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Incidence, Bacteriology and Risk Factors of Surgical Site Infection (SSI) at Tertiary Care Teaching Hospital

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ABSTRACT

Surgical wound infections (SSI) are the most common post-operative complication, causing significant postoperative morbidity and mortality. To study bacteriological profile, antimicrobial sensitivity pattern and factors affecting surgical site infections (SSI). This was a prospective observational non-interventional study conducted over period of one year (Jan 2011 to Dec 2011). Both the genders with suspected SSI were included. Proforma included demographic information, present and past medical illness, laboratory parameters and wound swab culture and sensitivity and resistance pattern. All samples were processed as per standard microbiological methods. Antibiotic susceptibility testing was performed by Kirby Bauer disc diffusion method following CLSI recommendations. Total one fifty six patients were selected clinically suspected cases of postoperative wound infections of all age groups and both the sexes admitted to our hospital were included in this prospective study. Statistical analysis was done by SSPE statistical software trial version 11. All numerical variables were calculated for mean, standard deviation and chi-square test. The 'p' value < 0.05 was considered as statistically significant. Total 619 patients underwent operative procedures with suspected SSI, during study period. Total 156 (25.20%) patients were examined clinically suspected SSI of them total 79 (50.64%) patients fulfilling criteria of surgical site infection were enrolled in present study for analysis. The overall incidence of SSI was 12.76%. Of total 79 patient with culture positive SSI, 55(69.62%) were male with mean age of 56 (SD±12.7) years and 24(30.37%) were female with mean age of 45 (SD±9.5) years. SSI was predominated by male patients ('p'<0.02). Of total 136 microscopically documented organisms 25 (18.38%) were GPC and 111(81.61%) were GNB and outnumbered by GNB ['p'<0.01]. Total 17 (68%) GPC and 87(78.37%) GNB were monomicrobial SSI. Total 8 (32%) GPC and 24 (21.62%) GNB were polymicrobial SSI. Total 17 (13.82%) cultures were grown for *Staph. aureus*, 6 (4.87%) for CONS, 2 (1.83%) for *Enterococcus species*. Total 22 (17.88%) were E. Coli, 9 (7.31%) Pseudomonas species, 15(12.19%) Pseudomonas aeruginosa, 2(1.62%) *Pseudomonas fluorescens*, 11 (8.94%) Klebsiella species, 9 (7.31%) *Klebsiella pneumoniae*, 9(7.31%) *Citrobacter species*, 7 (5.69%) *Citrobacter freundii*, 8 (6.50%) *Proteus mirabilis* and 5 (4.06%) were *Acinetobacter spp.* Bacteriological culture profile shows that the majority of SSI infection was with GNB. ('p' < 0.03). GPC were sensitive to Vancomycin and Linezolid. All pseudomonas showed moderate resistance to quinolones, cephalosporin and Aminiglycosides with significant drug resistance for Amox-clav and Ampicillin. *Klebsiella species* showed significant resistance to β-lactum, cotrimaxozole and quinolones. Seventy five percent of *S. aureus* and fifty percent of *CONS* and *Enterococcus spp* were resistant to Oxacillin. The majority of GNB were sensitive to Colistin, Meropenem, Amikacin and quinolones in decreasing trend ('p' < 0.013). The majority of GNB were sensitive to Colistin (80-100%), Meropenem (about 80%) and Piperacillin-tazobactam (about 55%). The overall incidence of SSI in our study was 12.76% with increased isolation rate of gram negative (GNB) organisms, with significant incidence of drug resistant organisms to commonly used antibiotics. The most common organisms were *E. Coli, Staph. aureus*, *Pseudomonas aeruginosa, Klebsiella spp* and relatively less common were *Acinetobacter spp*, *Citrobacter spp* and *CONS*. Majority of GPC were sensitive to Vancomycin and Linezolid and majority of GNB were sensitive to Colistin, Meropenem and Piperacillin –Tazobactam. Abdominal laprotomy, appendicectomy renal surgeries had high incidence of SSI. We suggest for periodic surveillance of etiologic agent and antibiotic susceptibility to prevent further emergence and spread of resistant bacteria in the hospital environment.

Keywords: Surgical wound infections, Antibiotic susceptibility testing, gram negative organisms, Colistin, Meropenem, drug resistant organisms

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INTRODUCTION

Post-operative wound infections have been a problem in the field of surgery since time immemorial. Post operative wound infections are the commonest nosocomial infection and responsible for the increasing financial burden, morbidity and mortality related to surgical operations. Since the birth of surgery, surgical wound infection has been major complication. Despite an improved understanding of the patho-physiology and improved methods of prevention and prophylaxis, surgical site infections (SSI) remain the most common cause of post operative morbidity and mortality Studies have shown that such wound infections are universal and that the bacteria types present vary with geographical locations and various other factors. Hospitals have a notorious reputation for infection [1,2]. Although *Staphylococcus aureus* are the primary cause of such infections, in recent years, there has been a growing number of post-operative wound infections due to Gram-negative organisms mainly *Escherichia coli*, *Pseudomonas aeruginosa*, *Acinetobacter* and *Klebsiella spp* and many more. Resistance to antimicrobials is rapidly increasing in Gram-negative bacilli and MRS in gram positive bacteria to greater extent. SSI may originate during the operation i.e. as a primary wound infection or may occur after the operation from sources in the ward or as a result of some complications i.e. secondary wound infection and can be characterized by various combinations of the signs of infection [3]. So far there is inadequate data regarding bacteriology, antibiotic sensitivity and factors affecting surgical site infection in our country, to elucidate the same this prospective study was conducted.

