A Prospective Analytical Study on Surgical Site Infections in a Tertiary Teaching Hospital

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ABSTRACT

BACKGROUND

Surgical site infection (SSI) is defined as the infection that develops in a surgically created wound. SSI is the most frequently reported Hospital acquired infection in lower- and middle-income countries. Management of SSI especially when caused by drug-resistant pathogens becomes expensive due to prolonged hospitalisation with added morbidity as well. Early detection, treatment and prevention of surgical infections are important. We wanted to evaluate the risk factors of surgical site infections, identify the pathogens, and study their antimicrobial susceptibility pattern.

METHODS

176 post-operative patients were included in the study with the clinical profile of surgical site infections. Patients with history of diabetes mellitus, immunosuppression, obesity and those on steroids were excluded. Demographic data of the patients and the diagnostic criteria were observed. Risk factors like use of prophylactic antimicrobial agents, the type and duration of surgery, clinical evaluation of wound (considered infected if there was pus discharge or redness and swelling with fever), and laboratory data (including gram stain, culture results, identification of the bacterial isolates as well as antimicrobial susceptibility) were recorded. All the data was analysed using standard statistical methods.

RESULTS

Among the 176 patients, there were 102 (57.95%) male patients and 74 (42.04%) female patients. The youngest patient was 18 years old and the eldest patient was aged 64 years with a mean age of 42.45 ± 2.35 years. Patients between 28 and 57 years of age, accounted for 75/176 (42.61%) of the total patients. 176 swabs collected for culture, isolation and sensitivity tests for the organism 61/176 (34.65%) showed positive isolation. 16 / 176 (09.09%) patients had frank clinical infection requiring drainage of pus and frequent dressing. Emergency surgeries showed a significantly higher rate of infection compared to elective operations (P=0.021). The incidence of SSIs depending upon the sites of surgeries, duration and co-morbid diseases were found to be statistically significant with p values less than 0.05.

CONCLUSIONS

The rate of SSI was higher in females than in males. The rate of SSIs was higher in contaminated operations in females, when compared to males. This was comparable to some studies and higher than others. Bacteria cultured reflected the site of operation, with *Pseudomonas aeruginosa* being the most commonly isolated bacteria in the abdominal operations.

KEYWORDS

Surgical Site Infections, Pathogens, Antimicrobial Agents, Susceptibility, Risk Factors for Surgical Infection

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DOI: 10.18410/jebmh/2020/334

How to Cite This Article:
Noorudheen NK, Ahmed S. A prospective analytical study on surgical site infections in a tertiary teaching hospital. J Evid Based Med Healthc 2020; 7(32), 1591-1595. DOI: 10.18410/jebmh/2020/334

Submission 26-05-2020,
Peer Review 31-05-2020,
Acceptance 30-06-2020,
Published 10-08-2020.

BACKGROUND

Surgical Site Infection (SSI) is defined as an infection at or near surgical incisions within 30 days of an operative procedure or up to one year after surgery in patients receiving implants.[1] They account for increased surgical morbidity and mortality. SSI account for 15% of the nosocomial infections among the surgical patients.[2] The most common factors causing SSI are poor preoperative preparation, wound contamination, improper antibiotic selection, or the lack of ability of an immuno-compromised patient to fight against infection from microbes living in the vicinity of the incision.[3] In India the rate of SSI is found to be between 4% and 30%.[4] The National Research Council of USA in 1964 classified SSI into four categories based on the degree of their bacterial contamination. Infection rate in these categories are clean (1% - 5%), clean contaminated 3%-11% and contaminated 10% - 17% and dirty more than 27%.[5]

The common clinical presentations of SSI are characterized by pain, tenderness, warmth, erythema, swelling and pus formation.[6,7] The common pathogens causing SSIs vary with varying geographical location, between various procedures, between surgeons, from hospital to hospital or even in different wards of the same hospital.[8] In recent times gram negative organism and resistant organisms like MRSA are increasingly causing the in many hospitals all over the world.[9] Other factors worth mentioning are irrational use of broad spectrum antibiotics and increase in the incidence of anti-microbial resistance further deteriorating the prognosis of SSIs.[10] Another factor for this complication especially in developing countries is due to poor infection control practices and overcrowded hospitals.[11] The common risk factors of SSIs in any given population are patient's age, length of surgery, pre-operative shaving of the operative site, hypothermia and co morbidities like diabetes, obesity, associated malignancies, protein malnutrition, low haemoglobin levels and obesity.[12] Review of literature shows that the majority of organisms causing SSI are, gram positive cocci like staphylococcus aureus and gram negative bacilli like E. coli, Klebsiella, pseudomonas and Enterobacter species [13, 14]. The present study was conducted to look for the risk factors of surgical sites infections, to identify the pathogens and their antimicrobial susceptibility.

