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Drug Sensitivity Pattern of Different Causative Organisms Involved in Surgical Site Infections

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Abstract **Original Research Article**

Background: Surgical site infection or SSI is an infection that occurs after surgery in the part of the body where the surgery took place. To treat surgical site infections, several antimicrobials are used for this treatment. Due to higher risk of death, patients with SSIs are more likely to require readmission to hospital or intensive care unit (ICU). So, the sensitivity pattern of different causative organisms involved in SSI may support the surgeons as a treatment manual in treating SSI patients. ***Aim of the study:*** The aim of this study was to identify the drug sensitivity pattern of different causative organisms involved in the process of surgical site infection. ***Methods:*** This cross-sectional study was conducted in the Department of Surgery, in A Tertiary Care Hospital, Dhaka, Bangladesh during the period from August 2017 to July 2018. A total of 160 admitted patients who undergone the surgical procedure at the mentioned hospital were enrolled as the study population. Before using any antimicrobial blood culture as well a swab from wound culture was sent for confirmation of infection and culture sensitivity. All data were processed, analyzed, and disseminated by MS Office and SPSS version 22.0 as per need. ***Results:*** The most common organism involved in SSI was S. aureas (42.4%), followed in decreasing order by E. coli (27.3%), P. aeruginosa (12.1%), bacteroids (12.1%), and Klebsiella spp. (6.1%). In analyzing the drug sensitivity status, we found Meropenem as the most sensitive drug followed by Ceftriaxone according to coverage and efficacy. As per only coverage, Ceftriaxone showed better efficacy than that of other drugs. On the other hand, Gentamycin showed cent percent sensitivity for gram-negative organisms only. ***Conclusion:*** Considering the findings of this study we can conclude that Meropenem and Ceftriaxone may be considered as the most effective antibiotic in treating patients with surgical site infection. In such cases, applying very traditional or narrow-spectrum antibiotics may cause of increasing relapse rate.

Keywords: Drug sensitivity pattern, causative organisms, SSI, antimicrobials.

I INTRODUCTION

Patients with surgical site infections (SSI) are more likely to require readmission to hospital or intensive care unit (ICU) treatment, and are at higher risk of death, than those without such infections. Several antimicrobials are used to treat such infections. So, the sensitivity pattern of different causative organisms involved in SSI may support the surgeons as a treatment manual in treating SSI patients. Surgical site infection, previously called postoperative wound infections, may be defined as an infection that occurs at or near the surgical incision within 30 postoperative days of the surgical procedure, or within 1 year if an implant is left in place. SSI is further classified as Superficial incisional and Deep incisional [1-3]. Environment of operation theatre (OT) and surgery ward is a crucial factor for infection. Overcrowding of visitors in general access zone and within wards results in spreading by droplet due to talk, sneeze, and cough of personnel carrying intranasal and facial pathogens. On settling overall, bed, OT table, trolley, linens, etc, those microbes are transmitted to the operated patients [4]. Surgery team, in the same way, transmits microbial agents to the operation wound. The dirty floor of the ward as well as unclear logistics-all are risk factors for surgical site infection [5]. The pathogens isolated from infections differ, primarily depending on the type of surgical procedure. In clean surgical procedures, in which gastrointestinal, gynecologic, and respiratory tracts have not been entered, Staphylococcus aureus from the exogenous environment or the patient's skin flora is the usual cause of infection. In other categories of surgical procedures including clean-contaminated and dirty, the polymicrobial aerobic and anaerobic flora closely resembling the normal endogenous microflora of surgically resected organs are the most frequently isolated pathogens [6]. The single most disadvantage with those microbes stood as their multi-drug resistance property. To overcome this problem, newer cephalosporins and quinolones antibiotics are randomly used for prophylactic and therapeutic purposes. But in developing countries, this approach is not cost-effective. Many a time patient cannot afford those antibiotics due to poverty. So, the treatment course remains incomplete or improper leading to a chance of emerging resistance to that particular drug by those particular bacteria. This is rather a chronic situation. Hence the high magnitude of antibiotic resistance would rightly be expected but the number of variables can influence SSIs treatment rates. Preoperative planning and intra-operative technique for both emergency and elective surgery have become important in the prevention of SSI. Prevention of SSIs can be achieved by several methods. Organism in the wound can be reduced via better preoperative preparation of the surgical site, sound infection-control practice while performing operations and adherence to the principles of prophylactic antibiotic therapy, skilled surgical technique, and judicious use of electro-cautery can reduce the risk of hematoma. Enhancement of host defenses by increasing oxygen delivery, better core body temperature control during the perioperative period, and rigorous blood glucose control in surgical patients are new areas that have the potential to even further reducing the rate of SSI. Although an SSI rate of zero may not be achievable, continued progress in understanding the biology of infection at the site and consistent application of proven methods of prevention will allow us to further reduce the frequency, cost, and morbidity associated with SSI [7].

