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Original Article

Prevalence of surgical site infections in general surgery in a tertiary care centre in Eastern India

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Abstract

Background: *Surgical site infections (SSI) are one of the most common healthcare associated infections in the low-middle income countries. Data on incidence and risk factors for SSI following general surgeries in particular are scare. This study set out to study the prevalence and identify risk factors for SSI in patients undergoing General Surgery Department in an Indian rural hospital.*

Methods: *A prospective study was undertaken at the department of general surgery for a period of one year. The rate of SSI was studied in relation to its type, the type of surgical procedure and elective vs emergency surgeries. Surveillance for SSI was based on the Centre for Disease Control (CDC) definition and methodology. Incidence and risk factors for SSI, including those for specific procedure, were calculated from data collected on daily ward rounds. Swab samples were plated on blood agar and MacConkey agar medium.*

Results: *The final cohort therefore included 215 patients: 159 (73.95%) male and 56 (26.05%) female. Ages ranged from 9 years to 82 years (mean standard deviation: 37.10± 25.23). About 26 (12.09%) anaemic patients who underwent surgery developed SSI. About 45 (20.93%) were prescribed 1 antimicrobial agent (most commonly metronidazole), 133 (61.86%) were prescribed a combination of 2 antimicrobial agents (commonly cephalosporin combinations), and 37 (17.29%) received a combination of 3 antimicrobial agents (commonly cephalosporin with metronidazole and amikacin).*

Conclusion: *SSI surveillance can be reported general surgeries and can be part of routine practice in resource-constrained settings.*

Keywords: *Surgical site infection (SSI), Surgical wound infection, Surgery, Risk factors, Antimicrobial resistance.*

Introduction

Quality of healthcare in hospitals is of major public health importance. Surgical site infections (SSI) are the most common Hospital acquired infection. The Centre for Disease Control and Prevention (CDC) [and the European Centre for Disease Prevention and Control (ECDC)] defines SSI as postoperative infection occurring within 30 days of a surgical procedure (or within one year for permanent implants).[1-3]

SSI are classified based on the depth of involvement of the infection, which may be confined to the skin and subcutaneous tissues (superficial incisional SSI), involve the deep soft tissue, such as the facial and muscular layers (deep incisional SSI), or extend further beyond these anatomic boundaries (organ/space SSI). Incisional SSIs are further subdivided into primary and secondary for cases with more than one incision. For instance, a primary Incisional SSI involves the primary incision (e.g., chest incision for coronary artery bypass grafting), and a secondary Incisional SSI involves secondary incisions (e.g., leg incision for donor site in coronary artery bypass grafting).[3,4]

The CDC wound classification system defines wound class based on risk and is divided into 4 categories: clean, clean-contaminated, contaminated and dirty.[5] With clean wounds, the expected risk is from microbes located directly on the surface of the skin, or introduced from the external environment. With increasing wound class, there is increased exposure to microorganisms that are present on internal structures of the body, such as epithelial surfaces of the gastrointestinal tract and genitourinary tract. In the early epidemiologic studies, the SSI rate increased with wound class (I: 2.1%; II: 3.3%; III: 6.4%; IV: 7.1%).[2]

Postoperative surgical site infections (SSI) are an important health care associated (HAI) infection and one of the most frequent causes of post-operative morbidity.[6] In high income countries, approximately 2% of surgeries are affected by SSIs.[7,8] World Health Organization (WHO) shows that SSIs are most frequently reported type of HAI in low and middle-income countries (LMICs) with a pooled incidence of 11.8 episodes of SSI per 100 surgical procedures.[9] In India, the risk of acquiring SSI is high (range, 4%-30%).[10] Nonetheless, prevention and control of HAI is not prioritized and antibiotic (AB) resistance is an ever-growing problem.[11] Moreover, surveillance data are still scanty.[12]

The development of an SSI causes a substantial increase in the clinical and economic burden of surgery. The financial burden of surgery is increased due to the direct costs incurred by prolonged hospitalization of the patient, diagnostic tests, and treatment.[13] The present study was done to study the prevalence and risk factors of SSI in the Department of Surgery.

