ejpmr, 2022, 9(10), 526-531

SJIF Impact Factor 6.222

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

SPECTRUM OF SURGICAL SITE INFECTIONS IN GENERAL SURGERY: RISK FACTORS AND ANTIBIOTIC SUSCEPTIBILITY PATTERN IN TERTIARY CARE CENTRE, INDIA

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Article Received on 17/08/2022 **Article Revised on 06/09/2022** **Article Accepted on 27/09/2022**

ABSTRACT

Surgical site infections are a significant problem associated with major surgeries and are the third most frequently reported nosocomial infection. In cases of deep or extensive infection, this resulted in a mortality rate of 70-80%. This study aims to identify the risk factors and common microorganisms that are associated with surgical site infection. A prospective study was undertaken in the department of general surgery for a period of 3 months. The rate of surgical infection was studied in relation to its type of surgical procedure, elective v/s emergency surgeries, comorbidities, American Society of Anesthesiology, and Southampton grading system. The present study revealed that among 144 operated, the incidence rate was 12.5%. An alarming 11% of infections were associated with emergency surgeries as compared to 7% of elective surgeries, wherein 16% of infections was observed in diabetic patients. The antibiogram and their susceptibility patterns revealed that meropenam and linezolid have better coverage against both gram positive and negative organisms. Periodic surveillance of bacteria and antibiotic susceptibility coupled with the implementation of strict protocol antibiotic administration is important to minimize the risk of surgical site infection.

KEYWORDS: Surgical site infection, Nosocomial infection, Antibiotic susceptibility.

INTRODUCTION

Surgical site infection (SSI) previously termed postoperative wound infection is defined as infection presenting up to 30 days after a surgical procedure, if no prosthetic is placed and up to 1 year if a prosthetic is implanted in the patient.[1] They are the most common nosocomial infections after Urinary tract infections (UTI), responsible for increasing cost, substantial morbidity and occasional mortality related to surgical operations, even in hospitals with the most advanced facilities, standard protocols of pre operative preparation and antibiotic prophylaxis. The WHO reported that the incidence of SSI rate has varied from a low of 0.5% to a high of 15%.[2]

SSI can lengthen a patient's stay in the hospital and, as a result, raise the cost of health care.[2] Pathogens that cause SSI's are acquired either endogenously from the patient's own flora or exogenously from contact with operative room personnel or the environment.[1,2] However, the most significant change in the microbiology of SSI has been the increased involvement of resistant organisms like MRSA.[3] Surgical site infections may extend from the skin and superficial subcutaneous tissues of incision sites to deep subcutaneous tissues and organ spaces.[5] However, the period of greatest risk remains the time between opening and closing the operating site.[1] The risk factors that are mainly associated with SSI's are patients age, gender, duration of surgery, type of operation, operation category, smoking, obesity, hypertension, diabetes and chronic kidney disease (CKD).

Healthcare-associated infections (HIAs) are a major cause of morbidity and mortality that can be avoided. More than 30% of the HIA are surgical site infections (SSI), due to poor infection prevention practices among healthcare professionals in low-middle income countries.[4] Periodic surveillance of bacteria and antibiotic susceptibility coupled with the implementation of strict protocol antibiotic administration is important to minimize the risk of SSI.

Therefore, our study aimed to determine the incidence, risk factors and common micro-organisms that causes SSI. This study could provide insight into surgical site infections and help in evidence-based interventions like assessment of bacterial drug resistance, proper pre and post surgical management, surveillance of surgical site should be followed in order to prevent the occurrence of SSI in tertiary care hospital.

