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Consequences of Surgical Site Infections, Bacterial Etiologies and Associated Factors among Post-Operative Patients in a Tertiary Level Hospital

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Abstract **Original Research Article**

***Background*:** Surgical site infections (SSIs) are infections that occurs one month after a surgery or one year after implant surgery or surgical procedure, either at the injury site or near the injury site. Surgical Site Infections are still a major global problem, especially in developing countries, where they cause increased morbidity and mortality. There is a dearth of information regarding SSIs, about its magnitude, bacteriological aetiologies and associated factors in this study hospital. ***Aim of the Study*:** The aim of the study to see the correlation among sterilization, antibiotic resistance and malnutrition with surgical site infection in a tertiary level hospital. ***Methods*:** This cross-sectional observational study was conducted in the Department of Surgery, Shaheed Suhrawardy Medical College and Hospital. Informed written consent, detailed history, physical examination and necessary investigations were performed. Total 160 admitted patients undergoing different surgical procedure were included in this study, irrespective of their age, sex, race and ethnic group. Data were collected by using a semi-structured questionnaire. Collected data were analyzed by the SPSS 25. ***Results*:** Average age of all patient was 36.10±12.15 years (range: 13-65 years), wherein maximum patients were aged <40 years, male gender (56.3%), had normal BMI (61.3%) and non-smoker (62.07%). About $1/4^{th}$ patients had diabetes mellitus. Maximum patients had undergone abdominal surgery (34.4%) followed by orthopedics and traumatology (20.6%), General surgery other than abdominal surgery (18.8%), Neurosurgery (13.8%), Vascular surgery (12.5%). Pre-operative waiting period for surgery was <3 days in most of the cases (48.8%), followed by 3-7 days (31.3%) and >7 days (20%). Mean operation duration was 1.49±0.73 hours. Twenty-nine patients (18%) developed SSI, of which 7% had deep incisional SSI, 6% had superficial incisional SSI and 5% had organ/space SSI. SSI culture reports showed that majority (93.1%) had positive culture growth, wherein 66.7% had single microorganism and rest 33.3% had multiple growth. Staphylococcus aureus (34.48%) was the most frequently found microorganism. surgical team sterility was properly maintained in maximum surgical procedures (71.9%). Besides, OT room and surgical instruments were also properly sterilized in most of the cases (65.6% and 70%, respectively). Older age, abnormal BMI, smoking history, DM, longer pre-operative waiting period and operation duration was significantly associated with development of SSI. Besides, surgical team sterility, OT room sterility and Instrument sterility were not properly maintained in most of the surgical procedures among SSI patients (65.52%, 68.97% and 58.62%, respectively). ***Conclusion*:** Abnormal BMI (underweight and overweight or obese) and poor sterilization had significant association with development of SSI. However, further studies are needed to establish and use the findings.

Keywords: SSI, Meropenem, Staphylococcus.