II OBJECTIVES

General Objective

- To identify the drug sensitivity pattern of different causative organisms involved in the process of surgical site infection.

Specific Objective

- To assess the frequency of surgical site infection among study population
- To assess the risk factors responsible for SSI among participants.
- To identify the organisms responsible for SSI.
- To evaluate the drug sensitivity pattern of different organisms responsible for SSI

III METHODOLOGY & MATERIALS

This cross-sectional study was conducted in the Department of Surgery, in A Tertiary Care Hospital, Dhaka, Bangladesh during the period from August 2017 to July 2018. Through purposive sampling technic in a total of 160 admitted patients who undergone surgical procedures at the mentioned hospital were enrolled as the study population. According to the exclusion criteria of this study patients presented with infected wounds, needed drainage of abscess, patients of road traffic accident, patients of below 12 years of age, and patients having prosthetic surgery were excluded. Before commencing the study, the study protocol was accepted by the Ethical review committee of SSMC. The patients undergoing elective surgery and who were admitted into the Department of Surgery were approached for inclusion in the study. All patients were screened in according to inclusion and exclusion criteria prior to final selection. Formal permission was taken from each subject. After inclusion and assessment, all patients were interviewed by the researcher for baseline data like age, sex, socioeconomic status, BMI, and co-morbid disease. Moreover, they were investigated for anesthetic fitness as well as to identify comorbidities. Following the operation, all patients were followed up for 30 days. Patients who were discharged earlier the period were also followed up over the telephone. Wound infection or surgical site infection were defined by standard criteria as mentioned in the operational definition. Moreover, these infections were managed by both regular surgical dressing and the use of proper antibiotics. Before that blood culture as well as swabs from the wound culture were sent for confirmation of infection and culture sensitivity. After collection of the culture sensitivity report, antibiotics were chosen according to the sensitivity report. Face to face interview was conducted by using a semi-structured questionnaire containing socio-demographic parameters and relevant information about surgery by the researcher himself. All collected data from the interview were recorded in a separate case record form. Patients who withdraw themselves or provide incomplete data were also excluded from the study. Data were edited and sorted according to the variables set during protocol development and data input was done in statistical software. A data analysis plan was developed during protocol development and data analysis was done by SPSS 22.0.

IV RESULT

In this study total of 160 patients undergoing different types of surgeries were included. The mean age of the study population was 51.79±11.30 years ranging from 27-72 years. The majority of patients belonged to 51- 60 years (36.3%). The male were the majority patients (59%). Females constituted 41% of the study population. 61% of patients came from rural areas and 39% came from urban areas. The majority of patients were from the lower socio-economic class