MATERIALS AND METHODS

This was a prospective and descriptive study conducted for a period of 3 months in department of general surgery at SS Institute of Medical Science and Research Centre (SSIMS and RC) Hospital between February to April, 2022. Ethical approval was obtained from the Institutional Ethics Committee (BPC/IEC/82/2021-22) of Bapuji Pharmacy College, Davangere, Karnataka and prior to data collection, informed consent was obtained from the study subjects. A total of 144 patients aged from 18 - 65 years, who underwent general surgery were included in this study and children less than 12years, pregnant women were excluded. All patients were evaluated from the time of administration to the time of discharge. Detailed history regarding demographics characteristics like age, sex, social habits (smoking, alcohol) were noted. Variables like BMI, co-morbid conditions (diabetes, hypertension), prophylactic antibiotic use, the type and duration of surgery, name of procedure, length of hospital stay, wound class, American Society of Anesthesiologists (ASA) score, Southampton Grading were recorded and compared in the infected (with SSI) and non-infected groups (without SSI). Post surgical wound swabs were collected and sent to the microbiology laboratory for analysis. Later culture results, identification of the bacterial isolates, antimicrobial susceptibility were obtained from laboratory data and noted on a data sheet. A single proportion formula was used to calculate the appropriate sample size from the reference literature which was found to be 150.

Statistical analysis

The collected data was entered into MS Excel and was analyzed using SPSS software (statistical package for social sciences). Microsoft Excel 2013 has been used to generate tables, pie charts and bar diagrams for data analysis. Descriptive statistics, such as count and percentage, were used to delineate the demographic characteristics of the subjects. We used Chi square test and bivariate analysis for comparing the demographics characteristics with potential risk factors associated with SSIs. We considered $p<0.005$ as statistically significant whereas, $p<0.001$ as highly significant.

RESULTS

In this study, out of 144 subjects who underwent surgery, 18 patients developed surgical site infection (SSI) and 126 patients without SSI. Socio-demographic characteristics of participants who had undergone surgery is described in Table 1, among them majority (57) were of the age group of 36-55 years (39.5%), rest were distributed in the age of 18-35 years (34.7%) and 56-75 years (25.6%). The majority 77 (53.4%) of the patients were males, out of which 12 patients developed with SSI and 67 (46.5%) were females in which 6 developed SSI. Consumption of alcohol was found in 24 (9%) patients whereas, 34 (23.6%) patients were smokers.

The overall incidence of SSI after surgery was 12.5% (18/144). The maximum number of patients with SSI (8) was seen in the age group of 56-75 years (44.44%) and minimum number of patients without SSI (29) was found in the age group of 56-75 years (23.01%). The incidence of SSI was 15.5% among male patients compared to 8.9% among females. The occurrence of SSI was more seen in alcohol consuming patients (41.6%), followed by smoking (23.5%), compared to patients without these social habits, a difference, which was highly statistically significant (p= <0.00001; 0.026).

Table 1: Socio-demographic characteristics of participants who had surgery.

	Total (%) (n= 144)	**N (%) With SSI, (n=18) 12.5%**	**N (%) Without SSI, (n=126) 87.5%**	**p-value**
Age(Years)				
18-35 years	50 (34.72)	7 (38.88)	43 (34.12)	0.594
36-55 years	57 (39.58)	3 (16.66)	54 (42.85)	
56-75 years	37 (25.69)	8 (44.44)	29 (23.01)	
Gender				
Male	77 (53.47)	12 (66.66)	65 (51.58)	0.230
Female	67 (46.52)	6 (33.33)	61 (48.41)	
Social Habits				
Smoking				
Yes	34 (23.6)	8 (44.44)	26 (20.63)	0.026*
No	110	10 (56.55)	100 (79.36)	
Alcohol				
Yes	24 (9.02)	10 (55.55)	14 (11.11)	<0.00001**
No	120	8(44.44)	112 (88.88)	

As shown in Table 2, the SSI rate for emergency procedures (61.1%) was higher than the SSI rate for elective procedures (38.8%), hence there is a highly statistically significant difference (p=0.00023). Majority of patients with (88.8%) and without SSI (98.4%) were discharged from hospital while 4 patients died.

Table 2: Clinical and procedure characteristics of participants who had surgery.