METHODS

In this Prospective study 176 patients who underwent various General surgery procedures in the department of general Surgery of KMCT Medical College, Manassery, Kozhikode, Kerala were included. An ethical committee clearance was obtained before the commencement of the study. An ethical committee cleared consent form was used for this study.

The demographic data of the patients and the diagnostic criteria were included in the proforma circulated among the residents to collect the data during the study. The risk factors like use of prophylactic antimicrobial agents, the type and duration of surgery, clinical evaluation of wound (considered infected if there was pus discharge or redness and swelling with fever), and laboratory data (including, culture results, identification of the bacterial isolates as well as antimicrobial susceptibility) were recorded on a data sheet.

Inclusion Criteria

1. Patients of both genders and aged between 18 years and 67 years were included.
2. Patients undergoing both in General wards and General surgical intensive care wards were included.
3. Patients matching the criteria of definition of SSI were included.

Exclusion Criteria

1. Patients aged below 18 ears and above 65 years were excluded.
2. Patients with history of Diabetes mellitus, immunosuppression, and obesity and those on steroids were excluded.

The surgical wounds were classified according to the guidelines of the Centers for Disease Control and Prevention - CDC Atlanta 1999.[14] "Surgical operation" was defined as a procedure to involve skin incision and should be in an operating theatre under any type of anesthesia**.** The surgical operations were classified as clean, clean contaminated, contaminated and dirty according to the system employed in the American College of Surgeons, Committee for Centers of Surgical Infection Qualities.[14] A fixed protocol was used to collect the swabs of pus from the deeper aspects of infected surgical wounds. All the swabs were tested for Gram's stain, isolation of organism, culture for aerobic and anaerobic organism on blood agar as well as in cooked meat broth. In vitro Bacterial for susceptibility was done. Appropriate antibiotics were administered in required doses for 10 days. Necessary secondary suturing or wound repairs were done in all patients. Following discharge, two follow-up visits were planned for the patients at two and four weeks in the surgical outpatient clinic to assess the surgical site. All the data was analysed using standard statistical methods.

RESULTS

Among the 176 patients included in the present study there were 102 (57.95%) male patients and 74 (42.04%) were females. The youngest patient was 18 years old and the eldest patient was aged 64 years with a mean age of 42.45 ± 2.35 years. Patients belonging to the age groups between 28 to 57 years accounted for 75/176 (42.61%) of the total patients. The incidence among the age groups of 48 to 67 was 61/176 (34.65%). The other demographic data was tabulated in Table 1.

Observation	Male- 102 (57.95%)	Female- 74 (42.04%)
Age		
18 to 27	14 (07.95%)	07 (03.97%)
28 to 37	19 (10.79%)	17 (09.65%)
38 to 47	36 (20.45%)	23 (13.06%)
48 to 57	20 (11.36%)	15 (08.52%)
58 to 67	13 (07.38%)	12 (06.81%)
BMI		
20 to 25	37 (21.02%)	24 (13.63%)
26 to 35	41 (23.29%)	31 (17.61%)
>35	24 (13.63%)	19 (10.79%)
Smoking		
Yes	49 (27.80%)	12 (06.81%)
No	53 (30.11%)	62 (35.22%)
Alcohol		
Yes	62 (35.22%)	08 (04.54%)
No	40 (22.72%)	66 (03.40%)

Table 1. Demographic Data (n-176)

Among the 176 swabs collected for culture and isolation and sensitivity tests for the organism 61/176 (34.65%) showed positive isolation. 16/176 (09.09%) patients had frank clinical infection requiring drainage of pus and frequent dressing. The multiple factors associated with SSI in this study were observed and there were 138/176 (78.40%) elective surgeries and 38/176 (21.59%) emergency surgeries. Among the elective surgeries there were 73 males (41.47%) and 65 (36.93%) were females. Among the emergency surgeries there were 29/176 (16.47%) males and 9/176 (05.11%) females. Abdominal surgeries were the commonest surgeries where SSIs were observed. There were 70/176 (39.77%) abdominal surgeries in the study. Among these 42 (23.86%) were in males and 28 (15.90%) were in females. The next common surgery performed resulting in SSIs was Neck surgeries accounting for 23/176 (13.06%) cases. Among these 14/176 (07.95%) were males and 09/176 (05.11%) were females. Among the 22 (12.50%) Breast surgeries observed in this study 20 were in females (Lumpectomy in 08/ 20 (40%) patients, Total mastectomy in 09/20 (45%) patients and breast abscess in 03/20 (15%) patients) 20/176 (11.36%) cases were infected (Table 2). Surgical sites were clean in 130/176 (73.86%) of the total surgeries included in this study. Contaminated sites of surgery were observed in 46/176 (26.13%) of the total cases (males 22/176 (12.50%) and females 24/176 (13.63%)). The duration of surgeries being Less than 2 hours was observed in 109 (61.93%) of the cases and more than 2 Hours of surgery was observed in 67/176 (38.06%) of the total cases (Table 2). Co-morbid diseases like diabetes was seen in 28 (15.90%), oral steroids intake in 15/176 (08.52%) of patients and immunosuppressive drugs intake in 06 (03.40%) of the patients (Table 2).