MATERIAL AND METHODS

It was prospective observational non-interventional study conducted over period of one year (Jan. 2011 to Dec. 2011). Both the genders with suspected SSI were included in this prospective study. Post operative surgical site infection patient from surgery (neurosurgery, plastic surgery and onco-surgery) and obstetrics and gynecology patients were included in present study. Patients with trauma, inplants, diabetic foot, abscesses and other with contaminated tissue before operative procedure were excluded from present study. All the wound infections other than postoperative wound and obviously pre-operatively infected patients were excluded from the study. Proforma included demographic information, present and past medical illness, laboratory parameters and wound swab culture and sensitivity and resistance pattern. Study is approved by ethical committee Krishna institute of medical sciences Karad.

Aim and objectives

- To isolate, identify and study bacteriological profile of surgical site infections (SSI) at tertiary care teaching hospital.
- To study antimicrobial sensitivity pattern of surgical site infections (SSI).
- To study factors affecting surgical site infections (SSI). Total one fifty six patients were selected clinically suspected cases of postoperative wound infections of all age groups and both the sexes admitted to our hospital were included in this prospective study.

Collection of sample

Wounds were examined for suggestive signs and symptoms of infection in post operative period, during wound dressing or when dressings were soaked, until patient was discharged from the hospital. When infection was clinically suspected, relevant clinical history of the patient was taken. The wounds were inspected for characteristics that indicate anaerobic infection, which include foul odour, black necrotic tissue, or black discharge, blood and purulent discharge. The area around surgical wound was cleaned with 70% ethyl alcohol. The exudates were collected from the depth of the wound using two sterile cotton swabs and for anaerobic culture, collected using a third swab. The swabs were collected and immediately put in nutrient broth at the bed side [4-6].

Transport and Processing

All specimens (pus) from suspected SSI were collected and transported immediately to the laboratory for further processing and was incubated at 37°C for 24 hours. Using first swab, a smear was made on a clean glass slide and stained by Gram staining. The smear was screened for pus cells and organisms. The Gram reaction, morphology, arrangement and types of organisms were noted [5,6].

Aerobic culture

The second swab was inoculated on blood agar and MacConkey agar by rolling the swab over the agar and streaking from primary inoculum using a sterile bacteriological loop. These plates were incubated at 37°C for 24-48 hours. Primary plates were observed for any visible growth after overnight incubation and if there was no growth after 24 hours, subcultures were done from nutrient broth. Primary plates were further incubated for another 24 hours. Plates were observed for growth. The isolates were identified following standard identification procedures like colony morphology, Gram stained smear from the colony, motility, enzymatic tests and other special tests if any [4,5].

Antibiotic susceptibility testing

All samples were processed as per standard microbiological methods. Antibiotic susceptibility testing was performed by Kirby Bauer disc diffusion method following CLSI recommendations. The strengths of antibiotic discs used (in µ) are as follows: Ampicillin (10µ), Ciprofloxocin (5µ), Oxocillin (1µ), Cefotaxime (30µ), Cotrimoxozole (25/23.75µ), Ceftazidime (30µ), Amikacin (30µ), Meropenem (10µ), Gentamicin (10µ), Vancomycin (30µ), Amoxycillin/Clavulanic acid (20/10µ). (HiMedia). Gram positive isolates were tested for Linezolid, Vancomycin, Gentamycin, Co–trimoxazole, Ampicillin- clavulanic acid, Amoxicillin. Gram negative isolates were tested for Ciprofloxacin, Gentamycin, Amikacin, Piperacillin/Tazobactam, Ampicillin/Sulbactam, Amoxicillin/Clavulanic acid, Cotrimoxazole, Ciprofloxacin, Meropenem and Colistin [5-7]. Statistical analysis was done by SSPE statistical software trial version 11. All numerical variables were entered in statistical data entry sheet and calculated for mean, standard deviation and chi-square test. The 'p' value < 0.05 was considered as statistically significant.

RESULTS

Total 619 patients underwent operative procedures (Patients with trauma, inplants, diabetic foot, abscesses and other with contaminated tissue before operative procedure and obviously pre-operatively infected patients were excluded), during study period. Total 156 (25.20%) patients were examined clinically suspected SSI of them total 79 (50.64%) patients fulfilling criteria of surgical site infection (SSI) were enrolled in present study for analysis. Of total 79 patient with culture positive SSI, 55(69.62%) were male with mean age of 56 (SD±12.7) years and 24(30.37%) were female with mean age of 45 (SD±9.5) years. SSI was predominated by male patients ('p'<0.02). The overall mean of study population was 51 years (SD±12.5). [Table no. 1] Total 619 surgeries were performed with possible suspected infection of them LSCS were 122(19.7%), mastectomy were 55 (8.89%), plastic surgeries were 57(9.21%), hepato-biliary surgeries were 34 (5.49%), hernia surgeries were 107 (17.3%), craniotomy surgeries were 35 (5.65%), surgeries for malignancy were 65 (10.5%), laprotomy surgeries were 55(8.89%), appendicectomy surgeries were 69 (11.1%), hysterectomy surgeries were 13 (2.1%) and renal surgeries were 7. Total 12 (9.83%) patients with LSCS, 3 (5.45%) with mastectomy, 2 (3.5%) with plastic surgeries, 7 (20.58%) with hepato-biliary surgeries, 12 (11.21%) with hernia surgeries, 6 (17.14%) with craniotomy surgeries, 2 (3.07%) with surgeries for malignancy surgeries, 15 (27.27%) with laprotomy surgeries, 16 (23.18%) with appendicectomy surgeries, 2 (15.38%) with hysterectomy surgeries and 2 (28.57%) with renal surgeries were found to have SSI. Overall total 79 (12.76%) patient had positive culture and growth. [Table no. 2] Renal surgeries, laparotomy, appendicectomy, hepatobiliary and craniotomy surgeries had relatively more incidence of SSI in present study ('p' <0.05) which can be explained on basis of longer duration of surgeries, more tissue handling, more devitalized tissue and associated infection as a etiological agent. [Figure no.1] In direct microscopy total 23 (18.69%) patients were found to have gram positive cocci (GPC) and 61 (49.59%) had gram negative bacilli (GNB) and GPC with GNB mixed bacteria was found in 39 (31.70%) patients. The gram negative bacilli were predominantly and statistically significantly seen in SSI and followed by mixed organisms ('p' <0.001). [Table no. 3] Total 123 patients were positive for culture growth. Total 17 (13.82%) cultures were grown for *Staph. aureus*, 6 (4.87%) for *CONS*, 2 (1.83%) for *Enterococcus species*. Total 22 (17.88%) were *E. Coli*, 9 (7.31%) *Pseudomonas species*, 15(12.19%) *Pseudomonas aeruginosa*, 2(1.62%) *Pseudomonas fluorescens*, 11 (8.94%) *Klebsiella species*, 9 (7.31%) *Klebsiella pneumonia*, 9(7.31%) *Citrobacter species*, 7 (5.69%) *Citrobacter freundii*, 8 (6.50%) *Proteus mirabilis* and 5 (4.06%) were *Acinetobacter species*. Bacteriological culture profile shows that the majority of SSI infection was with GNB. ('p' < 0.032) [Table no. 4 & Graph no. 1] [Figure no.2 & 3-A, B, C] Total 88.2% *S aureus* were sensitive to Vancomycin, 5.88% were sensitive to Ampicillin and 70.5 % were sensitive to Meropenem. All pseudomonas showed moderate resistance to quinolones, cephalosporin and Aminiglycosides with significant drug resistance for Amox-clav and

