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Original Research Article

Surgical site infection: Clinico- bacteriological Profile and antibiogram in a tertiary care hospital in Kolkata

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ABSTRACT

Introduction: Surgical site infections (SSIs) are a major health care associated infections and possess a great challenge to clinicians. It increases duration of hospital stay, associated morbidity and mortality and treatment cost. For prompt and appropriate management, it is necessary to understand the appropriate microbial etiology and its antimicrobial susceptibility pattern.
Aim: To determine the prevalence of SSI along with its clinico-bacteriological profile and antibiogram and to correlate with the risk factors.
Materials and Methods: A cross-sectional study was conducted in the Department of Microbiology of Nil Ratan Sircar Medical College & Hospital, Kolkata for a period of one year (2020-2021). Post-operative surgical site infections within 30 days after surgery were included in the study. All samples were collected from clinically suspected SSI cases and processed in the lab as per standard laboratory protocol. Vitek®2 compact system (BIOMERIEUX) was used for further identification and antimicrobial susceptibility testing. All Gram negative pathogens resistant to 3rd generation cephalosporins were screened for ESBL and AmpC. Carbapenem resistant isolates were subjected to Carba NP test for carbapenemase production.
Results and Analysis: Out of 6582 surgeries, clinically suspected SSIs were detected in 220 cases. Among these 220 patients, 186 patients were confirmed as SSI in the laboratory, SSI rate being 2.83%. In 62.27% cases, growth was mono-microbial. Growth of gram negative organisms were noted in 58.72% cases and gram positive growth was 38.53%. *Staphylococcus aureus* (57.14%) was the predominant isolates followed by *Escherichia coli* (35.94%). Diabetes mellitus, obesity and using prophylactic antibiotic >2 hours prior to surgery were found to be significantly associated. For gram positive organism, Vancomycin and Linezolid were found to be most susceptible antimicrobials and for gram negative organisms, it was Polymyxin B and Meropenem. Most of the gram negative organisms were ESBL producer (67.97%).
Conclusion: Rapidly emerging multi drug resistant organisms are complicating the management of surgical site infection day by day and possessing significant burden to health care system. For implementation of appropriate antimicrobial policy, it is important to identify bacteriological profile and antibiogram in every hospital.

1. Introduction

Surgical site infection, a major public health problem, is the second most frequently reported health care associated infections worldwide.[1] Center of Disease Control (CDC),

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US redefined the 'wound infection' in 1992 and renamed as 'Surgical site infections'. It is defined as infections that develop at the surgical site within one month after a surgical operation or three months after implant surgery, breast, cardiac and joint surgeries.[2] According to CDC, SSIs are classified as superficial incisional, deep incisional and organ/space SSIs.[3] In India Incidence of SSIs is reported between 3.6 % to 22.5%.[4] The risk of SSIs can significantly be influenced by factors such as old age, poor nutritional status, obesity, preexisting comorbidities (diabetes Mellitus, hypertension), poor surgical technique, prolonged duration of surgery, inadequate antimicrobial prophylaxis etc.[5] Surgical site Infections (SSIs) are usually caused by exogenous and endogenous micro-organisms infecting the wound during the surgery. Pathogenic drug resistant bacteria are emerging due to inappropriate choice of antibiotics. Although Gram positive organisms, especially *Staphylococcus* spp, are the common causative agents of SSIs, multi drug resistant (MDR) gram negative organisms are taking upper-hand day by day.[1] Therefore, the identification of bacterial pathogens causing surgical site infections along with their antibiogram is utmost important in a hospital setting to reduce incidence of health care associated infections, post-operative hospital stay and cost and to implement antimicrobial stewardship appropriately.[6] The study was aimed to find out bacteriological profile of surgical site infections along with their antibiogram in a tertiary care hospital in Kolkata.

2. Materials and Methods

A cross sectional and observational study was conducted after Institutional Ethical Committee clearance in the Department of Microbiology of Nil Ratan Sircar Medical College in Kolkata for a period of 12 months from September 2020 to August 2021. A total 6582 surgeries were performed within this one-year time period in the Institute. Pus or discharge collected from 220 (3.34%) clinically suspected SSI cases by swab sticks in duplicate from various surgical wards and sent immediately to Microbiology Laboratory for further processing.