The comparison of incidence of SSI among the emergency surgeries and elective surgeries showed a significantly higher rate of infection in elective cases than in emergency cases with a p value 0.021. The incidence of SSIs depending upon the sites of surgeries, duration and co-morbid diseases were found to be statistically significant with p values less than 0.05 in both emergency and elective cases (Table 2). The rate of SSI was higher in females than in males. The rate of SSIs was higher in contaminated operations in females (13.63%) when compared to males (12.50%), (Table 2).Total number of organism isolated from the surgical sites of patients and their multidrug resistance (MDR) status were tabulated and observed multidrug resistance was observed in 32/176 patients (18.18%) and non-Multidrug resistance was observed in 29/176 (16.47%) patients (Table 3). When the organisms were resistant to more than 3 drugs then they were labelled as MDR. If the resistance was less than for 3 drugs they were labelled as non-MDR organism. The incidences of MDR and non-MDR organisms in the study were tabulate in Table 3. The commonest organism isolated in this study was *Pseudomonas aeruginosa* (21/176 (11.93%), Staphylococcus aureus was isolated in 16/176 (09.09%), E. coli in 08 (04.54%) and Klebsiella in 05/176 (02.84%) of the SSI wounds.

Associated Factors	Male- 102	Female- 74	P Value
Nature of Surgery			
Elective surgery- 138 (78.40%)	73 (41.47%)	65 (36.93%)	0.021
Emergency surgery- 38 (21.59%)	29 (16.47%)	09 (05.11%)	
Site of Surgery			
Abdomen- 70 (39.77%)	42 (23.86%)	28 (15.90%)	
Neck- 23 (13.06%)	14 (07.95%)	09 (05.11%)	
Back- 17 (09.65%)	11 (06.25%)	06 (03.40%)	
Thorax- 13 (07.38%)	09 (05.11%)	04 (02.27%)	0.047
Breast- 22 (12.50%)	02 (01.13%)	20 (11.36%)	
Axillae- 12 (06.81%)	07 (03.97%)	05 (02.84%)	
Perineal- 11 (%)	06 (03.40%)	05 (02.84%)	
Limbs- 08 (06.25%)	05 (02.84%)	03 (01.70%)	
Surgical Site			
Clean- 130 (73.86%)	80 (45.45%)	50 (28.40%)	0.022
Contaminated- 46 (26.13%)	22 (12.50%)	24 (13.63%)	
Duration			
< 2 Hrs. - 109 (61.93%)	66 (37.50%)	43 (24.43%)	0.43
>2 Hrs- 67 (38.06%)	36 (20.45%)	31 (17.61%)	
Co morbid Diseases			
Diabetes- 28 (15.90%)	21 (11.93%)	07 (03.97%)	0.511
On Steroids- 15 (08.52%)	11 (06.25%)	04 (02.27%)	
On Immunosuppressive drugs- 06 (03.40%)	04 (02.27%)	02 (01.13%)	

Table 2. Associated Factors in the Study of SSI (n-176). (MDR-Multi Drug Resistance)

Isolated Organism- 61	MDR- 32	Non- MDR- 29
Pseudomonas aerogenes- 21 (11.93%)	11	10
Staphylococci aureus- 16 (09.09%)	09	07
E. coli- 08 (04.54%)	04	04
Proteus -06 (03.40%)	02	04
Klebsiella- 05 (02.84%)	03	02
Strepto cocci- 03 (01.70%)	02	01
Acinetobacter Sp.-02 (0.56%)	01	01

Table 3. Different Bacteria Isolated and Their Sensitivity Pattern (n-61)

(MDR: Multi drug resistance; Non MDR = Non multidrug resistance)