Ampicillin. *Klebsiella spp and Kleb pneumoniae* were sensitive to amikacin (about 50%) and majority of other antibiotics shows significant resistance (β-lactum, cotrimaxozole and quinolones). Similar sensitivity and resistance pattern was observed for *Citrobacter species and Proteus mirabilis.* Majority of GPC were sensitive to Vancomycin and Linezolid. The majority of organisms were shows moderate to severe resistance to gentamycin, cotrimaxozole, Ampicillin and Amox-clav seventy five percent of *S. aureus* and fifty percent of *CONS* and *Enterococcus spp* were resistant to Oxacillin. [Table no. 5 &6] [Graph no.2] *Pseudomonas* were (*Pseudomonas spp. Pseudomonas A, P. Fluorescens*) sensitive 100% to Colistin and 80% to Meropenem. *Klebsiella spp and Klebsiella Pneumoniae* were most sensitive to Meropenem and colistin. All *Acinetobacter spp.* Were sensitive to colistin and 80% for Meropenem and 20% for Ceftazidime. The majority of GNB were sensitive to Colistin, Meropenem, Amikacin and quinolones in decreasing trend (‘p’ < 0.013). [Table no. 5 & 6] [Graph no.2] The majority of GPC were sensitive to Vancomycin and Linezolid, and majority of GNB were sensitive to Colistin (80-100%), Meropenem (about 80%) and Piperacillin-tazobactam (about 55%). The mean age of patient without SSI was 36±12 years and with SSI was 51(±12.5). Type 2-diabetes mellitus was present in 45(8.33%) patients without SSI and 23(29.11%) with SSI. Advancing age and associated co-morbidities like diabetes mellitus were the confounding risk factors for developing SSI in present cohort.

Table 1: Demographic profile of surgical site infection

Variables	N= 79	%	Mean (±SD)
Males	55	69.62	56 (±12.7)
Females	24	30.37	45 (±9.5)
Total	79	100	51(±12.5)

Table 2: Suspected SSI and actual culture positive SSI

Surgery	Suspected SSI infection	%	No of infected	%
L.S.C.S.	122	19.7	12	9.83
Mastectomy	55	8.89	3	5.45
Plastic surgeries	57	9.21	2	3.50
Hepatobiliary	34	5.49	7	20.58
Hernia surgeries	107	17.3	12	11.21
Craniotomy	35	5.65	6	17.14
Malignancy surgeries	65	10.5	2	3.076
Laporatomy	55	8.89	15	27.27
Appendicectomy	69	11.1	16	23.18
Hysterectomy	13	2.1	2	15.38
Renal surgeries	7	1.13	2	28.57
Total	619	100	79	12.76

Table 3: Microscopic profile of gram positive cocci and gram negative bacilli

Direct microscopy	Culture positive	%
Gram positive cocci (GPC)	23	18.69
Gram negative bacilli (GNB)	61	49.59
GPC + GNB	39	31.70
Total	123	100

Table 4: Monomicrobial and polymicrobial profile of GPC and GNB organisms

Variables	n	%	Monomicrobial	%	Polymicrobial	%
Gram positive	25	18.38	17	68	8	32
Gram negative	111	81.61	87	78.37	24	21.62
Total	136	100	104	76.47	32	23.52

Table 5: Organisms isolated in Surgical Site Infection

Organisms	Number	Percentage
Staphylococcus aureus	17	13.82
CONS	6	4.87
Enterococcus spp.	2	1.83
Escherichia coli	22	17.88

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Pseudomonas aeruginosa	15	12.19
Pseudomonas spp	9	7.31
Pseudomonas fluorescens	2	1.62
Klebsiella pneumoniae	9	7.31
Klebsiella spp	11	8.94
Citrobacter freundii	7	5.69
Citrobacter spp.	9	7.31
Proteus mirabilis	8	6.50
Acinetobacter spp	5	4.06
Total	123	100