2.1. Inclusion criteria

All patients irrespective of age and gender, having post-operative wound infections were included in this study.

2.2. Exclusion criteria

Infection at surgical site after 30 days' post-operative are excluded from the study except breast, implant, and joint surgeries. Infections in episiotomy wounds or wounds with cellulitis were also not considered.

2.3. Detailed clinical history

A detailed clinical history from every case regarding age, gender, type of wound, risk factors and associated comorbidities, use of prophylactic antimicrobial, was obtained.

2.4. Processing in microbiology lab

All samples collected are subjected to gram stain for provisional diagnosis. Another swab was inoculated on MacConkey agar (MAC) and 5% sheep blood agar (BA) and plates and incubated at 37°C overnight. No growth after incubation for 48 hours were reported as sterile. Growth on culture plates was identified by its colony morphology followed by battery of standard biochemical tests[7,8]. Vitek®2 compact system (BIOMERIEUX) was used for further identification and antimicrobial susceptibility testing. All gram negative isolates were stocked in glycerol broth at (-) 80°C for further testing of antimicrobial resistant mechanisms. All dehydrated media and reagents were purchased from Hi Media Laboratories Pvt. Ltd., Mumbai, India. *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 were used as control.

2.5. SSI rate calculation

Surgical site infection (SSI) rate was calculated using the following formula.[9]

$$\text{SSI Rate} = \frac{\text{Total number of culture positive specimens}}{\text{Total number of surgeries performed}} \times 100$$

2.6. Detection of antimicrobial resistance

All Gram negative pathogens resistant to 3rd generation cephalosporins were screened for extended spectrum β lactamases (ESBLs) including Amp C detection phenotypically by disc diffusion method followed by confirmatory test as per CLSI guideline[10]. Carbapenemase production was detected from carbapenem resistant gram-negative isolates phenotypically by Carba NP test as per CLSI guideline[10].

2.7. Statistical analysis

Calculations were done in Microsoft Excel. Data were analyzed using Graph Pad Prism 7.

3. Results

In the present study, 6582 surgeries were performed during the study period in the Institute, out of which 220 (3.34%) cases were suspected clinically for SSI. Significant growth was detected in 186 (2.83%) cases [Table 1], out of which 137 (62.27%) showed mono-microbial growth and 49 (22.28%) growth was poly-microbial. No growth was noted

after 48 hours of incubation in 34 (15.45%) cases [Table 2]

Table 1: Showing number of suspected SSI, confirmed SSI and rate of infection

Total surgeries performed	6582 (100%)
No of symptomatic SSI	220 (3.34%)
No of culture positive Samples	186 (2.83%)
Infection rate in SSI	2.83%

Table 2: Showing number of isolates from clinical specimens

Single growth	137 (62.27%)
Multiple growth	49 (22.28%)
No growth	34 (15.45%)
Total	220 (100%)

In the present study,161 (73.18%) cases were male and 59 (26.82%) cases were female, with male: female ratio being 2.73:1. The peak of incidence of SSI was observed in age group of >60 years (44.55%) followed by in 51-60 years' age group (16.82%) [Figure 1]. Superficial SSI was detected in 123 (66.13%) cases, whereas 63 (33.87%) cases showed features of deep SSI. Presence of Diabetes mellitus, obesity and using prophylactic antibiotic >2 hours prior to surgery were found to be significantly associated [Table 3].

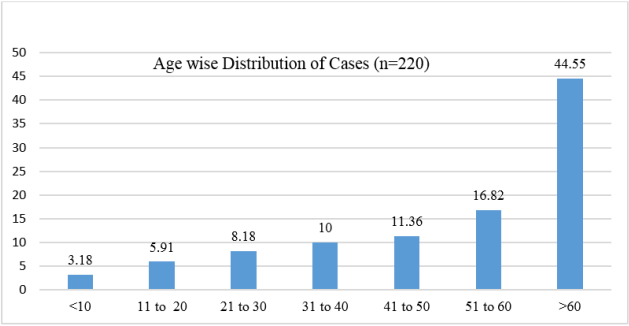

Fig. 1: Showing age wise distribution of cases (n=220)

Table 3: Showing risk factors associated with SSI (n=220)

