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Pattern and aetiological factors of surgical site infection among patients undergone surgery in a tertiary care hospital

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Article Info

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Abstract

Surgical site infections (SSIs) are the second most common nosocomial (hospital-acquired) infections after urinary tract infections. Despite recent advances in aseptic techniques, till now SSI has been considered as a major source of morbidity and mortality in developing countries and continued to represent about one fifth of all healthcare-associated infections. This cross-sectional study was conducted to analyze the pattern & aetiological factors of SSI among patients undergoing surgery at Sir Salimullah Medical College Mitford Hospital, Dhaka, Bangladesh involving 160 admitted patients during the study period. Of all SSIs, 73.0% were superficial and 27.0% were deep infections. Among the risk factors, Hypertension (29.4%), Diabetes Mellitus (24.4%), old age (>60 yr) [19.4%], anaemia (28.7%), and below average nutrition (13.8%) were the most common and had statistically significant relation with SSIs ($p<.05$). Moreover, incidence of SSIs was significantly higher in patients who required more duration of operation. The most common organism involved in SSI was S. aureas (42.4%), followed by E. coli (27.3%), P. aeruginosa (12.1%), bacteroids (12.1%) and Klebsiella spp. (6.1%). However, Meropenem was the most sensitive drug followed by Ceftriaxone according to culture and sensitivity screening. Gentamycin was 100% sensitive for gram-negative organism only. The incidence of SSIs are about one fifth of the post-surgical cases, where Staphylococcus aureus was the most prevalent organism. Meropenem and Gentamicin were the two most sensitive drugs against infections.

Introduction

Infection at surgical incision site has always been a burden in clinical practice for years. Numerous studies and analysis have been performed and reported to get to the root of it. A series of update has been engraved to the history of analysis and monitoring, subjecting the patterns and aetiology. Surgical site infection (SSI), previously called 'postoperative wound infections', may occur within 30 post-operative days of the surgical procedure, or within 1 year if an implant is left in situ (eg, mesh, heart valve). SSI have been further classified as (i) superficial incisional and deep incisional.[1-3] (ii) Organ/space SSI. Factors for acquiring infection are host factors, surgical factors, environmental factors and nature of microbes.[4-6] 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 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 i.e. diabetes or other immunosuppressive states remain, small inoculums of virulent bacteria can ensure SSI and overwhelming infection occurs. On the other hand, virulent bacteria of drug resistant nature may be the single factor of an fulminant infection.[7-9]

Environment of operation theatre and surgery ward are crucial factors for infection. Overcrowding of visitors in general access zone and within wards results in spreading of infection by droplet from talking, sneezing and coughing.[10] Surgery team in the same way transmits microbial agents to the operation wound. Dirty floor of the ward & unclear logistics are risk factors for surgical site infection.[11]

The pathogens isolated from infections differ, depending on type of surgical procedure. In clean surgical procedure, in which gastrointestinal, genito-urinary 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 disadvantage of those microbes is their multi-drug resistance property. To overcome this problem, newer antibiotics such as new generation cephalosporins and quinolones are randomly used for prophylactic and therapeutic purpose. But this approach is not cost effective in developing countries. Most of the time, patient cannot afford those antibiotics due to poverty. So, treatment remains incomplete, leading to development of resistance to that particular drug.

Enhancement of host defenses by increasing oxygen delivery, better core body temperature control during the perioperative period and rigorous blood glucose control have the potential to reduce the rate of SSI. Although an SSI rate of zero may not be achievable, continued progress in understanding the pathogenesis of infection and application of methods of prevention will allow us to further reduce the frequency, cost, and morbidity associated with SSI.[13]

Methods

This cross sectional study was conducted at Sir Salimullah Medical College and Mitford Hospital (SSMC&MH) over a period of one year (August 2017 to July 2018) among the admitted patient in the Department of Surgery. A total of 160 subjects (n=160) were recruited. Patients with road traffic accident, under 12 years of age, history of prosthetic surgery such as mesh repair of hernia surgery, orthopaedic implants and with formed abscess needing drainage were excluded from the study. All patients were interviewed and assessed for base line data like age, sex, socioeconomic status, BMI and co-morbid diseases such as Diabetes Mellitus, Jaundice, Respiratory tract infections, Chronic renal failure etc. Subjects were investigated for anesthetic fitness as well as to identify comorbidities. All patients were followed up for 30 days after operation. Patients who were discharged earlier, was also followed up over telephone. Wound infection or surgical site infection was 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 culture and sensitivity. After getting culture and sensitivity report, antibiotics were changed accordingly. A semi-structured questionnaire containing socio-demographic parameters and relevant information was used for this study.

Results

Total 160 patients undergoing different types of surgeries were included. Mean age of the study population was 51.79±11.30 years ranging from 27 – 72 years. Majority patients belonged to 51 – 60 years (36.3%), among which 59% were male and 41% were female. (Figure - 1 and Figure - 2) Majority patients were from lower socio-economic class (52.5%). followed by middle class (33.8%) and upper class (13.8%).