Table 5: Antibiotic susceptibility of Gram positive and Gram negative isolates

Organisms	n	%	A	%	Ac	%	Co	%	G	%	Ak	%	Ox	%
S. aureus	17	13.8	1	5.88	2	11.7	5	29.4	2	11.7	4	**23.5**	5	29.4
CONS	6	4.87	1	16.6	3	50	2	33.3	2	33.3	3	**50**	4	66.6
Enterococcus spp.	2	1.62	0	0	0	0	1	50	0	0	1	**50**	0	0
E. coli	22	17.8	1	4.5	1	4.54	3	13.6	7	31.8	13	**59.0**	0	0
P. aeruginosa	15	12.1	0	0	0	0	1	6.66	2	13.3	4	**26.6**	0	0
Pseudomonas spp.	9	7.31	0	0	0	0	1	11.1	1	11.1	3	**33.3**	0	0
Pseudo. fluorescens	2	1.62	0	0	0	0	0	0	1	50	1	**50**	0	0
Kleb. Pneumoniae	9	7.31	0	0	0	0	0	0	1	11.1	5	**55.5**	0	0
Klebsiella spp.	11	8.94	0	0	0	0	0	0	1	9.09	5	**45.4**	0	0
Citrobacter freundii	7	5.69	0	0	0	0	0	0	0	0	2	**28.5**	0	0
Citrobacter spp.	9	7.31	0	0	0	0	0	0	1	11.1	3	**33.3**	0	0
Proteus mirabilis	8	6.50	0	0	1	12.5	1	12.5	0	0	3	**37.5**	0	0
Acinetobacter spp.	5	4.06	0	0	0	0	0	0	0	0	0	0	0	0
Total	123	100	3	2.4	7	5.6	14	11.3	18	14.6	47	38.2	9	7.31

[Abbreviations: A-Ampicillin, Ac-Amoxicillin/Clavulanic acid, Co-CoTrimoxazole, G-Gentamycin, Ak-Amikacin]

Graph 1: Distribution of gram positive and negative bacteria on culture growth of SSI

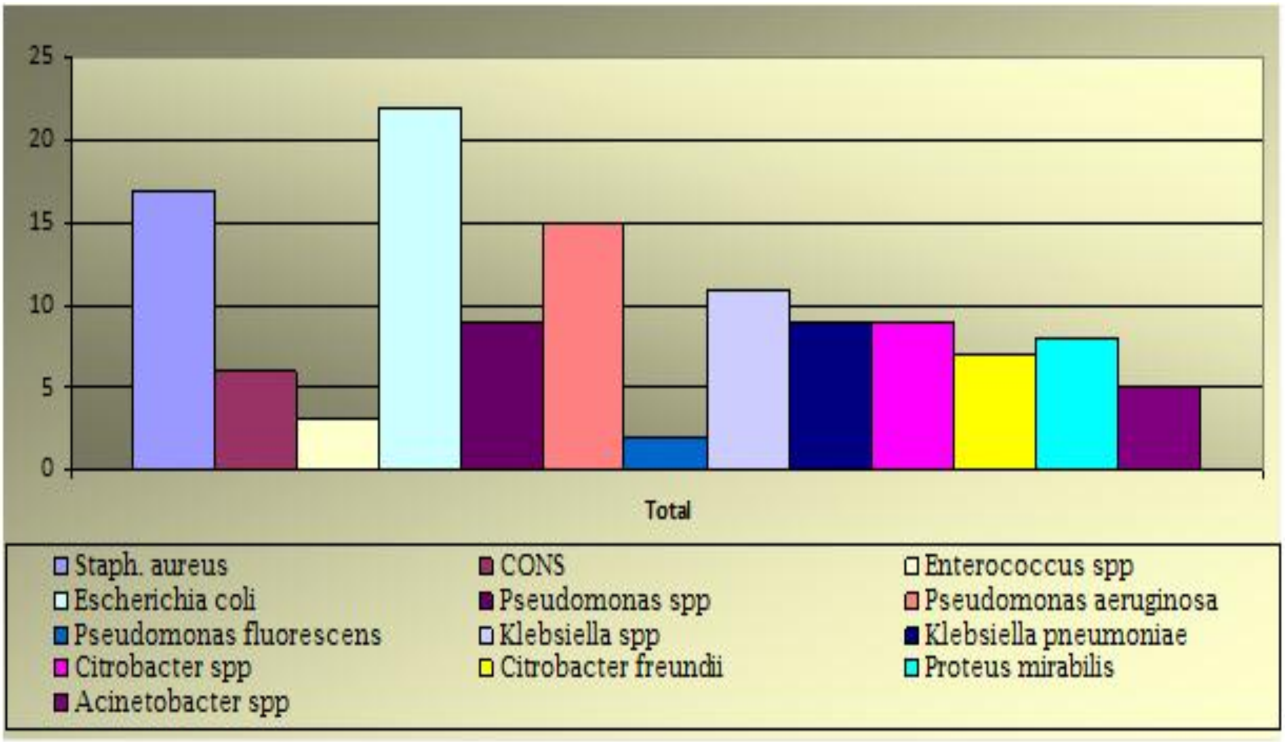

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Table 6: Antibiotic susceptibility of Gram positive and Gram negative isolates