(52.5%) followed by the middle class (33.8%) and upper class (13.8%). The most common surgical procedure performed was cholecystectomy (31.9%), followed in decreasing order by mastectomy (21.9%), gastrectomy (17.5%), genioplasty (10%), Whipple's procedure (5%), prostatectomy (4.4%), abdominoperineal resection (3.8%), colectomy (3.8%) and splenectomy (1.9%). Among all patients in 33 (21%) developed surgical site infection. Among infected cases of SSI, 73% were superficial infections and 27% were deep infections. The most common risk factors for SSI were HTN (29.4%), followed in decreasing order by anaemia (28.7%), DM (24.4%), jaundice (21.3%), age > 60 years (19.4%), smoking (15%), obesity (15%), nutritional status below average (13.8%), and renal failure (6.3%). The proportion of HTN, DM, older age (>60 yr), anemia, and below-average nutrition was significantly higher in patients who had SSI (p<.05). Among patients who had SSI, 75.8% required more than one hour of operation time and among patients who did not have SSI, 57.5% required operation more than one hour. The difference was significant (p<0.05). The most common organism involved in SSI was S. aureas (42.4%), followed in decreasing order by E. coli (27.3%), P. aeruginosa (12.1%), bacteroids (12.1%), and Klebsiella spp. (6.1%). In analyzing the drug sensitivity status, we found Meropenem as the most sensitive drug followed by Ceftriaxone according to coverage and efficacy. As per only coverage, Ceftriaxone showed better efficacy than that of other drugs. On the other hand, Gentamycin showed cent percent sensitivity for gram-negative organisms only.

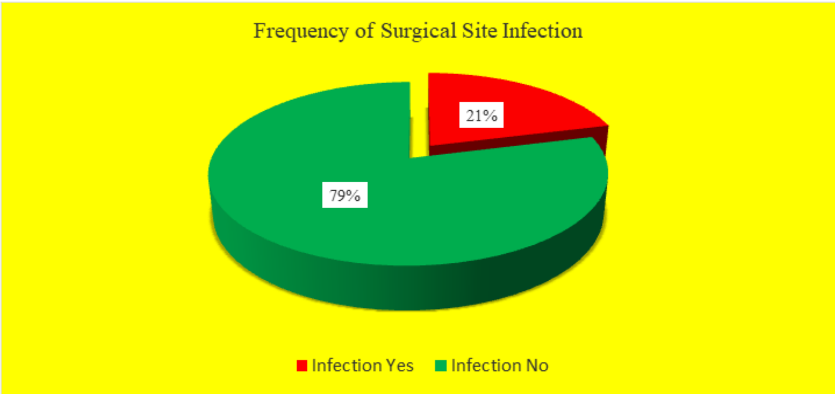

Figure I: Frequency of surgical site infection among study population (N=160)

Table I: Distribution of surgical procedures among participants (N=160)

Indications	n	%
Cholecystecomy	51	31.9
Mastectomy	35	21.9
Gastrectomy	28	17.5
Hernioplasty	16	10.0
Whipple's procedure	8	5.0
Prostatectomy	7	4.4
Abdominoperineal resection	6	3.8
Colectomy	6	3.8
Splenectomy	3	1.9

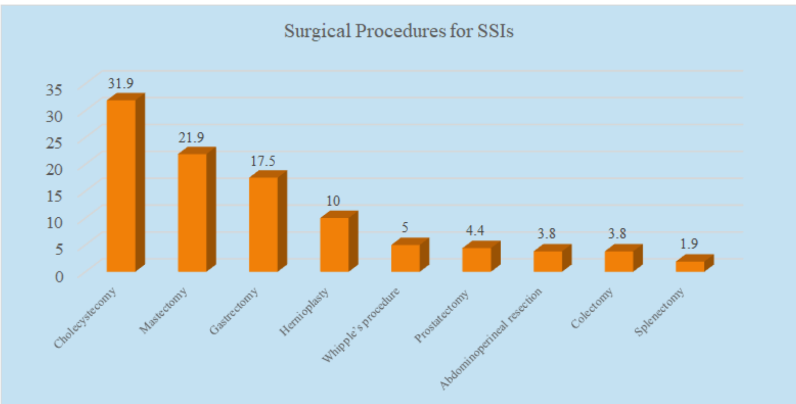

Figure II: Surgical Procedures for SSIs (N=160)

Table II: Risk factors responsible for SSI (N=160)

