Prevalence, bacteriological profile and antibiogram of surgical site infections at tertiary care teaching hospital, south India: A cross sectional study

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ABSTRACT

Background: Surgical site infection (SSI) is one of the common causes of nosocomial infections. Nosocomial infections are responsible for a prolonged hospital stay and also associated with increased morbidity, mortality, and increased economic burden on the patients and family as well as overburden the hospital staff. Globally overall SSI rate varies from 2.5% – 41.9% resulting in high morbidity and mortality. However, a simple step such as hand washing, knowledge of bacteriological profile of SSIs in a hospital, and antibiotic susceptibility pattern of those isolates would help clinicians in choosing the empirical antibiotic treatment and curtail the SSIs.

Objectives: The present study was undertaken to determine the prevalence of SSI, to isolate the causative organisms, and to study their antibiotic susceptibility pattern in a hospital.

Materials and methods:

The present hospital-based, cross-sectional study was conducted at a tertiary care teaching hospital in northern Telangana, India, from August 2017 to June 2018. All pus specimens from patients of clinically suspected SSIs that were received in the microbiology laboratory were processed as per standard microbiological techniques. The data recorded and maintained in the microbiology laboratory register was reviewed and analyzed for the study. Data was analyzed by calculating the percentages and applying the Chi-square test. The p-value <0.05 was considered as significant.

Results : We observed that during the study period, 2249 major surgeries were conducted and out of these, a total of 77 pus specimens from patients clinically suspected of SSIs were received in the microbiology laboratory. 36 (46.7%) specimens were culture positive giving 36 isolates. The SSI prevalence rate was 3.4%. Females (54.5%) were affected more than males (45.5%). The most commonly isolated organism from SSI cases was *E. coli* (27.8%) followed by *Klebsiella* species (16.6%) and coagulase negative *staphylococcus* (CONS) (16.6%).

Conclusion:

In this study, SSI prevalence rate was 3.4%. The most commonly isolated organism from SSI cases was *E.coli* (27.8%). The gram-negative bacilli showed better sensitivity to imipenem and polymixin B. Majority of the gram-negative bacilli showed less sensitivity to the other commonly prescribed antibiotics like cephalosporins, fluoroquinolones, cotrimoxazole, piperacillin-tazobactam, gentamicin. Knowledge of the common pathogens and their antibiotic susceptibility status can guide clinicians to choose appropriate antibiotics for the empirical treatment of patients.

Keywords: Antibiotic susceptibility pattern, Bacteriological profile, Surgical site infections (SSIs).

INTRODUCTION

Surgical site infection (SSI) is the third most frequently reported nosocomial infections. SSI contributes to about 15% of all nosocomial infections which have an adverse effect on patient and hospital [1, 2]. SSI causes prolonged hospital stay to a patient and more economic burden to the patient and family [1, 3]. SSIs shows multifactorial association like patient condition, pre-existing disease, exogenous or endogenous etiological agent, drug resistance, hospital environment, and many others related to the operation. The spectrum of microorganisms isolated from SSI varies greatly from time to time, hospital to hospital as well as developed to developing countries [4, 5]. Globally overall SSI rate varies from 2.5% – 41.9% resulting in high morbidity and mortality [6, 7]. To curtail the nosocomial infections, continuous surveillance of SSI is required which would help to formulate hospital infection control strategy and antibiotic policy in a hospital. Moreover, a clinician's awareness regarding most frequent microbes causing SSI, and their changing antibiotic sensitivity pattern in a hospital would definitely reduce the SSI rate in any hospital.

With this background, the present study was undertaken to determine the prevalence rate of SSI, to isolate the causative organisms, and to study their antibiotic susceptibility pattern in a hospital. This study would also help in a formulation, implementation as well as evaluation of the hospital infection control measures and antibiotic policy in a hospital.

MATERIALS AND METHODS

The present hospital-based, cross-sectional study was conducted at a tertiary care teaching hospital in northern Telangana, south India, from August 2017 to June 2018. All pus specimens clinically suspected of SSI sent to the microbiology laboratory were processed as per standard microbiological techniques. All the specimens were cultured on blood agar and MacConkey agar, incubated at 370^{0}C for 24-48 hours before being reported as sterile and organisms were identified by colony character, gram stain, motility, biochemical tests [(8)]. Antibiotic susceptibility testing was done using a modified Kirby-Bauer disc diffusion method on Mueller-Hinton agar and results were interpreted as per CLSI guidelines [(9)]. Antibiotic discs were obtained from HiMedia. The data recorded and maintained in the microbiology laboratory register was reviewed and analyzed for the study. Data was analyzed by calculating the percentages and applying the Chi-square test. The p-value <0.05 was considered as significant.

RESULTS

A total of 2249 patients underwent major surgeries in various departments (surgery, orthopedics, obstetrics, and gynecology) from August 2017 to June 2018. Patients clinically suspected of having SSIs were 77 (3.4%) of whom specimens were sent to the microbiology laboratory. Out of 77 specimens; 40 (51.9%) specimens were sterile, while one specimen had grown aerobic spore bearers (contaminant) and 36 (46.7%) specimens were culture positive giving 36 isolates. Out of these 36 isolates, 34 (94.4%) were bacterial isolates and 2 (5.6%) were fungal isolates.