Organisms	n	%	Cf	%	Ce	%	Ca	%	Me	%	Va	%	Cs	%
S. aureus	17	13.8	3	17.6	5	29.4	5	29.4	12	**70.5**	15	**88.2**	4	13.6
CONS	6	4.87	1	16.6	1	16.6	2	33.3	4	**66.6**	6	**100**	3	9
Enterococcus spp.	2	1.62	1	50	1	33.3	0	0	1	**50**	2	**100**	2	**66.6**
E. coli	22	17.8	3	13.6	6	27.2	10	45.5	21	**95.4**	0	0	19	**86.3**
P. aeruginosa	15	12.1	4	26.6	2	13.3	3	20	13	**86.6**	0	0	15	**100**
Pseudomonas spp.	9	7.31	4	44.4	3	33.3	2	22.2	8	**88.8**	0	0	9	**100**
Pseudo. fluorescens	2	1.62	0	0	0	0	0	0	2	**100**	0	0	2	**100**
Kleb. Pneumoniae	9	7.31	1	11.1	1	11.1	1	11.1	8	**88.8**	0	0	9	**100**
Klebsiella spp.	11	8.94	2	18.1	4	36.3	3	27.3	11	**100**	0	0	11	**100**
Citrobacter freundii	7	5.69	0	0	1	14.2	1	14.3	7	**100**	0	0	7	**100**
Citrobacter spp.	9	7.31	0	0	1	11.1	1	11.1	9	**100**	0	0	9	**100**
Proteus mirabilis	8	6.50	1	12.5	2	25	1	12.5	7	**87.5**	0	0	8	**100**
Acinetobacter spp.	5	4.06	0	0	0	0	1	20	4	**80**	0	0	5	**100**
Total	123	100	20	16.2	27	21.9	30	24.4	108	87.8	27	21.9	103	83.7

[Abbreviations: Cf-Ciprofloxacin, Ce-Cefotaxime, Ca-Ceftazidime, M-Meropenem, Ox-Oxacillin, Va-Vancomycin, CS- Colistin]

Graph 2: Antibiotic susceptibility of Gram positive and Gram negative isolates

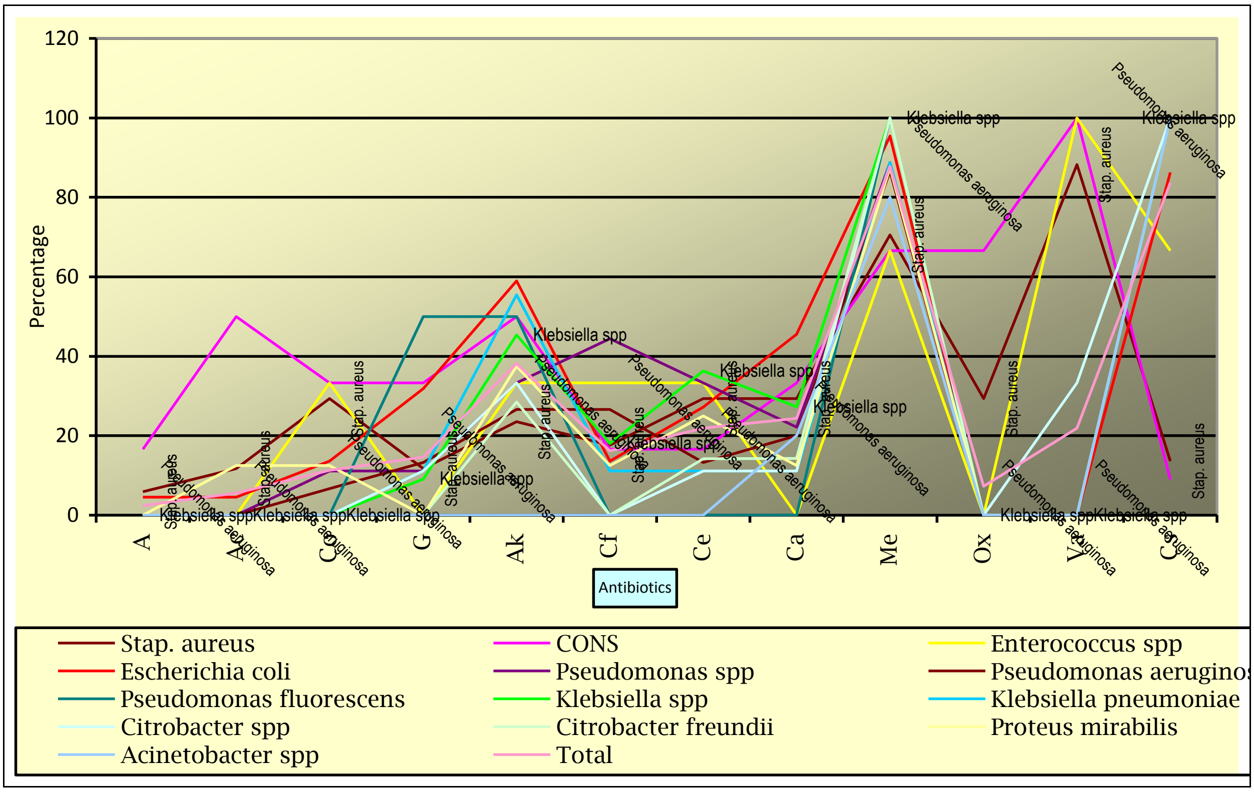

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Figure 1: Incidence of SSI according to type of surgical procedure.

