Section: Microbiology

Original Research Article

VARIOUS ANTIMICROBIAL RESISTANCE PATTERNS IN SURGICAL SITE INFECTIONS

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Abstract

Background: The infection of a wound can be defined as the invasion of organisms through tissues following a breakdown of local and systemic host defences, leading to cellulitis, lymphangitis, abscess and bacteraemia. Infections of surgical wounds are called as surgical site infections (SSIs). SSIs are defined as infections occurring within 30 days after a surgery or within one year if an implant is left in place after the procedure and affecting either the incision or deep tissue at the operation site. **Materials and Methods:** This was a Hospital based Prospective Cross sectional study and carried out at the Department of Microbiology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Trichy, Tamilnadu. The study was carried out over a period of one year (May 2017 to April 2018). Consecutive cases of both sexes and all adults belonging to various surgical wards and underwent surgical procedure during the study period comprising of elective as well as emergency were considered for the present study. **Result:** Out of 124 isolates, 44 were resistant to more than 3 groups of antimicrobial drugs (35.4%)which included Staphylococcus aureus 11, Pseudomonas aeruginosa 9, Acinetobacter spp 6, Klebsiella spp 9, E.coli 7, Proteus mirabilis 2. No MRSA carrier was identified in the present study. During the study period, none of them had hypothermia, hypoxia or shock status. Chlorhexidine bath preoperatively was not adopted for the cases. Razor was used for removal of hair for all patients undergoing surgery. No significant difference was observed with regard to duration of surgery, experience of surgeon or excess trauma to the tissues as the surgeries were carried out by senior surgeons. Standard aseptic procedures were adopted by all surgeons and sterility of the operation theatre was monitored and maintained. **Conclusion:** Among 32 Staphylococcus aureus, 11(38%) were Methicillin Resistant Staphylococcus aureus. Gram negative bacilli which showed resistance to 3rd generation cephalosporins, cefoxitin and imepenem in routine antiobiotic susceptibility testing were subjected to phenotypic confirmatory test for ESBL, Amp C and MBL producers. Phenotypic test was performed on the 81 gram negative bacilli such as combined disc test, Amp C disk test and Modified Hodge test showed 46%, 16.8% and 13.2% of them were ESBL, Amp C and MBL producers. The prevalence of MDR strains during the study period was 35.3%.

INTRODUCTION

The infection of a wound can be defined as the invasion of organisms through tissues following a breakdown of local and systemic host defences, leading to cellulitis, lymphangitis, abscess and bacteraemia. Infections of surgical wounds are called as surgical site infections (SSIs).[1]

SSIs are defined as infections occurring within 30 days after a surgery or within one year if an implant is left in place after the procedure and affecting either the incision or deep tissue at the operation site.

According to the National Nosocomial Infection Surveillance program (NNIS), it is classified into superficial, deep, organ/space infections.[2]

Source of SSIs include the patient‘s own normal flora, organisms present in the hospital environment that are introduced into the patient by medical procedures, specific underlying disease, trauma or burns which may cause a mucosal or skin surface interruption.[3]

SSIs are serious operative complications that occur in approximately 2% of surgical procedures and account for 20% of health care-associated infections.

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Many studies reported that SSIs rank third among common nosocomial infection next only to urinary tract and respiratory tract infections.

Recent studies reported that SSI rate ranges from 19.4% to 36.5% all over the world, whereas in India it ranges from 3% to 12%. SSI remains a common and widespread problem that contributes to significant morbidity and mortality, prolongs hospital stay and consequently increasing health care cost.[4]

Factors which promote SSIs include length of hospital stay, Obesity, Diabetes mellitus, smoking etc. The development of a post-operative wound infection depends on the complex interplay of many factors. Most postoperative wounds are endogenous. Exogenous infections are mainly acquired from the nose or skin flora of the operating team and transmitted through the hands of the surgeon or improper operation theatre sterilization which includes pre-operative, intra operative and post-operative care.

Some significant factors that can influence the incidence of subsequent infection are surgical techniques, skin preparation, timing, method of wound closure and antibiotic prophylaxis after certain types of surgery. Also many other factors have been identified as having an effect on the potential for infection and these should be considered by the healthcare professionals before, during and after surgery.