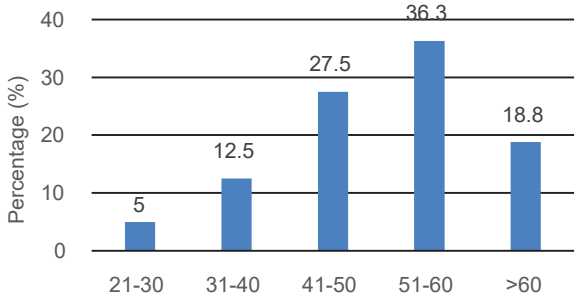

Figure - 1: *Age distribution of study population (n=160)*

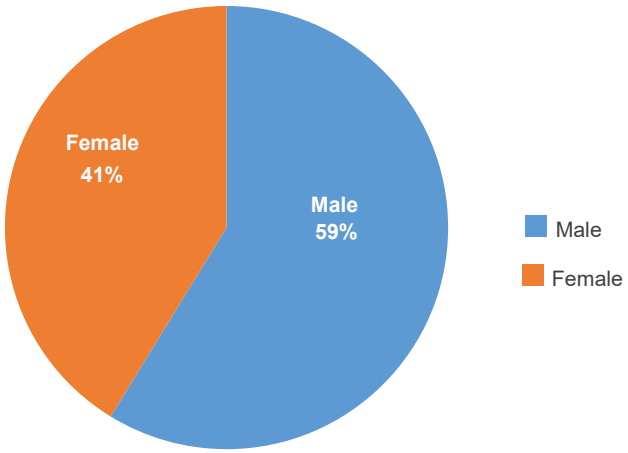

Figure - 2: *Sex distribution of study population (n=160)*

The most common surgical procedure performed was cholecystectomy (31.9%), followed in decreasing order by mastectomy (21.9%), gastrectomy (17.5%), hernioplasty (10%), Whipple's procedure (5%), prostatectomy (4.4%), abdominoperineal resection (3.8%), colectomy (3.8%) and splenectomy (1.9%).(Table - I)

Table-I

Frequency of different surgical procedures (n=160)

Indications	Frequency	Percentage (%)
Cholecystecomy	51	31.9
Mastectomy	35	21.9
Gastrectomy	28	17.5
Hernioplasty	16	10
Whipple's procedure	8	5
Prostatectomy	7	4.4
Abdominoperineal resection	6	3.8
Colectomy	6	3.8
Splenectomy	3	1.9

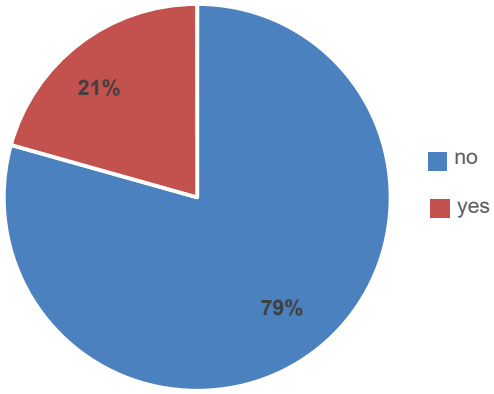

Figure-2: *Frequncy of Surgical Site Infection*

In this study 21% patients developed surgical site infection among which 73% were superficial infection and 27% were deep infection. (Figure - 2 & 3)

The most common risk factors for SSI was HTN (29.4%), followed by anaemia (28.7%), Diabetes Mellitus(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 yr), anaemia and below average nutrition were significantly higher in patients who had SSI (p<.05). (Table - II)

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). (Table -III)

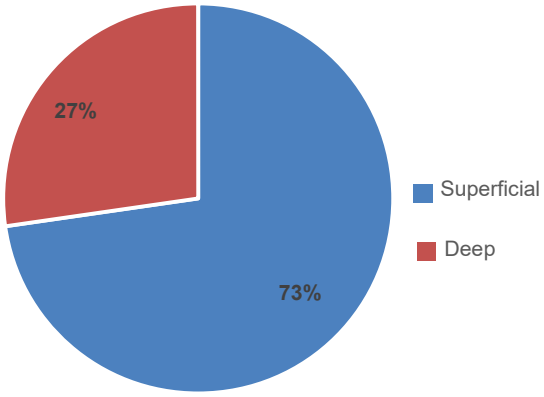

Figure-4 *Type of surgical site infection*

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	<.001
DM	21	63.6	18	14.2	39	24.4	<.001
Obesity	7	21.2	17	13.4	24	15	.262
Older age (>60 years)	15	45.5	16	12.6	31	19.4	<.001
Nutritional status below average	8	24.2	14	11.0	22	13.8	.049
Anaemia	17	51.5	29	22.8	46	28.7	.001
Jaundice	11	33.3	23	18.1	34	21.3	.057
Smoking	8	24.2	16	12.6	24	15	.09

P value determined by Chi-square test

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	38.8	0.04
More than one hour	25	75.8	73	57.5	98	61.3	