INTRODUCTION

Surgical infection, particularly surgical site infection (SSI), has always been a major complication of surgery and trauma and has been documented for 4000-5000 years [1]. The most recent data from the National Nosocomial Infection Surveillance system (NNIS) of the CDC indicate that surgical site infections are the third most frequently reported nosocomial infection. The incidence of infection varies from surgeon to surgeon, from hospital to hospital, from one surgical procedure to another and most importantly from one patient to another. Despite the advances made in asepsis, antimicrobial drugs, sterilization and operative techniques, SSI continues to be a major problem in all branches of surgery in the hospitals [2]. SSI is associated with a mortality rate of 3% and 75% of SSI-associated deaths are directly attributable to the SSI [3]. All surgical wound is contaminated by bacteria but only a minority actually demonstrate clinical infection. These infections are the biological summation of several factors: the inoculum of bacteria introduced into wounds during the procedure, the unique virulence of contaminants, the microenvironment of each wound and the integrity of patients host defense mechanism. In most patients, infection does not develop, because innate host defenses are quite efficient in the elimination of contaminants at the surgical site. WHO described Hospital acquired infections as one of the major infectious diseases having huge economic impact [4]. These infections concern 2 million cases annually worldwide [5]. Surgical site infection (SSI), previously called postoperative wound infections, resulting from bacterial contamination during or after a surgical procedure [6]. Factors for acquiring infection are host factors, surgical factor, environmental factor and nature of microbes. Host factors contributing to increased risk of infection are age, length of hospital stay and concurrent infection at the other site of the body. Among surgical factors the nature and extensibility of operation, site and depth of the wound, logistic used and continued during and after operation and surgeons' technical skills are remarkable. Among microbial factors virulence and numbers of bacteria are important. Local tissue defense can combat minute inoculums of virulent bacteria. But if host damage is extensive and co-morbidity in the form of diabetes or other immunosuppressive states remains, small inoculums of virulent bacteria can ensure and overwhelming infection occurs. On the other hand, virulent bacteria of drug resistant nature may be the single factor of an overt and fulminant infection [7-9]. 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 over wall, bed, OT table, trolley, linens, etc, those microbes are transmitted to the operated patients [10]. Surgery team in the same way transmits microbial agents to the operation wound. Dirty floor of the ward as well as unclear logistics-all are risk factors for surgical site infection [11]. The pathogens isolated from infections differ, primarily depending on type of surgical procedure. In clean surgical procedure, in which gastrointestinal, gynaecologic 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 procedure 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 [12]. The single most disadvantages 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 purpose. But this approach is not cost effective in developing countries. Many a time patient cannot afford those antibiotics due to poverty. So, 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 high magnitude of antibiotic resistance would rightly be expected. The number of variables that can influence SSI rates is large. Preoperative planning and intra-operative technique for both emergency and elective surgery has become important in prevention of SSI. Prevention of SSIs can be achieved by several methods. Organism in the wound can be reduced via better preoperative preparation of 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 heamatoma. Enhancement of host defenses by increasing oxygen delivery, better core body temperature control during the perioperative period and rigorous blood glucose control in the 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 [13]. In our hospital, Shaheed Suhrawardy Medical College Hospital, a fair number of patients develop surgical site infection after surgery during routine and elective surgery. But there is no infection control policy that runs effectively in our hospital. So, purpose of the study was to see the correlation among sterilization, antibiotic resistance and malnutrition with surgical site infection in a tertiary level hospital.

MATERIALS AND METHOD

This is a cross sectional study done at Shaheed Suhrawardy Medical College and Hospital over a period of one year (August 2017 to July 2018) amongst the admitted patient in Department of Surgery. A total of 160 participants were chosen for purposive sampling. Patients with RTA, under 12 years of age, history of prosthetic surgery and with formed abscess needing drainage are excluded from this study. After inclusion and assessment, all patients were interviewed by the research team for base line data like age, sex, socioeconomic status, BMI and co-morbid disease. Participants were investigated for anesthetic fitness as well as to identify comorbidities. Following operation all patients were followed up for 30 days. Patients who were discharged earlier the period were also followed up over telephone. Wound infection or surgical site infection were defined by standard criteria as mentioned in operational definition. Moreover, these infections were managed by both regular surgical dressing and use of proper antibiotics. Empirical antibiotics were administered after detection of the infection. Before that blood culture as well as swab from wound culture was sent for confirmation of infection and culture sensitivity. After collection of the culture sensitivity report, antibiotics were chosen in according to the sensitivity report. Face to face interview was conducted by using a semi-structured questionnaire containing socio- demographic parameters and relevant information.

RESULTS

This cross-sectional observational study was conducted in the Department of Surgery, Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh. After careful history taking, examination and appropriate investigations fulfilling inclusion and exclusion criteria, total 160 admitted patients undergoing different surgical procedure were included in this study, irrespective of their age, sex, race and ethnic group. The main aim of the study was to see the pattern and association of culture growth, sterilization and nutritional status with surgical site infection (SSI).

The most common surgical procedure performed was cholecystectomy (31.9%), followed in decreasing order by mastectomy (21.8%), gastrectomy (17.5%), hernioplasty (10%), Whipple's procedure (5%), prostatectomy (4.4%), abdominoperineal resection (3.8%), colectomy (3.7%) and splenectomy (1.9%).