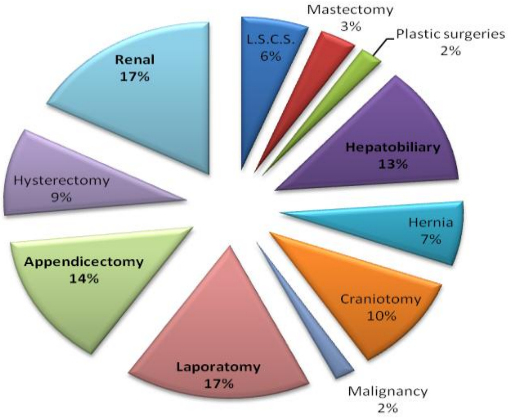

Figure 2: Bacteriological profile of SSI

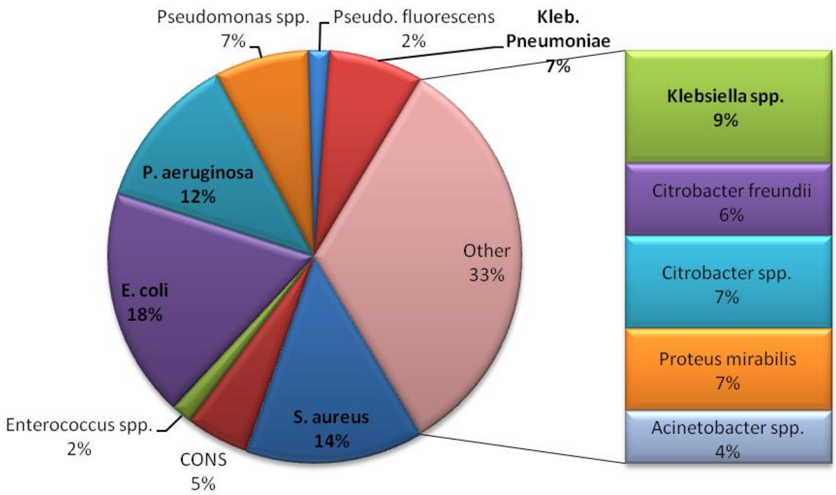

Figure 3-A: Culture growth pattern of GPC (*Staphylococcus aureus* on Blood agar) and GNB (*Escherichia coli* on MacConkey agar)

Figure 3-B: Culture growth pattern of GNB (*Proteus mirabilis* on MacConkey agar *Pseudomonas aeruginosa* on Nutrient agar)

Figure 3-C: Culture growth pattern of GNB (*Klebsiella Pneumoniae*)

