of operation indicates the sequence in which the operations were undertaken during an operative session, and applicable for only elective procedures. Ganguly et al made similar observations in their study on SSI [11]. This is attributed to the excessive contamination of the operation theatre following the earlier operation during the day, and reduced efficiency of the operating surgeons during the subsequent operations. Moreover, contaminated operations were performed towards the end of the operation session for the fear of contaminating the operation theatre early during the day.

Emergency operations were more likely, than routine, to be infected. Although the results were not found to be statistically significant, other researchers have demonstrated higher infection rate in the emergency operations attributable to inadequate pre-operative preparation and the severity of the underlying condition that necessitated emergency procedure [12].

FBSL was the only biochemical parameter significantly associated with the risk of SSI. The role of high blood sugar level in predisposing to local and systemic infections is well known. Age, sex and the duration of pre-operative stay did not reveal any statistically significant association with the occurrence of SSI.

Seventy-nine per cent (79.33%) of the isolates were gram-negative bacteria; pseudomonas being the commonest one, followed by Staphylococcus pyogenes (Table 3). The proportion of bacteria resistant to all antibiotics for which tested was as high as 63.93% (39/61). Of the sensitive organisms, 18.03% (11/61) were sensitive to cefoperazone-sulbactam combination. Staphylococcus pyogenes was the only organism that demonstrated sensitivity to other antibiotics, including vancomycin (3/12), teicoplenin and vancomycin (2/12), and rifampicin (1/12). Penicillins (34/114), metronodazole (70/114) and flouroquinolones

Table 2 Factors associated wit surgical site infections (quantitative variables)

Characteristics	SSI	N	Mean	Std. deviation	*t*	*p*
Length of stay	yes	13	17.76	9.26	4.641	0.000
	no	45	9.46	4.2		
Duration of operation	yes	13	1.99	1.05	-1.276	0.207
	no	45	2.71	1.93		
Duration of pre-op stay	yes	13	6.46	6.18	2.814	0.007
	no	45	3.26	2.47		
Duration of post-op stay	yes	13	12.84	7.87	5.084	0.000
	no	45	6.13	2.34		
Duration of drain	yes	13	3.3	3.03	6.288	0.000
	no	45	0.2	0.78		
Hemoglobin	yes	13	11.41	1.83	-1.737	0.088
	no	45	12.4	1.79		
FBSL*	yes	13	153.07	47.28	2.745	0.015
	no	45	115.24	28.41		
Serum creatinine	yes	13	1	0.39	1.507	0.137
	no	45	0.83	0.33		

*FBSL- Fasting Blood Sugar Level

Table 3 Bacterial isolates from the cases of Surgical Site-infections and their antibiotic sensitivity

Isolates	Resistant to all	Sensitive to cfs* only	Sensitive to cfs and Amikacin	Sensitive to others†	Total
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Pseudomonas	11 (78.6)	3 (21.4)	0 (0.0)	0 (0.0)	14 (22.9)
Staph pyogenes	5 (41.7)	0 (0.0)	0 (0.0)	7 (58.3)	12 (19.7)
A. baumanii	5 (55.6)	4 (44.4)	0 (0.0)	0 (0.0)	9 (14.8)
Klebsiella	6 (75.0)	0 (0.0)	2 (25.0)	0 (0.0)	8 (13.1)
E. coli	5 (71.4)	0 (0.0)	2 (28.6)	0 (0.0)	7 (11.5)
C. diversus	5 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (8.2)
C. freundii	0 (0.0)	4 (100.0)	0 (0.0)	0 (0.0)	4 (6.6)
A. colcoaceticus	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.6)
P. mirabilis	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.6)
Total	39 (63.9)	11 (18.0)	4 (6.6)	7 (11.5)	61(100.0)

*cfs- Cefoperazone and Sulbactam
†Others denote seven isolates of Stapylococcus pyogenes, 3 sensitive to vancomycin, 3 to rifampicin, and 2 to teicoplenin and vancomycin

(41/114) were among the frequently used antibiotics in the ward during the study period. Although third generation cephalosporins were used in 32 patients, cefoperazone and sulbactam combination was never used in the ward during the study period, and Amikacin was used only in 1.75% (2/114) of the patients. Thus the pattern of antibiotic sensitivity was found to be consistent with the antibiotic usage in the wards. Isolation of multi-drug resistant organisms in the absence of an evidence-based antibiotic prescription policy is not surprising. Other studies conducted in India have incriminated staphylococcus as the most common organism, followed by gram-negative bacilli [2, 12]. However, the increasing role of gram-negative bacilli in the aetiology of nosocomial infections has been emphasized in the research throughout the world [8, 19, 20].

Conclusions

The paper presents the findings of a prospective study undertaken in surgery wards of a teaching hospital. A high rate of SSI with relative preponderance of multi-drug resistant gram-negative bacilli calls for intensive infection control practices and routine surveillance of SSIs in the hospital.

Control of SSIs in the hospital is likely to contribute to adherence to the principle of *non-malfacience* in medical practice.

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