The resistance offered by a microbe to antimicrobial agent that is used in the prevention or treatment of infections is called antimicrobial resistance. Beta lactams are the most widely used antibiotics for treatment of postoperative wounds due to their broad spectrum of activity, safety profile and proven clinical efficacy. There are different mechanisms which cause resistance to beta lactams namely a reduction in the affinity of the drug targets (penicillin binding proteins) via amino-acid substitution, a phenomenon occurring in both gram positive and gram negative bacteria. Gram negative species, alteration in outer-membrane permeability that prevents passage to the beta lactams and in both Gram-positive and Gram-negative bacteria, the production of beta lactamase that inactivate the drug through hydrolysis of the beta lactam ring.[5] Hence widespread use of these groups of antibiotics has lead to emergence and rapid spread of resistance.

Aims and Objectives

- To isolate and identify aerobic pathogenic bacteria from surgical site infections (SSI).
- To determine the antimicrobial sensitivity pattern of pathogens.

MATERIALS AND METHODS

This was a Hospital based Prospective Cross sectional study and carried out at the Department of Microbiology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Trichy, Tamilnadu. The study was carried out over a period of one year (May 2017 to April 2018).

Consecutive cases of both sexes and all adults belonging to various surgical wards and underwent surgical procedure during the study period comprising of elective as well as emergency were considered for the present study.

Patients belonging to anyone of the following were excluded.

- Paediatric cases.
- Cases taken for second surgery at the same site for any reason.
- Patients on immunosuppressant or with immunodeficiency status.
- Patients on antibiotics already for any other infections.
- Presence of infection elsewhere in the body or focal sepsis.

The work was carried out after getting approval from Institutional research board and Institutional ethics committee. Informed consent (in vernacular) was obtained from every case.

Age, sex demographic details, clinical details including name of the procedure, date and duration of surgery, experience of surgeons, preoperative hospital stay, nature of surgery, antibiotic prescribed (prophylactic/post operative), post operative hospital stay, risk factors, onset of illness and other relevant history were collected and recorded in a proforma.

RESULTS

Gender wise distribution of SSI: Among the 1297 males who underwent surgery, SSIs were seen in 84(6.4%) of them and among the females (779) it was noticed in 32 (4.1%).

Age wise distribution of SSI: The age of the study subjects ranged from 16 years to 72 years. 33 (28.4%) of them belonged to >55years of age followed by 29 (25%) and 25 (21.5%) in 35-44 years and 45-54 years respectively. The least belonged to below 35 years. The odd‘s ratio for the development of SSIs among those below the age of 25 was 2.45.

Anti microbial susceptibility pattern: There were 32 Staphylococcus aureus and 3 Enterococcus spp isolated during the study period and the sensitivity pattern also.

Among 32 Staphylococcus aureus isolates from SSI, 11 were MRSA strains (37.9%) and the remaining 21 (62%) were MSSA as shown in [Figure 1].

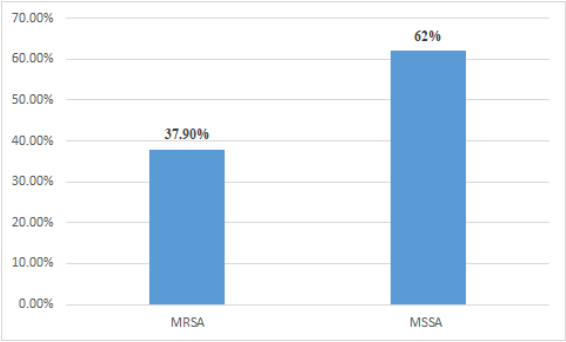

Figure 1: Frequency of MRSA in SSIs

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MRSA–Methicillin resistant Staphylococcus aureus, MSSA-Methicillin sensitive Staphylococcus aureus
The antibiotic susceptibility of gram negative bacilli are furnished in [Table 2] given below
The gram negative organisms were further tested for production of various enzymes like ESBL, Amp C and MBL. The details are described in the ensuring paragraph.

Distribution of ESBL producing gram negative bailliin SSIs: Out of 61 Enterobacteriaceae, 28 were ESBL producers (46%) on combined disctest. Among them 15 (53.5%) were E.coli, 11(39.2%) were Klebsiella spp, 2 (7.0%) were Enterobacter spp as shown in [Figure 2].