Materials & Methods

The study was conducted in 90 beded general surgery wards of DBCRH, Haldia, a 500-beded teaching hospital associated with IIMSAR, Haldia, West Bengal. The obstetrics and gynecology; ear, nose, and throat; and orthopedic wards were not included. All patients admitted between January 2016 and December 2016 was included prospectively in the survey. Institutional ethics committee permission was obtained. The US Centers for Disease Control and Prevention (CDC) surveillance methods for SSI was used.[14]

Following the surgical procedure, surgical sites were examined on postoperative day 3 and every 3 days thereafter. Wounds were graded on the following scale: grade 1= normal healing; grade 2 = suture line erythema < 1cm; grade 3 = suture line erythema > 1cm; grade 4 = frank, purulent drainage.[15] We did the grading for all the subjects. Cultures were obtained on all wounds determined to be infected or as otherwise clinically indicated. Grade 3 or 4 wounds were considered infected. Wounds from which a positive culture was obtained in the setting of physical signs of infection (i.e., fever, inflammation) were also considered infected.

Swab samples were plated on blood agar and MacConkey agar medium. Standard conventional microbiological methods were used to identify pathogenic bacteria.[16] The Kirby-Bauer disc-diffusion method on Mueller-Hinton agar plates was used for AB susceptibility testing. Disc strengths were as recommended by the Clinical and Laboratory Standards Institute (CLSI). CLSI interpretative criteria for susceptibility and resistance testing were used.[17]

Antibiogram was prepared from culture sensitivity reports to evaluate the sensitivity pattern of organisms. Demographic characteristics like age and sex were noted. Variables like BMI, comorbid conditions, prophylactic antibiotic use, blood transfusion, and preoperative waiting period were compared in the infected and non-infected groups. All the age groups excluding the children <5 years with confirmed cases of SSI (As per case definition) and who consented for the study were included. Infection occurring 30 days after the surgery, infection of episiotomy, donor sites of split skin grafts and refusal to give consent for participating in the study were excluded. A structured questionnaire form consisting of demographic data, risk factors, past medical history, antibiotic usage history, and particulars of surgery, antibiotic prophylaxis was noted.

Results

The present study at a tertiary care hospital, Haldia was done for a period of one year. During the study period a total of 2234 surgeries were conducted and 215 defined cases of SSI as per CDC guidelines were enrolled in the study. Among the 3 types, superficial incision SSI was most prevalent (147 cases) followed by deep incisional SSI (49 cases) and finally by organ/space SSI (19 cases). The elective surgical procedures included cholecystectomy, hernioplasty, gastrectomy, mastectomy, resection anastomosis of bowel, hemorrhoidectomy, fistulectomy, parotidectomy, thyroidectomy. The commonly performed surgeries under emergency conditions were exploratory laparotomy and resection anastomosis of bowel. The surgical procedure most commonly performed and the respective rates of SSI associated with them. Among them abdominal surgeries constituted majority 121 (56.28%) followed by limb surgeries.

The final cohort therefore included 215 patients: 159 (73.95%) male and 56 (26.05%) female. Ages ranged from 9 years to 82 years (mean standard deviation: 37.10± 25.23). Majority (44.95%) of them belonged to 18-30 years group. Three patients contracted SSI died during the study duration (04/215; 1.9%). Among the 215 patients developed surgical site infections giving a cumulative incidence of 215/2234 (9.62%). About 29 (13.5%) patients were more than 50 years who developed surgical site infection. It was found that the frequency of SSI increased with age and this was statistically significant [Table 1]. Majority of the study subjects 154 (71.63%) had normal BMI. Out of SSI cases 32 underweight patients (14.89%) and overweight patients 29 (13.49%) developed infection of their surgical sites. This difference was found to be statistically significant.

Table 1: Demographic characteristics and factors associated with the surgical site infections (SSI)

Characteristics	SSI / Total	Percentage
SSI	215	
Male	159	73.95%
Female	56	26.05%
Age [Range]	9 years to 82 years	Mean, SD: 37.10± 25.23
Cumulative incidence of SSI	215/2234	9.62%
Weight [Normal]	154	71.63%
Underweight	32	14.89%
Overweight	29	13.49%
Elective surgery	197	91.63%
Emergency surgery	18	8.37%
Major surgery	161	74.9%
Clean surgery	49	22.79%
Clean contaminated	135	62.79%
Contaminated	23	10.7%
Dirty	8	3.7%
Surgery less than 1 hour	148	68.83%
Surgery more than 1 hour	67	31.16%
Preoperative stay	3.5 days	SE 0.86
Postoperative stay	7.5 days	SE 0.45
Anaemic patients with SSI	26	12.09%
Smokers	57	26.51%

The majority of surgeries 197 (91.63%) were elective. Most patients underwent major surgery 161 (74.9%), and many were clean 49 (22.79%) or clean contaminated 135 (62.79%). Only a few were contaminated 23 (10.7%) or dirty 8 (3.7%). Most surgeries lasted less than 1 hour 148 (68.83%) [Table 1].