Risk factors	SSI present (n=33)		SSI absent (n=127)		Total (n=160)		P value
	N	%	N	%	N	%	
HTN	22	66.7	25	19.7	47	29.4	<.001^{s}
DM	21	63.6	18	14.2	39	24.4	<.001^{s}
Obesity	7	21.2	17	13.4	24	15	0.262^{ns}
Older age (>60 years)	15	45.5	16	12.6	31	19.4	<.001^{s}
Poor nutritional status	8	24.2	14	11	22	13.8	0.049^{s}
Anaemia	17	51.5	29	22.8	46	28.7	0.001^{s}
Jaundice	11	33.3	23	18.1	34	21.3	0.057^{ns}
Smoking	8	24.2	16	12.6	24	15	0.09^{ns}

P value was determined by Chi-square test

Table III: Organisms responsible for SSI (n=33)

Organism	n	%
Gram positive bacteria		
Staphylococcus aureas	14	42.4
Bacteroids	4	12.1
Gram negative bacteria		
Escherichia coli	9	27.3
Pseudomonas aeruginosa	4	12.1
Klebsiella spp.	2	6.1

Table IV: Drug sensitivity pattern of different organisms responsible for SSI (n=33)

Drug tested	Organism				
	S. aureas	E. coli	P. aeruginosa	Bacteroids	Klebsiella spp.
Amoxycillin	57.10	0.0	0.0	100.0	0.0
Cloxacillin	57.10	11.10	0.0	75.0	50.0
Ceftriaxone	85.70	77.80	25.0	100.0	100.0
Cefixime	42.90	33.30	0.0	75.0	50.0
Cefuroxime	57.10	55.60	0.0	0.0	100.0
Ciprofloxacin	64.30%	33.30	0.0	0.0	100.0
Nitrofurantoin	NA	77.80	NA	NA	50.0
Gentamycin	NA	66.70	75.0	NA	100.0
Meropenem	100.0	100.0	100.0	NA	NA