P value determined by Chi-square test

Multiple logistic regression analysis of risk factors showed that DM, obesity and anaemia had significantly higher odds of developing SSI after an operation (OR 6.57, 95% CI 1.93-22.38, p=0.003; OR 6.25, 95% CI 1.64- 23.83, p=0.007 and OR 6.35, 95%CI 1.99 – 20.25, p=0.002, respectively). Other factors including HTN, age more than 60 years, below average nutrition, jaundice, smoking and duration of surgery more than one hour also had higher odds of developing SSI but was not significant. (Table -IV)

The most common organism involved in SSI was *S. aureas* (42.4%), followed by *E. coli* (27.3%), *P. aeruginosa* (12.1%), bacteroids (12.1%) and *Klebsiella* spp. (6.1%). 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. (Table –V, & Table-VI)

Table-IV

Multiple logistic regression of risk factors responsible for SSI (n=160)

Risk factors	Odds Ratio (OR)		95% CI	P value
HTN	2.03	0.63	6.63	0.237
DM	6.57	1.93	22.38	0.003
Obesity	6.25	1.64	23.83	0.007
Age > 60 years	2.82	0.61	13.15	0.185
Below average nutrition	1.83	0.42	8.02	0.422
Anemia	6.35	1.99	20.25	0.002
Jaundice	3.84	0.98	15.11	0.054
Smoking	1.82	0.48	6.89	0.375
Duration of surgery >1 hr	1.21	0.34	4.33	0.765

Table-V

Microorganisms responsible for SSI (n=33)

Microorganisms	Frequency	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-VI

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	100%	0
Cloxacillin	57.1%	11.1%	0	75%	50%
Ceftriaxone	85.7%	77.8%	25%	100%	100%
Cefixime	42.9%	33.3%	0	75%	50%
Cefuroxime	57.1%	55.6%	0	0	100%
Ciprofloxacin	64.3%	33.3%	0	0	100%
Nitrofurantoin	NA	77.8%	NA	NA	50%
Gentamycin	NA	66.7%	75%	NA	100%
Meropenem	100%	100%	100%	NA	NA

Discussion

In this 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 mean age of 44.69±19.16 years. This difference may be due to difference in inclusion criteria of these studies. Sickder et al included children and young adult in their study which might have decreased the overall mean age. In our study majority patients belonged to age group 51–60 years (36.3%). This corresponded with the findings of Nur-e-elahi et al in BSMMU.[16] In their study highest number of infections were noted in fifth decade of life.

Majority patients were male (59%) in this study. This is similar to the findings of Sickder and Nur-e-elahi in Bangladesh but was not consistent to the findings of Mawalla in Tanzania and Kumar and Rai in India who reported a female predominance.[14-18] In this study most of the patients came from rural area (61%). This corresponds with national distribution of population in rural and urban areas. Also, similar to this study , 57.1% patients came from rural area in the study conducted by Laloto and his team.[15]

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%).[14-18] In our study 73% SSIs were superficial infections and 27% were deep. In comparison of another study, done by Sickder and colleagues, 58.1% SSIs were superficial and 41.9% were deep. 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 developing SSI in this study were 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 Hypertension, Diabetes Mellitus, older age (>60 yr), anaemia and below average nutrition carried significant association with SSI. Similarly Mawalla[18], Laloto and Siddique[15,20] found that diabetes was significantly associated with increased prevalence of SSI ($p<0.05$). Mawalla also found HTN as 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)[18,20]. Anaemia was found to be a risk factor for SSI by Lubega[19]. Smoking was significantly associated with SSI in the study by Laloto et al. Obesity was found to be associated with increased chance of SSI by Mawalla. [15,18] 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 [16] a higher incidence of SSI was observed when duration of operation was more than 150 minutes. Cruse et al [20] found an increase of wound infections with procedures of longer duration, roughly doubling with every hour of the procedure. This might be due to several factors like doses of bacterial contamination increases with the time and longer procedures are more liable for 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 have 6.27-time higher odds (95% CI 1.93-22.38, $p<0.05$) of developing SSI. Laloto et al [15] found that diabetes had OR 1.44 (95% CI 0.14-14.) and Mawalla[18] 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 [15] enlisted an OR 2.18 (95% CI 0.188-25.23, $p<0.05$) in their study. In this study presence of anemia was associated with significant high odds OR6.35, 95%CI 1.99 – 20.25($p=0.002$). Lubega et al[19] noted similar findings. 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.

The most prevalent organism cultured from wound swab was *S. aureas* (42.4%), followed by *E. coli* (27.3%), *P. aeruginosa* (12.1%), bacteroids (12.1%) and *Klebsiella* spp. (6.1%). In contrast Nur-e-Elahi 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%) as the most common organism 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 were Staphylococcus aureus; Enterococcus spp.; Klebsiella spp.; and Pseudomonas aerginosa.[21] 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[21].

Drug sensitivity pattern varied depending on isolated organism. *E. coli* showed resistance mostly to cloxacillin, cefixime, ciprofloxacin and sensitivity 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 Nur-e-elahi found in their study 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. Meropenem was found to 100% sensitive for all bacteria isolated in this study.

Conclusion

SSI is a serious postoperative complications with significant impact on morbidity and mortality. 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. S. 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. 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.

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