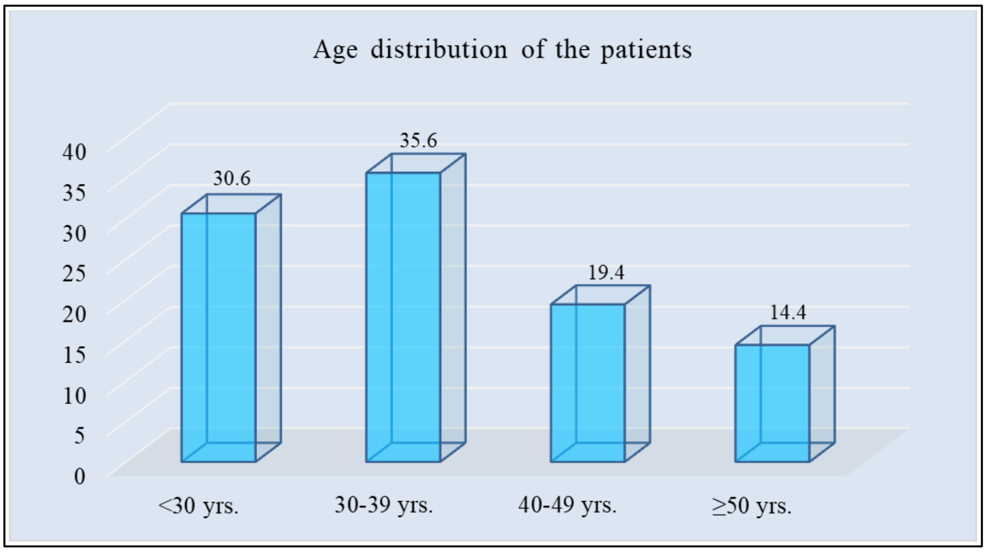

Figure 1: Column chart showed age wise patients (N=160)

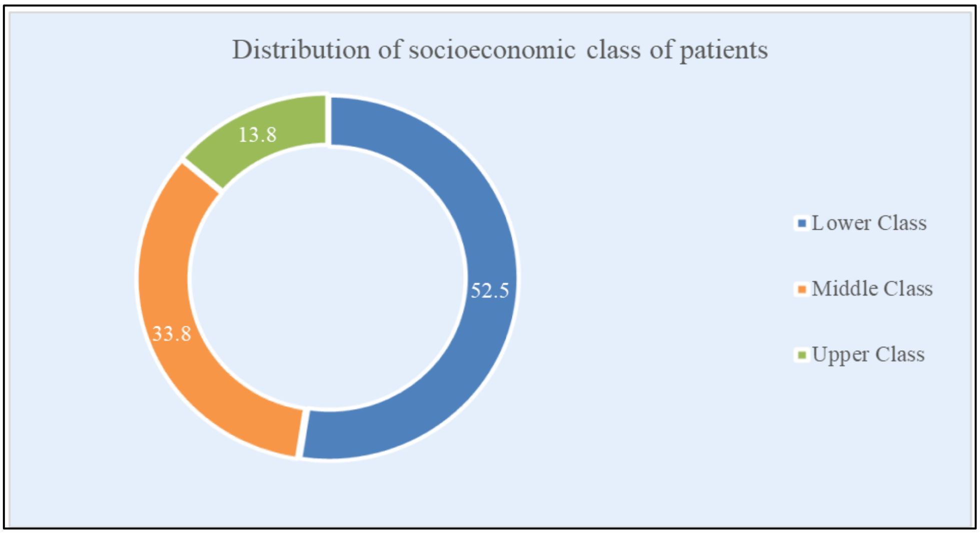

Figure 2: Ring chart showed economic class wise patients (N=160)

Table I: Frequency of different surgical procedures (N=160)

Indications	Frequency(n)	Percentage (%)
Cholecystecomy	51	31.9
Mastectomy	35	21.8
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	3.7
Splenectomy	3	1.9