DISCUSSION

Post operative wound infections have been found to pose a major problem in the field of surgery. Advances in control of infection have not completely eradicated this problem because of development of drug resistance [8]. Microbe-related risk factors, for SSI are with Staphylococcus aureus and *Streptococcus pyogenes* being particularly virulent. The host-related risk factors, like morbid obesity, an index of disease severity, old age, protein-calorie malnutrition, diabetes, cancer and systemic infection. The operation-related risk factors, including prolonged hospital stay before surgery, duration of the operation, tissue trauma, poor hemostasis, and foreign material in the wound, greatly increasing the risk of serious infection despite of all preventive measures. The performance of an intra-abominal procedure, operation time >2 hours, a contaminated or dirty-infected operation, and concomitant illness of significance were other important factors. We compared our results with various studied form India and overseas. Kenneth Rolston et al studied 35 cases of SSI of breast cancer surgery. Monomicrobial infections predominated (69%) with *S. aureus* being isolated most often. A wide variety of gram-positive and gram-negative organisms were isolated from the 31% of polymicrobial infections. Although all *S aureus* isolates were susceptible to vancomycin. The organisms were susceptible to trimethoprim/sulfamethoxazole, rifampin, linezolid, daptomycin, and tigecycline [9]. Similarly in our study mastectomy were done in 55 (8.89%) of them 5.45% had SSI with 13.82% had *Staphylococcus aureus* on culture and of them majority were sensitive to vancomycin and linezolid with predominant monomicrobial growth. Rao R et al studied postoperative wound infections and their antimicrobial susceptibility pattern. Of total 100 patients with 149 isolates from 96 culture positive cases with 71.8% of isolates were GNB and 28.2% were GPC. *Escherichia coli* was the most common isolate (20.8%), followed by *Staphylococcus aureus* (16.1%), *Pseudomonas spp (16.1%), Klebsiella spp (15.4%), Citrobacter spp (9.4%) and CONS (8.1%).* Most of the isolates were highly resistant to commonly used antibiotics. All Gram negative isolates were sensitive to Imipenem and 75.7% of them were sensitive to Amikacin. All GPC were sensitive to Vancomycin [10]. Similarly in our study 13.82% were *S. aureus,* 17.88% were *E. Coli*, 12.19% were *P. aeruginosa*, 8.94% were *Klebsiella spp.* and 7.31% *Kleb. Pneumoniae* with majority of GPC were sensitive to vancomycin and Linezolid and majority of GNB were sensitive to Colistin and Meropenem. Insan NG et al reported most frequent isolate was *S. aureus* 24 (32.8%) followed by E. coli 15 (20.5%), Pseudomonas species (16.4%) these findings are comparable with our study in which, 13.82% were *S. aureus,* 17.88% were *E. Coli*, 12.19% were *P. aeruginosa*, 8.94% were *Klebsiella spp.* and 7.31% *Kleb. Pneumoniae.*[11] *Insan NG et al* quoted Ampicillin+Sulbactum was most effective antibiotic for Gram positive bacteria and Lomifloxacin was most effective against Gram negative bacteria [11]. These findings are in contrast to our findings in which majority of GPC were resistant to Ampicillin, amox-clav and were sensitive to vancomycin and Linezolid and majority of GNB were sensitive to Colistin and Meropenem with moderate resistance to amikacin and quinolone. K Prabhat Ranjan et al quoted 29.6% were *P. aeruginosa*, followed by *E. coli* 20.3%, *Klebsiella spp.* 16.6%, *S. aureus* 14.3%, *Proteus spp*. 6.3%, *Acinetobacter spp* 3.0% associated with SSI [12]. Similarly in our study 13.82% were *S. aureus,* 17.88% were *E. Coli*, 12.19% were *P. aeruginosa*, 8.94% were *Klebsiella spp* and 7.31% *Kleb. Pneumoniae. K Prabhat Ranjan et al* reported susceptibility to imipenem, followed by meropenem, cefoperazone-sulbactam, ticarcillin-clavulanate, and amikacin [12]. Similarly in our study majority of GNB were sensitive to colistin, meropenem Pipracillin-tazobactum with moderate resistance to amikacin and quinolone. Kranthi K et al stated that the most of all the gram negative isolates were highly sensitive to Imipenem (90.76%) followed by Amikacin (73.84%) and Piperacillin/Tazobactam (68.46%), where as highest number (61.53%) of gram negative isolates shown resistance to ceftazidime. Amikacin is most effective drug against gram positive and gram negative bacteria [13]. These findings are comparable with our results. *Kranthi K et al* studied 425 bacterial isolates with 24% were *S. aureus, 14.82% S. epidermidis, 19.76% E. coli*, 18.82% *P. aeruginosa* , 15.52% *Klebsiella P*. and 7.05% *Proteus vulgaris* . Highest number of gram positive isolates were sensitive to Levofloxacin (81.21%) followed by Vancomycin (72.72%) and Ofloxacin (71.51%) whereas highest number (86.06%) of gram positive isolates shown resistance to Oxacillin (86.06%).[13] Similarly in our study 13.82% were *S. aureus,* 17.88% were *E. Coli*, 12.19% were *P. aeruginosa*, 8.94% were *Klebsiella spp.* and 7.31% *Kleb Pneumoniae.* Reiye Esayas Mengesha et al reported total 83.1% of Gram negative and 100% of Gram positive isolates were sensitive to Gentamicin and Vancomycin, respectively, these findings are comparable with our study [14]. In our study SSI patients were predominated by male patients with 13.82% were *S. aureus,* 4.87% were CONS, 17.88% were *E. Coli*, 12.19% were *P. aeruginosa*, 8.94% were *Klebsiella spp.* and 7.31% *Kleb. Pneumoniae.* Similarly *Reiye Esayas Mengesha et al* studied 98 male and 30 female with clinical signs of post surgical wound infections of them 75% were culture positive aerobically, with predominant bacterial isolates were *S. aureus* 44 (35.77%), Kleb. Spp. 29 (22.76%) and (CoNS) 18 (14.63%), these findings are comparable with our results [14] *Reiye Esayas Mengesha et al* reported prevalence of SSI was 75% and multi drug resistance was seen in 82.92%, which is very high compared to present study in which incidence was 12.76% without multidrug-resistance pattern [14]. *Khyati Jain et al* reported Gram positive organisms were more prevalent than gram negative bacteria accounting for 47(67.14%) and 23(32.85%) of isolates respectively, these findings are similar to our results. *S. aureus* 41(58.6%), *P. aeruginosa* 10(14.3%) and *E.coli* 06(8.6%) were the common isolates with 48.78% *Coagulase positive S. aureus*, were Methicillin resistant. MRSA were found to be highly resistant to many antibiotics, similarly in our study 20.32 % were gram positive organisms in SSI infections [8]. *Giacometti et al* studied 614 isolates with single etiologic agent in 271 patients and multiple agents in 343 patients with preponderance of aerobic bacteria like, *S. aureus* 28.2%, *P. aeruginosa* 25.2%, *E. coli* 7.8%, *S. epidermidis* 7.1%, and *E faecalis* 5.6%, these findings are similar to our observations.[1] *Gales AC et al* reported *S. aureus* (31%) was the most common etiologic agent causing SSTI, followed by *Escherichia coli* (13.4%) and *Pseudomonas aeruginosa* (11%). Thirty-one percent of *S. aureus* isolates were resistant to oxacillin (methicillin). Meropenem was the compound with the highest susceptibility rate among the *Enterobacteriaceae* (100%) and *P. aeruginosa* (95%) isolates, these findings are comparable to our study [2]. *Meseret Guta et al* isolated 177 bacteria from SSI with most dominant isolates were *S. aureus*, *Kleb. spp*, *E. coli* and *CONS* accounting for 25.4%, 18.1%, 16.9% and 14.7% of the isolates respectively. Other bacteria isolated include *P. aeruginosa* (9.0%), *Proteus* spp. (6.8%), *Streptococci* (5.1%), *Citrobacter* spp. (2.3%) and *Enterobacter spp* (1.7%). Resistance of isolated organisms was 76.3% to amoxicillin, 71.2% to penicillin, 56.9% to vancomycin, 39.5% to ceftriaxone and norfloxacin and 31.1% to gentamicin. The susceptibility of *S. aureus* was 64.4% to gentamicin but it was 100% resistant to amoxicillin. All isolates of *P. aeruginosa* were resistant to penicillin and amoxicillin, these findings are comparable to our results in which, *P. aeruginosa* were resistant to β-lactum and quinolones [15]. *Twum-Danso K et al* reported 9.4% incidence of SSI. The commonest causative organisms were *S. aureus* 23.7%, *E. coli* 16.9%, *S. epidermidis* 13.5% and *P. aeruginosa* 13.0%. *Enterobacter spp Proteus spp, Kleb spp* and *P. aeruginosa* appeared to have a high probability of causing postoperative wound infection [3]. Present study showed 12.76% incidence of SSI. *Yalçin AN et al* quoted incidence of SSI 4.53%. High infection rates were noted after colon resection (32.1%), gastric and oesophageal operations (21.1%), cholesystectomy (17.2%), and splenectomy (10.2%) [16]. Low infection rates were noted after thyroidectomy, mastectomy, caesarean section and abdominal hysterectomy. The commonest causative organisms were *coagulase-negative staphylococci* 21.7%, *S. aureus* 19.7%, *E. coli* 19.7%, *Enterobacter spp* 17.6%, and *Pseudomonas spp* 10.7%, these findings are comparable with our results in which, most common organisms were *E. Coli, Staph. aureus*, *Pseudomonas aeruginosa, Klebsiella spp* and laprotomy, appendicectomy renal surgeries had relatively high incidence of SSI. *M. Raza et al* quoted *S. aureus* (37.5%) was the predominant gram positive isolate and *Escherichia coli* 25% was the major gram negative isolates in SSI. All *S. aureus* isolates were sensitive to aminoglycosides and vancomycin. The 41.66% *S. aureus* isolates were methicillin resistant (MRSA). *Staphylococcus epidermidis* showed high resistance (50%-100%) to all antibiotics but were sensitive to vancomycin. All gram negative isolates showed high resistance against cephalexin (75%-100%) and ceftriaxone (25%-100%). Overall multi-drug resistant isolates were 66.7% [17]. Similarly in our study most common organisms were *E. Coli, Staph aureus*, *Pseudomonas aeruginosa, Klebsiella spp* and majority of GPC were sensitive to Vancomycin and Linezolid and majority of GNB were sensitive to Colistin, Meropenem and Piperacillin –Tazobactam. Although surgical wound infections cannot be completely eliminated, a reduction in the infection rate to a minimal level have significant benefits, in reducing postoperative morbidity and mortality including wastage of health resources.