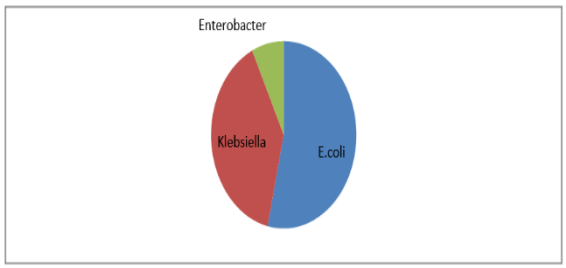

Figure 2: Distribution of ESBL producers in SSIs

Distribution of AMPC producers in SSIs: In the present study, out of 89 gram negative bacilli, 15(16.8%) were Amp C producers, out of which 6 were Pseudomonas aeruginosa, 4 Acinetobacter baumanii, 1 E.coli, 3 Klebsiella spp and 1 Enterobacter spp which are depicted in [Figure 3].

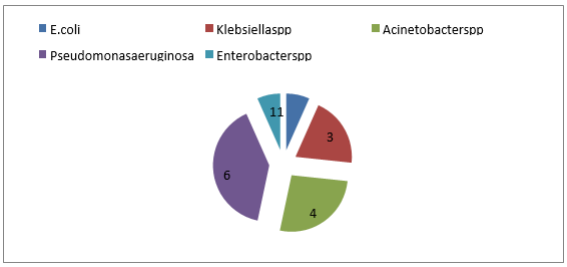

Figure 3: Distribution of AmpC in SSIs

Distribution of MBL in SSIs: Out of 89 gram negative bacilli, 12 (13.2%) were Metallobetalactamase producers on Modified Hodge test as shown in the figure no.17. (5 out of 9 Acinetobacterspp (41.6%), 4 out of 17 Pseudomonas aeruginosa (33.3%), 1 out of 27 E.col i(8.3%) and 2 out of 19 Klebsiellaspp (16.6%).

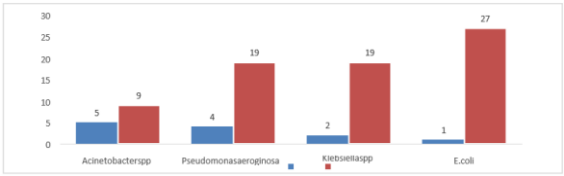

Figure 4: Distribution of MBL producers in SSIs

Distribution of multi drug resistance in SSIs: Out of 124 isolates, 44 were resistant to more than 3 groups of antimicrobial drugs (35.4%)which included Staphylococcus aureus 11, Pseudomonas aeruginosa 9, Acinetobacter spp 6, Klebsiella spp 9, E.coli 7, Proteus mirabilis 2 and are shown in [Figure 5].

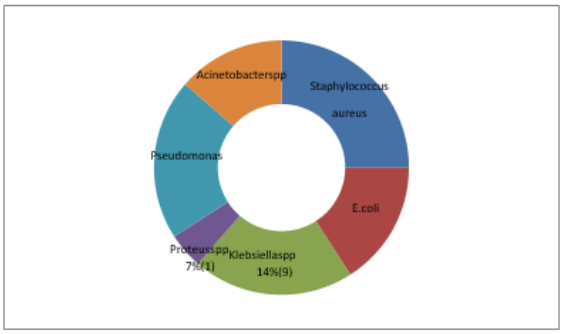

Figure 5: Distribution of MDR in SSIs

No MRSA carrier was identified in the present study. During the study period, none of them had hypothermia, hypoxia or shock status. Chlorhexidine bath preoperatively was not adopted for the cases. Razor was used for removal of hair for all patients undergoing surgery.
No significant difference was observed with regard to duration of surgery, experience of surgeon or excess trauma to the tissues as the surgeries were carried out By senior surgeons. Standard aseptic procedures were adopted by all surgeons and sterility of the operation theatre was monitored and maintained.
The patients were followed up from 24 hours after surgery till discharge with the help of respective surgeons for signs of local and systemic infection. Only 4 cases developed complications and underwent secondary surgery.

Table 1: Distribution of cases in relation to gender.