The mean duration of preoperative stay was 3.5 days (SE 0.86), whereas the mean duration of postoperative stay was 7.5 days (SE 0.45). For SSI patients, the mean preoperative stay was 6.9 days (SE 1.78) and 17.8 days postoperatively (SE 2.7). Some patients 18 (8.37%) had a history of previous hospitalization (hospitalization/s maximum 2 weeks prior admission). The majority showered and had hair removed preoperatively, mostly by shaving

Different comorbid conditions were studied. Hemoglobin of 13 and 12 gm% were considered as the cut off points for the diagnosis of anemia in men and women respectively. Those with less than 10gm% were considered severely anaemic and these were the ones who received maximum blood transfusions. About 26 (12.09%) anaemic patients who underwent surgery developed SSI. Few patients suffered from chronic diseases, including cardiac, renal, or hepatic disease; diabetes; or tuberculosis. Almost 57 (26.51%) were smokers, of whom 51 (89.47%) male and 6 (10.53%) were female. About 02 (0.93%) patients were immunosuppressed at time of surgery. Severity of disease, measured using American Society of Anesthesiologists (ASA) score, ranged from healthy (class I) to severe systemic disease, which is a constant threat to life (class IV). The proportion of patients in each class from class I to class IV was 141 (65.6%), 52 (24.19%), 16 (7.4%), and 6 (2.8%), respectively [Table 1].

Antimicrobial agents were prescribed to almost all admitted patients (99%). About 45 (20.93%) were prescribed 1 antimicrobial agent (most commonly metronidazole), 133 (61.86%) were prescribed a combination of 2 antimicrobial agents (commonly cephalosporin combinations), and 37 (17.29%) received a combination of 3 antimicrobial agents (commonly cephalosporin with metronidazole and amikacin). The DU90% included the following: metronidazole (27.5%), ciprofloxacin (12.5%), amikacin (9%), Amoxicillin+Clavulanate (20%), cotrimoxazole (8%), doxycycline (7.5%), Flucloxacillin (7.5%), cefotaxime (19%), Ceftriaxone (12,5%), gentamicin (7%), norfloxacin (10%), lincomycin (6%). The mean duration of antimicrobial therapy was 5.2 days (95% CI: 4.34-5.60), and the median was 4 days. The current study indicated that all patients received 3rd generation cephalosporins either alone or in combination with aminoglycoside. Metronidazole was prescribed for contaminated surgeries of gut and gall bladder, in which anaerobic organisms are expected to be present.

It was observed that in clean surgeries i.e., in hernioplasty, two trends of antibiotic prophylaxis were followed. In the first trend, cefotaxime (1 gm IV) was given ½ hour prior to surgery, which was followed by cefotaxime (1 gm IV BD) and amikacin (500 mg IV BD) post surgery for 5 days. The other trend was that ceftriaxone (1 gm IV) was given ½ hour. Prior to surgery, followed by ceftriaxone (1 gm IV BD) and amikacin (500 mg IV BD) post surgery for 3 days; then followed up by cefixime (500 mg Oral BD) for 5 days making a total of 8 days.

Out of 215 swabs collected 192 (89.30%) yielded positive growth. Gram positive isolates were 71/215 (33.02%) and gram negative isolates were 119/215 (55.35%). Staphylococcus aureus was the predominant isolate among all 61 (31.77%) followed by Escherichia coli 36 (18.75%) and Pseudomonas aeruginosa 33 (17.18%). Methicillin-resistant S aureus constituted 19 (31.15%) of all S aureus isolates and showed resistance toward coamoxyclav (78%), ciprofloxacin (47%), and amikacin (28%). About 8% of the S aureus isolates showed resistance to vancomycin. P aeruginosa isolates showed resistance toward cetazidime (67%), ciprofloxacin (58%), gentamicin (50%), amikacin (28 %), and imipenam (9%).