CONCLUSION

The overall incidence of SSI in our study was 12.76% with increased isolation rate of gram negative organisms, with significant incidence of drug resistant organisms to commonly used antibiotics. The most common organisms were *E. Coli, Staph. aureus*, *Pseudomonas aeruginosa, Klebsiella spp* and relatively less common were *Acinetobacter spp*, *Citrobacter spp* and *CONS*. Majority of GPC were sensitive to Vancomycin and Linezolid and majority of GNB were sensitive to Colistin, Meropenem and Piperacillin –Tazobactam. Abdominal laprotomy, appendicectomy renal surgeries had high incidence of SSI. Advancing age and diabetes mellitus were the associated factors for developing SSI. A preexisting medical illness, prolonged operating time and wound contamination strongly predispose to wound infection. Hospital disinfection and treatment protocols should be practiced thoroughly and to control the incidence of wound infections. Periodic SSI surveillance study may serve as guide to implement infection control practices, species of bacteria involved in post-operative wound infection and determination of their antimicrobial resistance so as to choose particular empiric antibiotic before the culture sensitivity report available. Proper infection control practice and rational antibiotic use are the integral part of controlling SSI. This study confirms that the bacteria commonly implicated in post-operative wound infections like *S. aureus*, *E. coli*, *P. aeruginosa* and *Klebsiella spp* continued to dominate and have developed drug resistance to the commonly used antibiotics. We suggest for periodic surveillance of etiologic agent for SSI and antibiotic susceptibility to prevent further emergence and spread of resistant bacteria in the hospital environment.

Limitations of study: Anaerobic culture was not performed contaminated wound were excluded from the study. Our results cannot be applied to other institute, as various factors affecting SSI may vary from institution to institution.

REFERENCES

[1] Giacometti O, Cirioni AM, Schimizzi MS, Del Prete F, Barchiesi MM, D'Errico, E Petrelli, and G Scalise. J Clin Microbiol 2000;38(2):918–922.
[2] Gales AC, Jones RN, Pfaller MA, Gordon KA, Sader HS. Int J Infect Dis 2000;4(2):75-84.
[3] Twum-Danso K, Grant C, al-Suleiman SA, Abdel-Khader S, al-Awami MS, al-Breiki H, Taha S, Ashoor AA, Wosornu L. J Hosp Infect 1992;21(1):29-37.
[4] Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Am J Infect Control 1999;27(2):97-132.
[5] Collee JG, Duguid JP, Fraser AG, Marmion BP, Simmons A. Laboratory strategy in diagnosis of infective syndromes. In:Collee JG, Fraser AG, Marmion BP, Simmons AC,editors.Mackie and McCartney Practical Medical Microbiology.14th ed.Churchill Livingstone: New York; p.53-94, 1996.
[6] Winn W, Allen S, Janda W, Koneman E, Procop G, Schreckenberger P et al. Koneman's Colour Atlas and Textbook of Diagnostic Microbiology. 6th Ed. Lippincott Publishing Philadelphia; 2006.

[7] Clinical and Laboratory Standards Institute (CLSI). Performance Standards for Antimicrobial Disk Susceptibility Tests; Approved Standard—Eleventh Edition. CLSI document M02-A11. 17th informational supplement M100- S22, Vol 32 No 1. (ISBN 1-56238-781-2 [Print]; ISBN 1-56238-782-0 [Electronic]). Clinical and Laboratory Standards Institute, 950 West Valley Road, Suite 2500, Wayne, Pennsylvania 19087 USA, 2012.

[8] Khyati Jain, Nilesh Shyam Chavan, S.M. Jain. Int J Integr Med Sci 2014;1(1):9-13.

[9] Kenneth Rolston, Coralia Mihu, Jeffrey Tarrand. Wounds 2010;22(5):132–135.

[10] Ramesh Rao S, Sumathi K, Anuradha D, Venkatesh S, Krishna. Int J Pharm Biomed Res 2013;4(2):72-76.

[11] Insan NG, Payal N, Singh M, Yadav A, Chaudhary B, Srivastava a. Post operative wound infection: bacteriology and antibiotic sensitivity pattern. IJCRR. 2013; 5(13): 74-79.

[12] K Prabhat Ranjan, Neelima Ranjan, Satish K Bansal, D R Arora. India J Labor Physn.2010;2(2): 74–77.

[13] Kranthi K, Raghava Rao DVMVSV, Manasa D, Ganapathi Swamy Ch. IJHSR. 2013; 3(11): 44-50.

[14] Reiye Esayas Mengesha, Berhe Gebre-Slassie Kasa, Muthupandian Saravanan, Derbew Fikadu Berhe and Araya Gebreyesus Wasihun. BMC Res Notes. 2014;7:575.

[15] Meseret Guta, Kassaye Aragaw, Yared Merid. African J Microbiol Res 2014; 8(11): 1118-1124.

[16] Yalçin AN, Bakir M, Bakici Z, Dökmetas I, Sabir N. J Hosp Infect 1995;29(4):305-9.

[17] M Raza, A Chander and A Ranabhat. Open J Med Microbiol. 2013;3(3):159-163.