No	Infected	Not infected	Total
Males	84	1213	1297
Females	32	747	779
Total	116	1960	2076

Table 2: Anti microbial susceptibility pattern in gram positive cocci

Antibiotics	Staphylococcus aureus N=32	Enterococcus spp N=3
Penicillin(10U)	1.2%	0
Doxycycline(30µg)	43.7%	66.6%
Erythromycin(15µg)	46..8%	100%
Clindamycin(2µg)	40.6%	-
Gentamycin(10µg)	68.7%	-

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Amikacin(30µg)	81..2%	-
Ciprofloxacin(5µg)	65.6%	33.3%
Cotrimoxazole(1.25/23.75µg)	37.5%	-
Tetracycline(30µg)	40.6%	33.3%
Linezolid(30µg)	100%	100%
Highlevel gentamycin(120µg)	-	100%

Table 3: Antibiotic susceptibility pattern in gram negative bacilli

Antibiotics	E.coli(27)	Kleb spp(19)	Proteus spp(7)	Enterobacter spp(7)	P.aeruginosa (19)	Acinetobacter spp (9)
AMP	3.7%	0	0	14.2%	0	0
AMC	14.8%	0	0	14.2%	0	0
CIP	44.4%	31.5%	71.4%	71.4%	36.8%	22.2%
COT	55.5%	31.5%	71.4%	57.1%	31.5%	22.2%
GEN	66.6%	52.6%	57.1%	85.7%	47.3%	11.1
AK	77.7%	63.1%	71.4%	85.7%	52.6%	22.2%
CTR	40.7%	36.8%	85.7%	57.1%	ND	11.1%
CTX	40.7%	36.8%	85.7%	71.4%	ND	11.1%
CAZ	44.4%	42.1%	71.4%	57.1%	63.1%	22.2%
CPM	62.9%	57.8%	85.7%	85.7%	63.1%	22.2%
AT	85.1%	73.6%	71.4%	71.4%	68.4%	22.2%
CX	77.7%	73.6%	85.7%	71.4%	68.4%	33.3%
IPM	88.8%	84.2%	85.7%	85.7%	78.9%	33.3%
PIT	96.2%	89.4%	100%	85.7%	84.2%	55.5%

Table 4

Organism	Total (124)	Percentage
Staphylococcus aureus	32	25.8%
E.Coli	27	21.7%
Klebsiella spp	19	15.3%
Pseudomonas aeruginosa	19	15.3%
Acinetobacter baumannii	9	7.2%
Enterobacter spp	7	5.6%
Proteus spp	7	5.6%
Enterococci spp	3	2.4%
Citrobacter spp	1	0.8%

DISCUSSION

Surgical site infections (SSIs) are a worldwide problem that has far reaching implications on patient morbidity and mortality, and also has impact in the cost of treatment. It is the third most common nosocomial infection, and the frequency of SSIs varies from hospital to hospital. Watanabe et al reported SSIsin15% of their series whereas Leigh Neumayer et al reported 38%.[6]

The occurrence of SSIs were more in males (6.4%) as compared with females (4.1%) in the present study. A study by Hernandez et al (2005) conducted in a Peruvian Hospital reported more among males 65.6%. Moses also reported male preponderance (64.3%) and this is in contrast to the study by Shanmugam et al who reported almost equal among females (52%) and males (48%). Increasing occurrence among males was attributable to nature of the infected wounds with which they come to surgical departments and also to more number of emergency among males.[7]

Though the Enterobacteriaceae was the second most frequently (49%) isolated organisms in the present study Cantlon et al noticed it to be low (12.4%).139 Similar to our study, rate of isolation of E.coli 28(44%), Klebsiella spp 21(31.2%) and Pseudomonas aeruginosa 19 (67%) by Arias et al was nearer to the present study99 whereas Rao and Harsha(1975) observed P. aeruginosa, E.coli and Klebsiellaspp.as the common gram-negative organisms.Also,Giacometti et al (2000) noticed pseudomonas aeruginosa (25.2%) to be the predominant organism in their study followed by Escherichia coli (7.8%) and others.[8]

Surgical site infections caused by bacteria that are resistant to multiple classes of antimicrobials are an important and increasing problem. Organisms such as methicillin-resistant staphylococci, extended spectrum beta-lactamase producing Enterobacteriaceae and multi-drug resistant Acinetobacter and Pseudomonas spp. are among the current concerns; however, the emergence and dissemination of other multi-drug resistant organisms is likely to follow.

Among 32 staphylococcus aureus, 11(37.9%) were MRSA identified using cefoxitin disc diffusion method similar to the studies done by Ranjan (27.96%), Krishna S (28.6%) and Farrin 29%. It is discordant with the study by Golia S etal who reported 88.8% of S. aureus as methicillin resistant strains.

Sanjay et al (2010) in their study on isolation and detection of drug resistance gram negative bacilli with special reference to postoperative wound infection noticed that E. coli was the predominant agent isolated from wound infections (37.3%), followed by Pseudomonas aeruginosa (20.9%),

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Klebsiellaspp (17.2%), Acinetobacter baumanii (14.2%) and other agents were less common.