Risk factors	**No (%)**	**p value**
Diabetes Mellitus	96 (43.64%)	**<0.00001**
Hypertension	61 (27.73%)	0.772279
Anemia	23 (10.45%)	0.5639
Overweight	34 (15.45%)	**0.038151**
Prophylactic antibiotic used prior to >2 hours	136 (61.82%)	**<0.00001**
>1 comorbidity	52 (23.64%)	0.7896
No comorbidity	17 (7.73%)	0.5436

Infection rate was observed to be maximum in Plastic Surgery Department (4.8%), followed by Pediatric Surgery Department (4.6%) and General Surgery Department (3.2%) [Table 4].

3.1. Bacteriological profile

Total 218 microbial pathogens were isolated. Out of these, 84 (38.53%) were gram positive cocci, 128 (58.72%) as gram negative bacilli and 6 (2.75%) as *Candida* spp. Out of 84-gram positive organisms, MRSA (Methicillin resistant *Staphylococcus aureus*) was the predominant isolates (39.29%) followed by CONS (Coagulase Negative *Staphylococcus* spp) (22.62%) and *Enterococcus* spp (20.24%). Gram negative bacilli were found to be predominant pathogen of SSI. *Escherichia coli* (35.94%) was the most frequent isolate (35.94%) among them, followed by *Klebsiella pneumoniae* (20.31%) and *Pseudomonas aeruginosa* (17.97%) [Table 5].

3.2. Antimicrobial susceptibity pattern

In the present study, gram positive organisms showed highest susceptibility to Linezolid (100%) and Vancomycin (97.62%) and least susceptibility to penicillin (4.76%) [Table 6]. Gram negative organisms showed more resistant pattern. Ampicillin, Cephalosporin or Ciprofloxacin were found to be least susceptible, whereas Polymyxin B, Meropenem or Cephalosporin –Sulbactum were found to be more effective antimicrobial agents [Table 7].

Among the gram negative isolates, ESBL (extended spectrum β lactamases) (67.97%) was the commonest resistance exhibited, followed by MBL (metallo β lactamases) (31.25%) and AmpC (4.69%) [Figure 2].

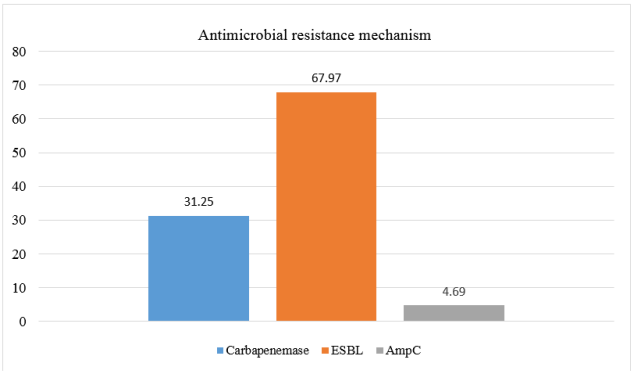

Fig. 2: Showing antimicrobial resistance mechanisms among gram negative isolates

4. Discussion

Post-operative surgical site infections are considered as a significant burden to health care centers in terms of extended hospital stay, substantial associated morbidity and mortality, and increased hospital cost.[11] It has been reported as one of the major causes of health care associated infections in spite of technological advances and wound management.[11] It has been estimated that infection rate of SSI in India varies between 2.5% to 41.9%.[12,13] In the present study,

Table 4: Showing rate of infection of SSI in various departments

Wards	No of Surgeries done	Suspected SSI	Lab confirmed SSI	Rate of infection
General Surgery	2082	72 (32.73%)	68 (36.56%)	3.2
Orthopedics	1953	49 (22.27%)	45 (24.19%)	2.3
Gynae & Obs	982	26 (11.82%)	22 (11.83%)	2.2
Neuro surgery	442	12 (5.45%)	7 (3.76%)	1.6
Paediatric surgery	282	18 (8.19%)	13 (6.99%)	4.6
Plastic surgery	332	20 (9.09%)	16 (8.60%)	4.8
Uro surgery	155	9 (4.09%)	5 (2.69%)	3.2
ENT	354	14 (6.36%)	10 (5.38%)	2.8
Total	6582	220 (100%)	186 (100%)	2.83