	Total (%) (n= 144)	N (%) With SSI, n=18 (12.5%)	N (%) Without SSI, n=126 (87.5%)	p-value
BMI kg/m^2				
< 25	97 (67.36)	11 (61.11)	86 (68.25)	0.724
25 to < 30	37 (25.69)	6 (33.33)	31 (24.60)	
> 30	10 (6.94)	1 (5.55)	9 (7.14)	
Type Of Surgery				
Emergency	37 (25.69)	11 (61.11)	26 (20.63)	0.00023**
Elective	107 (74.30)	7 (38.88)	100 (79.36)	
Outcome				
Discharge	140(97.22)	16 (88.88)	124 (98.41)	0.0478
Death	4(2.77)	2 (11.11)	2 (1.58)	

Table 3: Descriptive data and bivariate analysis of surgical risk factors associated with SSI

	Total (%) (n= 144)	N (%) With SSI, n=18 (12.5%)	N (%) Without SSI, n=126 (87.5%)	p-value	OR (95% CI)
Wound Class					
Clean and clean-contaminated	107 (74.30)	1 (5.55)	106 (84.12)	<0.0001**	0.101 (0.0014-0.0882)
Contaminated and dirty	37 (25.69)	17 (94.44)	20 (15.87)		
Length Of Hospital Stay					
<5 days	5 (3.47)	1 (5.55)	4 (3.17)	0.610	1.794 (0.1892-17.0106)
≥5 days	139 (96.52)	17 (100)	122 (84.72)		
Duration Of Surgery					
< 2 hour	6(4.16)	1 (5.55)	5 (3.96)	0.753	1.4235 (0.1567- 12.9282)
≥ 2 hour	138 (95.83)	17 (94.44)	121 (96.03)		
Co-morbidities					
Hypertension				0.6389	1.3000 (0.4345- 3.8895)
YES	97 (67.36)	13 (72.22)	84(66.66)		
NO	47 (32.63)	5 (27.77)	42 (33.33)		
Diabetes Mellitus					
YES	87(60.41)	16 (88.88)	71 (56.34)	0.0180*	6.1972 (1.3669-28.0972)
NO	57 (39.58)	2 (22.22)	55 (43.65)		
ASA Score					
1	43 (26.30)	1 (16.66)	42 (27.77)	0.0408*	0.1176 (0.0151-0.9144)
2 – 4	101 (73.61)	17 (83.33)	84 (72.22)		
Southampton Grade					
Grade 0 to 1	68 (47.22)	1 (5.55)	67 (53.17)	0.0046**	0.0518 (0.0067-0.4012)
Grade 2 to 4	76 (52.77)	17 (94.44)	59 (46.82)		

The bivariate analysis of risk factors that predict the occurrence of SSI is shown in the Tables 2 and 3. Several known risk factors for SSI such as wound class, co-morbidities like diabetes mellitus, ASA score, Southampton grading are statistically significant in this study. Surgical procedures were grouped by wound classification, out of 18 patients with SSI, 17 (94.4%) were grouped under contaminated and dirty wounds, p=<0.0001 was statistically significant. However, there is no statistically significant difference was found for duration of surgery and long hospital stay when compared with and without SSI. Majority (88.8%) of the patients with SSI were found to have a clinical history of diabetes mellitus, thus it showed statistical significance with p=0.0180. Severity of the disease was measured using American Society of Anesthesiologists (ASA) score ranged from class I-IV. High proportions (73.6%) of patients were found in the class II-IV. ASA class II and above had a significantly increased incidence of SSIs (16.8%) compared with ASA class I (2.3%) with significant p value 0.0408. Severity of the post-surgical wound infection was assessed using Southampton wound grading system. It ranges from grade 0-V. Most of the patients (94.4%) who developed with SSI were under the grade II-IV and there was a statistically significant difference was found (p=0.046).