In the present study, none of the isolates Klebsiella spp, Proteus spp, Acinetobacter baumanii and Pseudomonas aeruginosa were sensitive to Ampicillin and Amoxyclav. E.coli and Enterobacter spp showed only 14.2% sensitivity to Amoxyclav. The sensitivity of Acinetobacter baumanii for different antimicrobial agents commonly ranged from11% to 55%. The sensitivity was high to Piperacillin- tazobactam followed by Imepenem. In general, Acinetobacterbaum anii was resistant to fluoroquinolones, aminoglycosides, and all β-lactams, with the exception of the carbapenems and hence considered as the drug of choice with regard to Acinetobacter spp.

Brown et al noticed high resistance rate to many antimicrobial including carbapenem and it is emerging in many parts of the world, mainly due to carbapenemases and possibly other mechanisms, such as alterations of outer membrane proteins and these multiresistant Acinetobacter spp. may still retain susceptibility to the polymyxins (i.e., colistin and polymyxin B), sulbactam, and possiblytigecycline. Pan resistant isolates that are resistant to all available drugs are now being reported. The prevalence of resistance is more in the Europe, America than in Asia/Pacific.

Distribution of ESBL producing gram negative bacilliin SSIs: In the present study, 28/61(46%) were ESBL producers on combined disc test. Organisms were 14(53.5%) were E.coli, 11(39.2%) were Klebsiella spp, 2(7.0%) were Enterobacter spp. This is not in concurrence to the study by Rambabu et al who showed a prevalence rate of 35.71% ESBL producers (E.coli – 56%, Klebsiella spp – 52%, Proteus spp – 40% and Enterobacter spp – 16%). Asfia Sultan et al reported that 30% were ESBL. Prevalence of ESBL producers is high in a study by Golia et al who noticed 80% of E. coli and 100% of Klebsiella species.

Distribution of AmpC producers in SSIs: In the present study 15(16.8%) were Amp C producers by disc test. 6 were Pseudomonas aeruginosa, 4 Acinetobacter baumanii, 3 Klebsiella spp, 1 E.coli and 1 Enterobacterspp. On the contrary, Hemalatha reported 9.2% AmpC producers which was much lower than present study. Compared to ours Asfia Sultan et al and Tapan et al, reported very high prevalence (64.7%) and (48.5%) Amp C producers respectively.

Distribution of MBL in SSIs: In the present study 12(13.2%) were MBL producers. Among them were 5/9 Acinetobacterbaum anii (41.6%), 4/19 Pseudomonas aeruginosa (21%),1/27 E.coli (8.3%) and 2/19 Klebsiella spp (16.6%). Similar to our study Gupta reported 40%of A.baumannni and 20% of P.aeruginosa isolates showed resistance to imipenem.

Distribution of multi drug resistance in SSIs: In the present study 44(35.4%) isolates were resistant to three or more group of drugs and these MDR organisms were Staphylococcus aureus 11 (25%), Klebsiella spp 9(20%), Pseudomonas aeruginosa 9(20%), E.coli 7 (15%), Acinetobacter baumanii 6(13.6%) and Proteus mirabilis 2(4.5%). In the series by Manyahi et al 63% (93/147) were multidrug resistant (MDR) whereas Zahran et al reported 37.2% of MDR isolates.[9]

The present study has revealed the prevalence of SSIs in our centre. The SSIs were noticed more among the patients who underwent abdominal surgeries the highest rate in laparotomy. SSIs were frequent among those who had one or other risk factors. Bacteriological studies revealed SSIs were more due to gram negative bacilli. The present study indicates that every institution has to maintain a surveillance of SSIs and to find out changing trends so as to curtail SSIs and infections due to MDR strains.[10]

CONCLUSION

Among 32 Staphylococcus aureus, 11(38%) were Methicillin resistant Staphylococcus aureus. Gram negative bacilli which showed resistance to 3rd generation cephalosporins, cefoxitin and imepenem in routine antiobiotic susceptibility testing were subjected to phenotypic confirmatory test for ESBL, Amp C and MBL producers. Phenotypic test were performed on the 81 gram negative bacilli such as combined disc test, Amp C disk test and Modified Hodge test showed 46%, 16.8% and 13.2% of them were ESBL, Amp C and MBL producers. The prevalence of MDR strains during the study period was 35.3%.

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