Table 5: Characterization of various isolates obtained from patients with surgical site infection

MRSA	33 (39.29%)	*E. coli*	46 (35.94%)
MSSA	15 (17.85%)	*Klebsiella*	26 (20.31%)
CONS	19 (22.62%)	*Pseudomonas*	23 (17.97%)
Enterococcus	17 (20.24%)	*Acinetobacter*	12 (9.37%)
Total	84 (100%)	*Proteus*	13 (10.16%)
		Citrobacter	8 (6.25%)
Candida Spp	6 (2.75%)	Total	128 (100%)

(MRSA- Methicillin Resistant *Staphylococcus aureus*, MSSA- Methicillin Sensitive *Staphylococcus aureus*, CONS - Coagulase Negative *Staphylococcus* spp)

Table 6: Showing antimicrobial susceptibility pattern of gram positive isolates

Antimicrobials	Susceptible (%)	Resistant (%)	Intermediate susceptible (%)
Vancomycin	82 (97.62)	2 (2.38)	-
Linezolid	84 (100)	-	-
Erythromycin	15 (17.86)	68 (80.95)	1 (1.19)
Clindamycin	58 (69.05)	26 (30.95)	-
Oxacillin	36 (42.86)	48 (57.14)	-
Penicillin	4 (4.76)	80 (95.24)	-
Co amoxyclav	7 (8.33)	72 (85.71)	5 (5.92)
Cotrimoxazole	41 (48.81)	43 (51.19)	-
Ceftriaxone	11 (13.10)	70 (83.33)	3 (3.57)
Gentamicin	14 (16.67)	70 (83.33)	-
Ciprofloxacin	12 (14.29)	68 (80.95)	4 (4.76)

Table 7: Showing antimicrobial resistant pattern of gram negative isolates

	E.coli (n=46)(%)	Klebsiella (n=26)(%)	Citrobacter (n=8)(%)	Pseudomonas (n=23) (%)	Acinetobacter (n=12) (%)	Proteus (n=13)(%)
Ampicillin	43 (93.47)	26 (100)	7 (87.5)	NA	NA	12 (92.30)
Amoxyclav	36 (78.26)	20 (76.92)	6 (75)	NA	NA	11 (84.61)
3rd gen cephalosporin	32 (69.56)	18 (69.23)	6 (75)	11 (47.82)	8 (66.67)	10 (76.92)
Cefoperazone-Sulbactam	16 (34.78)	15 (57.69)	2 (25)	9 (39.13)	5 (41.67)	5 (38.46)
Piperacillin-Tazobactam	20 (43.47)	16 (61.53)	2 (25)	7 (30.43)	6 (50)	4 (30.76)
Amikacin	13 (28.26)	11 (42.30)	3 (37.5)	10 (43.47)	6 (50)	5 (38.46)
Gentamicin	21 (45.65)	13 (50)	3 (37.5)	12 (52.17)	7 (58.33)	8 (61.53)
Levofloxacin	35 (76.08)	17 (65.38)	4 (50)	9 (39.13)	8 (66.67)	6 (46.15)
Ciprofloxacin	37 (80.43)	18 (69.23)	5 (62.5)	12 (52.17)	9 (75)	7 (53.84)
Imipenem	13 (28.26)	13 (50)	1 (12.5)	7(30.43)	4 (33.33)	4 (30.77)
Meropenem	14 (30.43)	14 (53.84)	2 (25)	6 (26.08)	3 (25)	4 (30.77)
Co-trimoxazole	29 (63.04)	17 (65.38)	6 (75)	NA	8 (66.67)	NA
Polymyxin B	1 (2.17)	2 (7.69)	0 (0)	1 (4.34)	1 (8.33)	NA