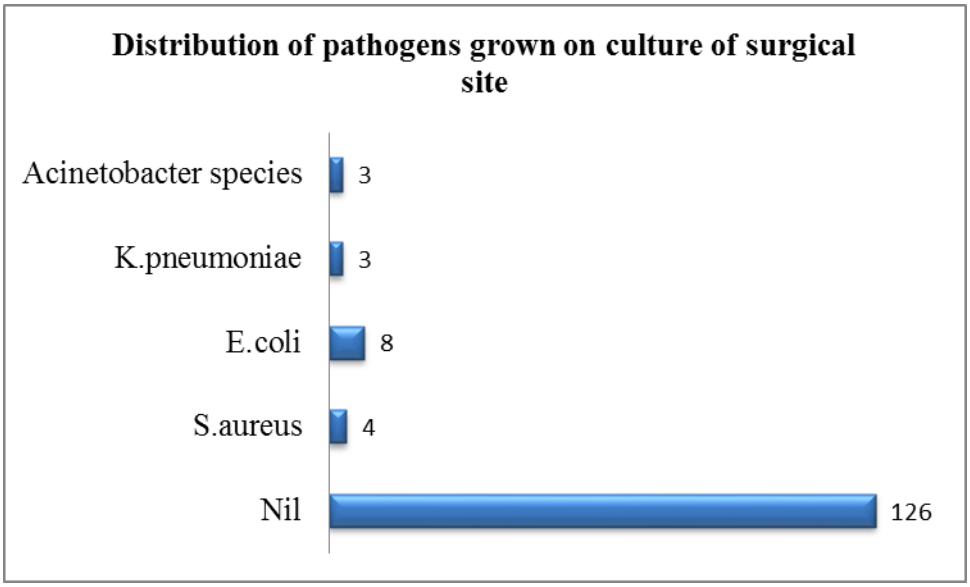

Fig.1 Distribution pattern of etiological agents.

A positive culture was obtained from 18 out of 54 swabs. As it is demonstrated in Figure 1, the most common organisms isolated was Escherichia coli with an incidence of 6%, followed by Staphylococcus aureus (3%). Other pathogens isolated were Klebsiella pneumonia (2%), Acinetobacter species (2%).

Table 4: Antimicrobial susceptibility pattern of etiological agents causing SSI.

Microorganisms	Resistance	Sensitivity
E.coli	Cefazolin, Imipenam	Ampicillin, Ciprofloxacin, Gentamycin, Meropenam, Pip-Tazo, Linezolid
S.auerus	Ciprofloxacin, Erythromycin, Moxifloxacin, Penicillin G	Clindamycin, Linezolid, Vancomycin,Cefoxiin
K.pneumoniae	Amikacin, Gentamycin, Ciprofloxacin	Ampicillin, Meropenam, Linezolid
Acinobacter Species	Ciproflxacin, Pip-Tazo, Ampicillin,Amikacin	Meropenam, Ceftriaxone

In the present study showed carbapenems (Meropenam) and oxazolidinones (Linezolid) had a better coverage against both gram positive and gram negative organisms.