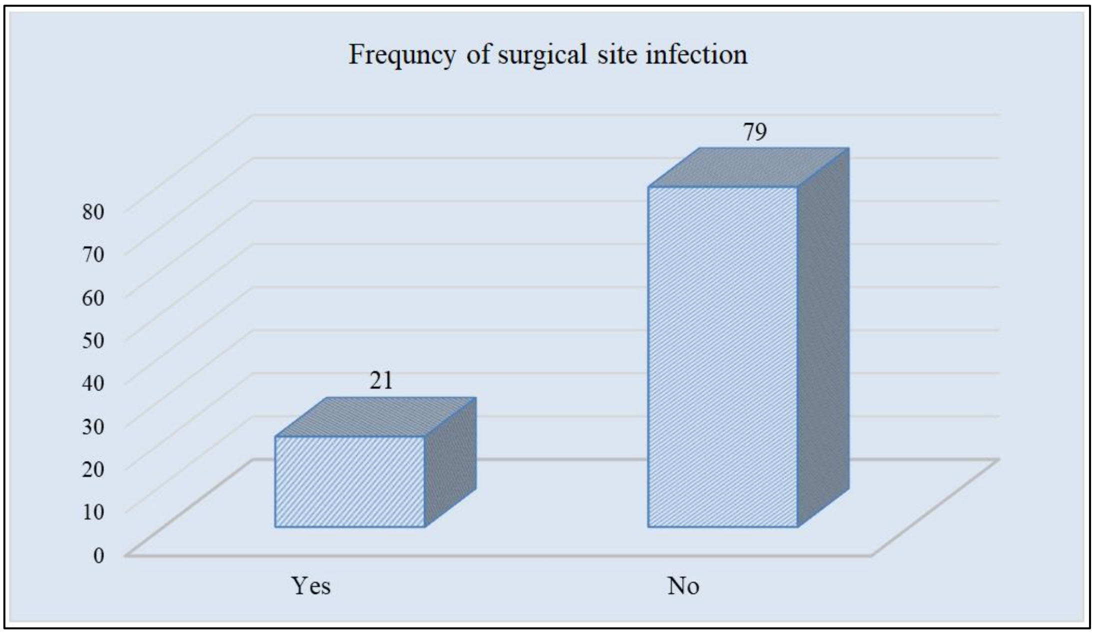

Figure 3: Column chart showed Frequency of surgical site infection of the patients (N=160)

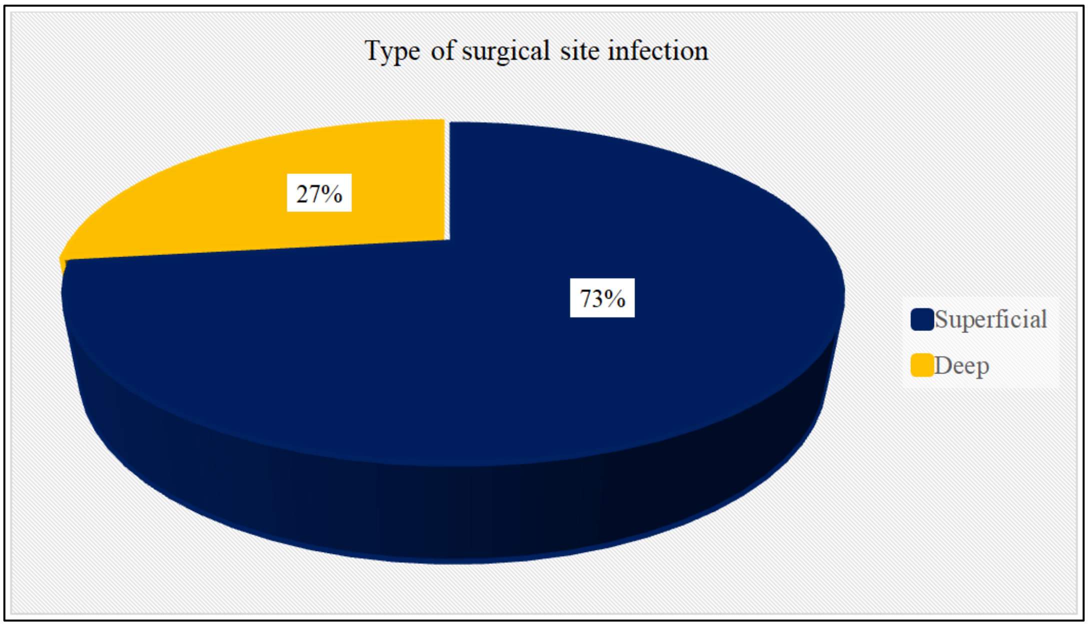

Figure 4: Pie chart showed type of surgical site infection of the patients (N=160)

Figure 3 & 4 showed among all patients 21% developed surgical site infection. Among cases of SSI 73% were superficial infection and 27% were deep infection.

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	<0.001
DM	21	63.6	18	14.2	39	24.4	<0.001
Obesity	7	21.2	17	13.4	24	15.0	0.262
Older age (>60 years)	15	45.5	16	12.6	31	19.4	<0.001
Nutritional status below average	8	24.2	14	11.0	22	13.8	0.049
Anaemia	17	51.5	29	22.8	46	28.7	0.001
Jaundice	11	33.3	23	18.1	34	21.3	0.057
Smoking	8	24.2	16	12.6	24	15.0	0.09

Table II showed the most common risk factors for SSI was 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%). Proportion of HTN, DM, older age (>60 yrs), anaemia and below average nutrition was significantly higher in patients who had SSI (p<.05).