infection rate was found to be 2.83%. It was reported to be 2.69% in the study of Kokate et al,[14] 3.43% in Khan et al,[9] 4.3% in Kamath et al[15] & 5.5% in Karan et al[16]. In the present study, rate of infection was predominant in male patient (73.18%) with male: female 2.73:1. This finding was concordant with the study of Negi V et al[1] (2.93:1), Naz R[17] (2.11:1). Chakraborty SP et al[18] and Malik S et al[19] also showed male preponderance in their study. The incidence of surgical site infection increases with advancing age due to low immunity, low wound healing, increased catabolism and presence of co-morbidities.[1] In the present study, maximum affected age group was found to be >60 years (44.55%) followed by 51-60 years of age group (16.82%). Similar findings were noted in Negi V et al,[1] Mangram J et al,[3] and Naveen K et al.[20] Diabetes mellitus and obesity were found to be significant risk factors associated with SSI. Use of prophylactic antibiotic within 60 minutes before surgery was another significant factor found to be associated. Leela Rani Kasukurthy, 2020 showed in her study that anemia, diabetes mellitus and hypertension were the most important risk factors, diabetes being the most frequent one.[6] Similar findings were also noted in Negi V et al[1] and Khan AKA et al.[21] Maximum rate of infection was observed in plastic surgery (4.8%) followed by paediatric surgery (4.6%) and general surgery (3.2%). Rate of infection was found to be maximum in orthopedics in Khan AS et al,[9] whereas it is maximum in general surgery in Nirupa et al.[22]

Out of 220 cases of clinically suspected SSIs, 186 (84.55%) cases were culture positive. Dhote et al[23] showed 92% growth, where as 52% growth was detected in Khan AS et al,[9] 60.5% in Kaur et al[23] and 49.5% in Kokate et al.[14] Growth was mono microbial in 62.27% cases in the present study, whereas in 22.28% cases multiple growth was detected. Growth was sterile in 15.45% cases. Predominant mono microbial growth was observed in the study of mama et al (91.6%),[24] Shreeram et al. (80.4%),[25] Negi V et al. (94.7%),[1] Mundhada et al. (50%),[26] Benebdeslam et al. (76.8%),[27] and Insan et al. (60%).[28] Gram negative bacilli (58.72%) were predominantly detected in our study followed by gram positive cocci (38.53%) and yeasts (2.75%). Out of gram negative bacilli, *E. coli* was the predominant isolate (35.94%) followed by *Klebsiella* (20.31%). Out of gram positive cocci, *Staphylococcus aureus* was the predominant isolate (57.14%) followed by CONS (22.62%). Similar findings were also demonstrated in Pradeep MSS et al,[29] Goswami et al,[30] Khan AS et al,[9] Amare et al,[31] Mama et al[24], Dhote et al[23], Kokate et al[14] and Shreeram et al.[25]

Antimicrobial susceptibility testing revealed high degree of resistance to majority of isolates. Among gram positive organisms, Methicillin resistant *Staphylococcus aureus* (MRSA) was found in 39.29% cases. Higher incidence of MRSA was detected in Pradeep MSS et al (44.8%)[29], Patnaik N et al (52.3%)[32] and Jain K et al (48.78%).[33] On the contrary, Aggarwal et al[34] showed incidence of MRSA 10% only and Negi V et al[1] showed it 15.7%. Vancomycin and Linezolid was found to be most effective antimicrobials, irrespective of methicillin resistance. This finding was also noted in Verma U et al,[35] Negi V et al,[1] Patnaik N et al[32] and Shreeram et al.[25] Gram negative organisms showed higher degree of resistance and Polymyxin B and Meropenem were found to be most effective antimicrobials. Better susceptibility to carbapenems was noted in Verma U et al,[35] Negi V et al,[1] Kamath et al[15], Khan et al[9] and Kaur et al.[23] Patnaik N et al[32] showed highest susceptibility of Polymyxin B to non-fermenters.[32] Among the gram negative isolates, ESBL (extended spectrum β lactamases) was produced in 67.97% cases, MBL (metallo β lactamases) in 31.25% cases and AmpC in 4.69% cases. ESBL was detected as the commonest mechanism of resistance in Kasukurthy LR[6] also.

5. Conclusion

Surgical site infections still remain a great concern to physicians and surgeons in health care facilities in spite of rapid improvement of technologies and knowledge.[1] Rapidly increasing resistance to majority of existing antimicrobials also makes the problems more challenging. As a result, it has become more evident to understand the microbial etiology of SSIs of every health care facility to establish improved antimicrobial policy and implement appropriate antimicrobial stewardship.[1]

6. Source of Funding

None.

7. Conflict of Interest

None.

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