V DISCUSSION

In this study, all of the patients had undergone elective surgery. The most common surgical procedure performed was cholecystectomy (31.9%), most of them being laparoscopic cholecystectomy. This was followed in the second and third by mastectomy and gastrectomy. Sickler et al., [8] found hernioplasty to be the most common elective operation done in their study. Also, in concordance with Laloto et al., [9] gastrointestinal surgery constituted the majority proportion of all operations in the present study (28.6% and 32% respectively). Surgical site infection (SSI) developed in 21% of patients in this study. This is higher than that of Sickder et al., [8] (14.13%) but lower than that of Mawalla et al (26%) but very similar to the study done by Nur-e-Elahi and colleagues in BSMMU (20.16%).[4,5] Prevalence of superficial SSI was 73% and deep SSI was 27%. In comparison, another study done in a tertiary care hospital by Sickder et al., [8] found 58.1% superficial SSI and 41.9% deep SSI. Their study included both emergency and elective surgery patients explaining the higher level of deep infection which could be associated with emergency surgeries. Common risk factors for development of SSI encountered in this study was HTN (29.4%), anaemia (28.7%), DM (24.4%), jaundice (21.3%), older age > 60 years (19.4%), smoking (15%), obesity (15%), nutritional status below average (13.8%), and renal failure (6.3%). In comparison in the BSMMU44 study anaemia (52%) was the most prevalent risk factor followed by malnutrition (44%), diabetes (38%), jaundice (30%), contaminated operation (44%) dirty operation (38 %), obesity, smoking, etc. In this study HTN, DM, older age (>60 yr), anaemia, and below-average nutrition carried a significant association with SSI. On a similar note, Mawalla, Laloto [5], and Siddique [6] and found that presence of diabetes was significantly associated with increased prevalence of SSI ($p<0.05$). Mawalla also found HTN to be an important risk factor for SSI ($p<0.05$). Older age as a risk factor of increased SSI was noted by Mawalla [5] (>60 years) and Siddique (>50 years). Anaemia was examined and found to be a risk factor for SSI by Lubega[7] who reported that the chance of SSI increased with the degree of anemia. Smoking was significantly associated with SSI in the study by Mawalla et al., [5] Obesity was found to be associated with an increased chance of SSI by Laloto [9]. The risk of wound infection had repeatedly been shown to be proportional to the length of operative procedures. A higher incidence of post-operative wound infection was observed when the duration of operation was more than 60 minutes. In the study by Nur-e-Elahi et al., [4] a higher incidence of SSI was observed when the duration of operation was more than 150 minutes. Cruse et al., [10] found an increase in wound infections with longer procedures, roughly doubling with every hour of the procedure. This may be due to several factors like doses of bacterial contamination increases with time and longer procedures are more liable to be associated with blood loss and shock, thereby reducing the general resistance of the patients. The increased amount of suture and electro-coagulation may also reduce the local resistance of the wounds. In this study, wound swab culture revealed an organism in hundred percent cases. The most prevalent organism was S. aureas (42.4%), followed in decreasing order by E. coli (27.3%), P. aeruginosa (12.1%), bacteroids (12.1%), and Klebsiella spp. (6.1%). In contrast, Nur-e-Elahi et al., [4] found that the most predominant isolated organism in their study was Escherichia coli (43%) followed by Staphylococcus aureus (33%) and Pseudomonas aeruginosa (11%). Sickler et al., [8] found Staphylococcus aureus (41.9%) to be the most common organism isolated among patients with SSI, followed by E. coli (30.8%); Enterococcus spp. (12%); Klebsiella spp. (8.5%); and Pseudomonas aerginosa (6.8%). Owens and Stoessel concluded in their literature that the causative organisms depended on the type of surgical procedures in 2008. The most common organisms isolated through the culture test were Staphylococcus aureus; Enterococcus spp.; Klebsiella spp.; and Pseudomonas aerginosa [11]. The etiology of SSI may be normal patient flora contaminated either through the surgical equipment or through the environment of entry. Gram-positive pathogens such as Staphylococcus aureus and Enterococcus spp. colonize the skin above the waist. On the other hand, both gram-positive pathogens and gram-negative pathogens normally colonize the skin below the waist. The microbiology of SSI may vary with the particular entry route [12]. Drug sensitivity patterns varied depending on the organism isolated. E. coli showed resistance mostly to cloxacillin, cefixime, ciprofloxacin was sensitive to ceftriaxone, nitrofurantoin, and gentamicin. S. aureas showed high sensitivity to ceftriaxone and meropenem. P.aeruginosa showed high sensivity to gentamicin and meropenem and complete resistance to amoxycilin, cefixime, ciprofloxacine. In 2011 the study by Nur-e-Elahi et al., [4] found that Escherichia coli was found resistant to Amoxycillin in 93.02% cases followed by Gentamicin in 37.21%, Ciprofloxacin in 32.56%, Nitrofurantoin in 25.58%, and least being Ceftriaxone in 11.63% and in the case of Staphylococcus aureus, it was most resistant to Amoxycillin (87.88%) followed by Cloxacillin (63.64%), Gentamicin (48.48%), Ciprofloxacin (36.36%) and least resistant to Ceftriaxone (12.12%). Also, in their study, Pseudomonas aeruginosa remained resistant to Amoxycillin in all (100%) cases. This shows that resistance of E. coli to ciprofloxacin has increased over time. But the sensitivity of gentamicin was higher than in their study. Also, for S. aureas sensitivity to amoxicillin and cloxacillin remained constant over time. This is also notable that ceftriaxone has remained sensitive to many cases till now, but without appropriate use of the drug which may decrease. Fortunately, Meropenem was found to 100% sensitive for all bacteria isolated in this study.

VI CONCLUSION AND RECOMMENDATIONS

Considering the findings of this study we can conclude that, Meropenem and Ceftriaxone may be considered as the most effective antibiotic in treating patients with surgical site infection. In such cases, applying very traditional or narrow-spectrum antibiotics may cause of increasing relapse rate. However, the findings provide an idea about the most recent pattern of surgical site infection and its aetiology and further nationwide studies are recommended. For getting more reliable information we would like to recommend conducting more studies in several places with a large sample size.

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