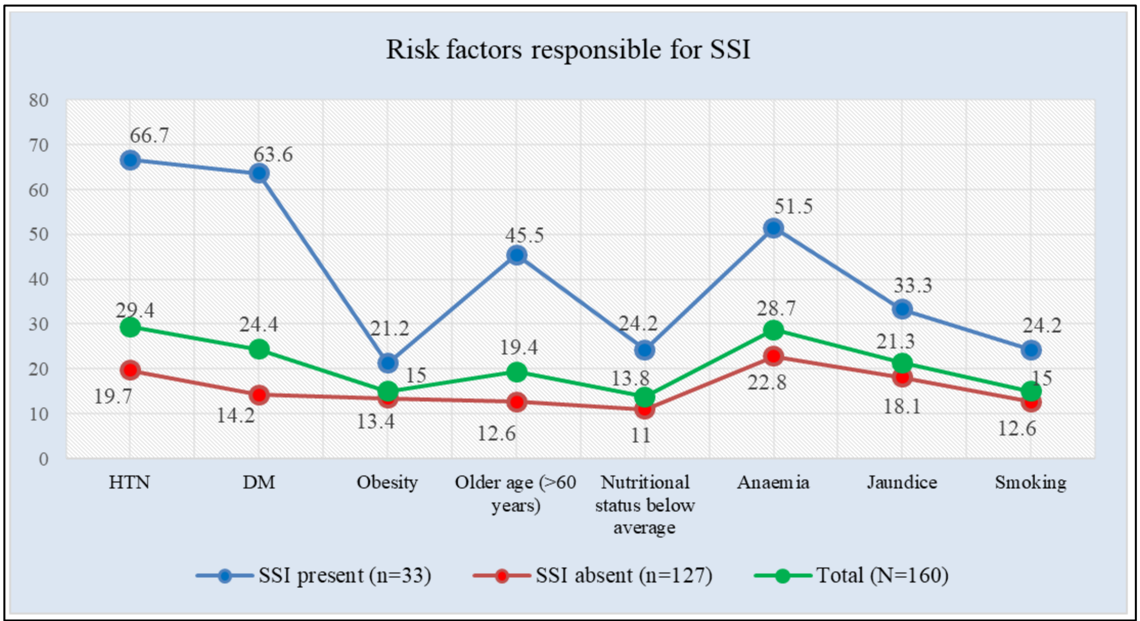

Figure 5: Line chart showed Risk factors responsible for SSI of the patients (N=160)

Table III: Duration of surgery and its relation with SSI (N=160)

Duration of surgery	SSI present(n=33)		SSI absent(n=127)		Total(N=160)		P value
	n	%	n	%	n	%	
One hour	8	24.2	54	42.5	62	38.7	0.04
More than one hour	25	75.8	73	57.5	98	61.3	

Table III showed 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 less than one hour. The difference was significant (p<0.05).

Table IV: Microorganisms responsible for SSI (n=33)

Microorganisms	Frequency(n)	Percentage (%)
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 showed 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%).

Table V: Drug sensitivity pattern of different organisms isolated from SSI (n=33)

Drugs tested	Organism				
	S. aureas	**E. coli**	**P. aeruginosa**	**Bacteroids**	**Klebsiella**
Amoxycillin	57.1%	0.0%	0.0%	100%	0.0%
Cloxacillin	57.1%	11.1%	0.0%	75%	50%
Ceftriaxone	85.7%	77.8%	25%	100%	100%
Cefixime	42.9%	33.3%	0.0%	75%	50%
Cefuroxime	57.1%	55.6%	0.0%	0.0%	100%
Ciprofloxacin	64.3%	33.3%	0.0%	0.0%	100%
Nitrofurantoin	NA	77.8%	NA	NA	50%
Gentamycin	NA	66.7%	75%	NA	100%
Meropenem	100%	100%	100%	NA	NA

Table V showed the drug sensitivity pattern of different drugs isolated from SSI. Meropenem was the most sensitive drug followed by Ceftriaxone. Gentamycin was cent percent sensitive for gram negative organism only.