DISCUSSION

Surgical Site Infections were defined according to the guidelines of CDC. In this study we defined SSI following the guidelines of the CDC [(15)]. The rate of SSI was higher in females than in males. The rate of SSIs was higher in contaminated operations in females (13.63%) when compared to males (12.50%), (Table 2). These patients who developed SSIs needed regular follow up with improved drainage and change of antibiotics and secondary suturing. This rate was lower than the 16.7% rate reported in a multicenter study from a study from republic of Georgia.[16] This difference may be due to the involvement of many hospitals in the Georgian study.[16] However, the type of operation was found to affect the rate of SSI in patients undergoing simultaneous pancreas-kidney transplantation

where the rate of SSI was 46%. Among the 176 patients included in the present study there were 102 (57.95%) male patients and 74 (42.04%) females. The youngest patient was 18 years old and the eldest patient was aged 64 years with a mean age of 42.45 ± 2.35 years. Patients belonging to the age groups between 28 to 57 years accounted for 75/176 (42.61%) of the total patients. This was similar to study conducted by J. Tanner, D. Khan, et al.[17] But the incidence of SSI in vascular surgeries reported by L. Neumayer, P. Hosokawa, and K. Itani et al was higher in males reaching more than 82% in a study by on general and vascular surgery.[18] The higher incidence among the men in the later study may be because of the fact that more males had vascular problems than females.[19] In the present study Patients belonging to the age groups between 28 to 57 years accounted for 75/176 (42.61%) of the total patients.

A previous study by M. Sharma, M.G. Fakih et al showed a predominance of SSI in the age group >65 years compared to <65 years.[20] In the present study the incidence among the age groups of 48 to 67 was 61/176 (34.65%). This can be explained by the difference in the type of operations performed in each study population. The comparison of incidence of SSI among the emergency surgeries and elective surgeries showed a significantly higher rate of infection in elective cases than in emergency cases with a p value 0.021 (Table 2). Similar findings were reported in other studies by Astagneau and US Kamat who reported 22% and 38.5% respectively. [21,22] Risk factors (comorbid diseases) like diabetes was seen in 28 (15.90%), oral steroids intake in 15/176 (08.52%) of patients and immunosuppressive drugs intake in 06 (03.40%) of the patients in this study. Neumeyer et al[23] also found a higher incidence of SSI among diabetics. In the present study abdominal surgeries were the commonest surgeries where SSIs were observed. There were 70/176 (39.77%) abdominal surgeries in the study. Among these 42 (23.86%) were in males and 28 (15.90%) were in females. The next common surgery performed resulting in SSIs was Neck surgeries accounting for 23/176 (13.06%) cases (Table 2).

Other authors have also reported the rate of SSI to be higher in operations performed on the abdomen particularly on the colon (8.7%) and more so in colonic resection (19%),[24,25] Among the 22 (12.50%) Breast surgeries observed in this study 20 were in females (Lumpectomy in 08/ 20 (40%) patients, Total mastectomy in 09/20 (45%) patients and breast abscess in 03/20 (15%) patients) 20/176 (11.36%) cases were infected (Table 2). Similar reports of SSIs were quoted by V.P. Ward and J. Wilson in their surgical studies.[26,27] In the present study the rate of SSIs increased in an ascending order from clean, clean contaminated to contaminated wounds. Others have shown similar findings.[28,29] Total number of organisms isolated from the surgical sites of patients and their multidrug resistance (MDR) status were tabulated and observed multidrug resistance was observed in 32/176 patients (18.18%) and non-Multidrug resistance was observed in 29/176 (16.47%) patients (Table 3). When the organisms were resistant to more than 3 drugs then they were labelled as MDR. If the resistance was less than for 3 drugs they were labelled as non-MDR organism. The incidences of MDR and non-MDR organisms in the study were tabulate in Table 3. Staphylococcus aureus was isolated in 16/176 (09.09%), E. coli in 08 (04.54%) and Klebsiella in 05/176 (02.84%) of the SSI wounds. In a similar study from India, the most predominant isolate was Staphylococcus aureus (37%) of which 21.7% were MDR compared to the low isolation rate of Staphylococcus aureus in our study 09.09% where nearly 50% were MDR. The possible reason for this difference was the smaller number of abdominal and perineal operations in the Indian study, compared to our study.[30]

An interesting finding in our study is the infrequency of isolation of *Acinetobacter* species, an organism commonly isolated in Intensive Care Units. This may be explained by the small number of cases from the surgical intensive care in our study. In this study the commonest organism isolated in this study was *Pseudomonas aeruginosa* 21/176 (11.93%) with 50% of them being MDR compared to an Indian study where the second commonest isolate (37%) was P. aeruginosa but only one third of these were MDR.[31] This study suffers from a few limitations, firstly, the number of infected cases was small, and secondly, if follow up cultures and molecular typing were done, it would give a better view.

CONCLUSIONS

The rate of SSI was higher in females than in males. The rate of SSIs was higher in contaminated operations in females, when compared to males. This was comparable to some studies and higher than others. The bacteria cultured reflected the sites of operation, with *Pseudomonas aeruginosa* being the most commonly isolated bacteria in the abdominal operations. The rate of surgical infection in diabetic patients and those who underwent emergency operations was significantly higher than others. *Acinetobacter* species were isolated in a significant number of SSIs. MDR organisms were nearly 50% of all SSIs studied.

Financial or Other Competing Interests: None.

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