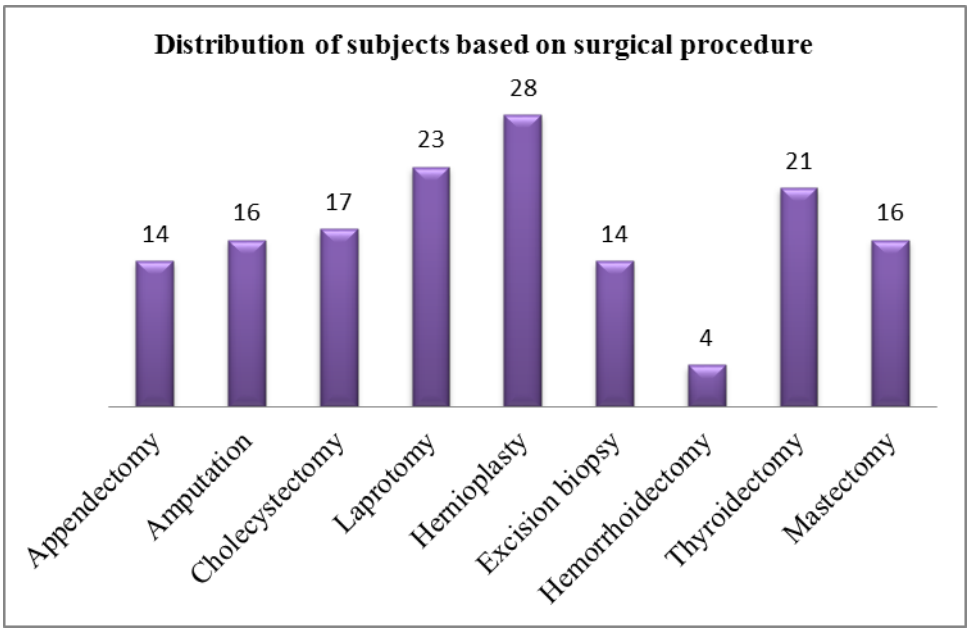

Fig.2 Distribution of subjects based on surgical procedure.

This figure shows that, out of 144 patients, most of them had undergone hernioplasty (28), followed by laprotomy (23).

DISCUSSION

This study has attempted to estimate the burden of SSI, by determining its incidence, risk factors along with etiological agents associated with SSI and their antimicrobial sensitivity and resistance pattern at a tertiary health care institution in Karnataka. During the study period, a total of 144 cases were monitored prospectively. Out of 144 subjects in our study, 18 reported to have SSI and 126 patients had no infection.

Our results indicate that incidence of SSI is mainly seen in males (15.5%) when compared to females (8.9%). This finding coincided with a study conducted in tertiary care hospital Rwanda, where 27 males and only 7 females developed with SSI.[7] The majority of SSI cases were found among alcohol consuming patients (41.6%). This result is similar to cross sectional study conducted in tertiary care hospital, Rwanda.[5]

In the present study both underweight (BMI<25) and overweight (BMI>30) have not been found significant influence on the onset of SSI. This finding was contrasting to study conducted by Naveen et al.[6] The SSI rate for emergency procedures (61.1%) was higher than the SSI rate for elective procedures (38.8%). This showed similar results in the studies conducted by Patel Sachin M et al and Mukagendaneza et al.[1,5]

In general, contaminated and dirty wound type, duration of surgery ≥2hr, length of hospital stay, comorbidities like hypertension, diabetes mellitus, ASA score are highly predictive factors for the development of SSI. This study findings showed that there was significant association with these factors which was also similar to other studies.[1,4,5]

It was observed that postoperative wound infective patients were maximum in grade 2-4 followed by grade 1 according to Southampton wound grading system. This is the first study which used wound grading system.

Comparing our case setting performed on 144 patients and to that of done by Arutra, Neelusree, performed on 130 patients the most common organism was Escherichia coli 6%, followed by Staphylococcus aureus (3%). On analysing the antibiogram, carbapenams (Meropenam) and oxazolidinones (Linezolid) had a better coverage against both gram positive and gram negative organisms.[3]

CONCLUSION

Surgical site infections are the leading cause of nosocomial infections among operated patients in both developed and developing countries. Among the 144 operated, SSI incidence rate was 12.5%. There was statistically significant association of SSI with social habits mainly alcohol consumption, type of surgery (emergency), wound type (dirty and contaminated), comorbidities like diabetes mellitus, ASA score and Southampton wound grading. The most common microorganism causing surgical site infection in our hospital setting was E. coli. The next most common organisms were Klebsiella, pseudomonas and Staphylococcus aureus. On analysing the antibiogram and their susceptibility pattern Meropenam and Linezolid have better coverage against gram positive and gram negative organisms. Therefore, the importance of hospital infection control monitoring with proper precautions and strict protocol for antimicrobial administration are important to minimize the burden of SSI.

ACKNOWLEDGEMENT

We would like to acknowledge to Dr. Basavarajappa, Dr. Ananthraj G S and Dr. Yashwanth C N Department of General Surgery, SSIMS & RC for their immense help and support.

Conflict of Interest

The author declares that there is no conflict of interest to disclose.

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