DISCUSSION

In the study mean age of the population was 51.79±11.30 years. This was slightly higher than that found by Sickder *et al.*, [14]. They reported a mean age of 44.69±19.16 years. The difference can be explained the difference in inclusion criteria of both these studies. Sickder *et al.*, [14] included children and young adult in their study which may have decreased the overall mean age. Majority patients belonged to age group 51-60 years (36.3%). This corresponds with the findings of Nur-e-elahi *et al.*, in BSMMU [15]. In their study highest number of infections was noted in fifth decade of life. Majority patients were male (59%) and 41% were female in this study. This is similar to the findings of Sickder and Nur-e-elahi in Bangladesh but is dissimilar to the findings of Mawalla in Tanzania and Kumar and Rai in India who reported a female preponderance [14-17]. In the present study majority patients came from rural area (61%). This corresponds with national distribution of population in rural and urban areas and probably represents that figure. Also, similar to this study Laloto and his team 57.1% patients coming from rural area [18, 19]. Surgical site infection (SSI) developed in 21% patients in this study. This is higher than that of Sickder *et al.*, (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%) [14-16]. Prevalence of superficial SSI was73% and deep SSI was 27%. In comparison another study done in a tertiary care hospital by Sickder and colleagues 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 [14]. 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 this study HTN, DM, older age (>60 yrs), anaemia and below average nutrition carried significant association with SSI. On a similar note Mawalla [16], Laloto and Siddique [19, 20] 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 (>60 years) and Siddique (>50 years) [16]. Anaemia was examined and found to be a risk factor for SSI by Lubega [20, 21] who reported that chance of SSI increased with degree of anemia. Smoking was significantly associated with SSI in the study by Mawalla *et al.*, Obesity was found to be associated with increased chance of SSI by Laloto [16, 19]. 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 duration of operation was more than 60 minutes. In the study by Nur-e-elahi *et al.*, [15] a higher incidence of SSI was observed when duration of operation was more than 150 minutes. Cruse *et al.*, [22] 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 the time and longer procedures are more liable to be associated with blood loss and shock, thereby reducing the general resistance of the patients. Increased amount of suture and electro-coagulation may also reduce the local resistance of the wounds. Multiple regression analysis of risk factors showed that DM 6.27-time higher odds (95% CI 1.93-22.38, p<0.05) of developing SSI. On Laloto *et al.*, [19] found that diabetes OR 1.44 (95% CI 0.14-14.) and Mawalla [16] found that diabetes had OR 29.6 (95%CI 4.3-281, p <0.05). Obesity had an OR of 6.25 (95%CI 1.64-23.83) in this study. Laloto *et al.*, [19] enlisted an OR 2.18 (95% CI 0.188-25.23, p<0.05) in their study. In the present study presence of anaemia was associated with significant high odds OR6.35, 95%CI 1.99 – 20.25(p=0.002). Lubega *et al.*, [21] noted a similar picture. They found that moderate anemia had an OR 3.2 (95%CI1.05-9.90) and severe anemia had an OR 6.9 (95%1.28-37.66) of developing SSI on univariate regression. On multivariate regression 1 gm/L lowering of hemoglobin was found to be associated with 2.4 times increased risk (OR2.4, 95%CI1.12-5.34, p=0.024) of developing SSI. 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 [15] and team found that the most predominant isolated organism in their study was Escherichia coli (43%) followed by Staphylococcus aureus (33%) and Pseudomonas aeruginosa (11%). Sickder *et al.*, [14] 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%). In 2008, Owens and Stoessel concluded in their literature that the causative organisms depended on the type of surgical procedures. The most common organisms isolated through the culture test were Staphylococcus aureus; Enterococcus spp.; Klebsiella spp.; and Pseudomonas aerginosa [23]. 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 [24]. Drug sensitivity pattern varied depending on 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 [15] 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 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 sensitivity of gentamicin was higher than 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, which may decrease without appropriate use of the drug. Fortunately, Meropenem was found to 100% sensitive for all bacteria isolated in this study.

LIMITATIONS

There were a number of limitations of the study, which includes:

a) Sample size is not representative to generalized the findings.
b) Study samples were collected in only one tertiary care center.
c) Patients undergoing emergency operations were not included.
d) Influence of socioeconomic status behind SSIs was not examined.
e) Long term follow ups were not assessed.

CONCLUSION

Surgical site infections (SSI) are serious postoperative complications with significant impact on morbidity and mortality. In this study, the incidence of SSI among elective postoperative patients at SSMC&MH is high compared to that in the developing world and slightly less than developed countries. Staphylococcus aureus cause the majority of superficial SSIs, whereas *E. coli* is the most frequent organism isolated from deep SSIs. Development of SSI was associated with Hypertension, anemia, DM, increasing age and malnutrition. Sensitivity screening showed Meropenam and gentamycin were the two most potent antibiotics against organisms that cause SSI among the patients. However, the findings provide an idea about the most recent pattern of surgical site infection and its aetiology and further nationwide studies are recommended.

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