Discussion

SSIs negatively impact on patient physical and mental health. Increased patient morbidity, mortality, and loss of earnings during recovery are some of the indirect costs associated with infection. Intangible costs may also be incurred by the patient, such as pain and anxiety. In addition, patients may experience delayed wound healing and be more susceptible to secondary complications, such as bacteraemia.[18, 19]

Study by Akhter MS et al (2016)[20] showed a SSI rate of 11%. Risk factors associated with a higher incidence of SSI were found to be age (>55 years), diabetes mellitus (especially uncontrolled sugar in the perioperative period), immunocompromised patients (mainly HIV and immunosuppressive therapy patients), surgeon skill (higher in senior professors compared with junior residents), nature of the cases, (emergency surgeries), placement of drains, wound class (highest in dirty wounds), type of closure (multilayer closure), prolonged duration of hospital stay, longer duration of surgery (>2 hours), type of surgery (highest in cholecystectomy). The highest rates of causative organisms for SSIs found were Staphylococcus aureus, Escherichia coli and Klebsiella ssp.[20]

SSIs remain a frequent postoperative complication; developing in 3% to 20% of surgical procedures.[21] The rate of SSI is highly variable depending on the specific operative procedure, with rates that can be even higher depending on the number of risk factors present. There is a substantial impact of SSI on both morbidity and mortality. However, establishing the exact impact of SSI is difficult because of the dependence on accuracy of reporting and the variability of patient follow-up. In the 1980s, it was observed that SSI led to a 10-day increase in hospital length of stay.[22] The elements essential for a successful programme of prevention of SSIs include intensive surveillance and infection control activities and regular feedback of SSI rates to surgeons.[23] Despite the apparent effectiveness in lowering SSI rates when surgeons receive feedback, there has been no consensus on which surveillance methods are best for collecting data on SSIs.[24]

Despite major advances in infection control interventions, health care-associated infections (HAI) remain a major public health problem and patient safety threat worldwide.[25, 26] The global estimated prevalence of HAI, at any given time, approximates 1.4 million.[27] Third generation cephalosporins were the preferred antibiotics for pre-operative use as well as for the use in combination with aminoglycoside and metronidazole for better postoperative antibiotic coverage.[28]

ASA score was significantly associated with SSI development. Results suggest that patients with severe systemic disease (ASA classes III and IV) run a higher risk of SSI than patients with mild or no systemic disease, as supported by previous research.[29] An association between prior hospitalization and length of preoperative stay is probably due to patient exposure to the hospital environment, diagnostic and invasive procedures, and antimicrobials, as reported in previous studies.[30, 31] Thus, efforts should be made to reduce the length of hospital stay prior to surgery.

Patients of diabetes especially with poor glycemic control share much comorbidity, like obesity, poor nutritional status, poor peripheral oxygen supply, and metabolic derangements.[32] Our study did not find an association between preoperative blood transfusion and SSI. An explanation for risk for SSI following blood transfusion remains unclear and probably reflects a proxy for severe anemia and consequent low oxygen carrying capacity and delivery to the tissues, potential contamination, and transfusion related immunomodulation in presence of critical illness.[33, 34] A previous study showed a predominance of SSI in the age group >65 years compared to <65 years.[35]

We found a significantly higher rate of SSI in emergency operations compared to routine elective surgeries, (11.9% versus 4.4%; $P < 0.05$). Similar findings were reported in other studies, 39% versus 22% and 61.5 versus 38.5%.[36, 37]

Further studies showed that emergency operations significantly increased the rate of SSI.[38, 39] The effect of emergency surgery on the rate of SSI is likely to be due the fact that emergency procedures lack routine pre-op preparations which reduce the rate of SSI. (e.g. control of diabetes) and most of emergency operations involve contaminated areas such as the bowel and the perianal region.

Conclusion

Staphylococcus aureus was the most common organism associated with SSI. Majority of the SSIs were resistant to multiple antibiotics. Prevention of SSIs requires a multipronged approach with particular emphasis on optimising preoperative issues, adhering religiously to strict protocols during the intraoperative period and addressing and optimising metabolic and nutritional status in postoperative period. Rigorous procedures must be implemented to minimize SSIs. More economic and QoL studies are required to make accurate cost estimates and to understand the true burden of SSIs. Therefore, greater attention has been given to adherence to recommendations for the prevention and control of SSIs as well as to antibiotic prophylaxis protocols.

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