Majority of the SSIs were observed in >50 years age group (31.2%). Females (54.5%) were affected more than males (45.5%). However, in the present study, there was no statistically significant difference in the rate of SSI between male and female [Table 1].

Table 1: Age and gender-wise distribution of surgical site infections

Age group (years)	Specimens received		Total n=77 (%)
	Male (%)	Female (%)	
<20	00	03 (3.8)	03 (3.8)
21-30	03 (3.8)	09 (11.7)	12 (15.6)
31-40	10 (13)	09 (11.7)	19 (24.7)
41-50	12 (15.6)	07 (9.1)	19 (24.7)
>50	10 (13)	14 (18.2)	24 (31.2)
Total	35 (45.5)	42 (54.5)	77 (100)
p-value		0.1	

p-value (Statistically not significant)

Maximum culture positivity was seen with surgery (72.2%) followed by orthopedics (13.9%), obstetrics and gynecology (13.9%) department. This difference was statistically significant [Table 2].

Table 2: Department wise distribution of culture-positive surgical site infection specimens

Department	Specimens received (n=77)	Total culture positive specimens n=36 (%)	p-value
Surgery	44	26 (72.2)	
Orthopaedics	17	05 (13.9)	**0.04309**
Obstetrics and gynaecology	16	05 (13.9)	

p-value (Statistically significant)

Among 36 isolates, the most commonly isolated organism from SSI cases was *E. coli* (27.8%) followed by *Klebsiella* (16.6%), coagulase negative *staphylococcus* (CONS) (16.6%), *Staphylococcus aureus* (8.3%), *Enterococcus* species (5.6%), *Citrobacter* species (5.6%), *Pseudomonas aeruginosa* (5.6%), *Acinetobacter* species (5.6%), *Candida* species (5.6%), *Micrococcu species* (2.7%) [Table 3].

Table 3: Organisms isolated from surgical site infection specimens

Isolates	Number of isolates n=36 (%)
Gram positive organisms	12 (33.3)
CONS	06 (16.6)
Staphylococcus aureus	03 (8.3)
Enterococcus species	02 (5.6)
Micrococcus	01 (2.7)
Gram negative organisms	22 (61.1)
Escherichia coli	10 (27.8)
Klebsiella pneumoniae (02)	06 (16.6)
Klebsiella species (04) *Citrobacter* species	02 (5.6)
Pseudomonas aeruginosa	02 (5.6)
Acinetobacter species	02 (5.6)
Yeast	02 (5.6)
Candida species	02 (5.6)

Antibiotic susceptibility testing was done for all 33 isolates except one *micrococcus* and two *Candida* species isolates [Table 4] [Table 5]. *Staphylococcus aureus,* CONS, *Enterococcus* species isolates were (100%) susceptible to linezolid, and *Enterococcus* and CONS isolates were (100%) sensitive to vancomycin. Methicillin resistance (MRSA) was detected with cefoxitin disc, *S. aureus* isolates (66.7%) and CONS isolates (83.3%). Among gram-positive isolates highest antibiotic resistance was observed for fluoroquinolones (100%), macrolides (100%), amoxicillin-clavulanate (100%), followed by penicillin (90.9%), amikacin (90.9%), cephalosporins (81.8%), cotrimoxazole (72.7%), piperacillin-tazobactam (63.6%). *S. aureus* and CONS isolates showed statistically significant difference between antibiotic sensitivity and resistance pattern, whereas no statistically significant difference was seen in *Enterococcus* isolates [Table 4].

Table 4: Antibiogram of Gram-positive bacteria isolates in surgical site infections

Antibiotics	**Organisms**					
	***Staphylococcus aureus* (n=03) (%)**		**CONS (n=06) (%)**		***Enterococcus* species (n=02) (%)**	
	S	**R**	**S**		**S**	**R**
Penicillin	0	03 (100)	1 (16.7)	5 (83.3)	0	2 (100)
Erythromycin	0	03 (100)	0	6 (100)	0	2 (100)
Azithromycin	0	03 (100)	0	6 (100)	0	2 (100)

Cotrimoxazole	02 (66.7)	01 (33.3)	1 (16.7)	5 (83.3)	0	2 (100)
Ciprofloxacin	0	03 (100)	0	6 (100)	0	2 (100)
Levofloxacin	0	03 (100)	0	6 (100)	0	2 (100)
Amikacin	01 (33.3)	02 (66.7)	0	6 (100)	0	2 (100)
Cefoxitin	01 (33.3)	02 (66.7)	1 (16.7)	5 (83.3)	NT	NT
Vancomycin	02 (66.7)	01 (33.3)	6 (100)	0	2 (100)	0
Oxacillin	0	03 (100)	0	6 (100)	NT	NT
Linezolid	3 (100)	0	6 (100)	0	2 (100)	0
Amoxycillin-clavulanate	0	3 (100)	0	6 (100)	1 (50)	1 (50)
Piperacillin-Tazobactam	1 (33.3)	2 (66.7)	2 (33.3)	4 (66.7)	1 (50)	1 (50)
Cefepime	0	3 (100)	1 (16.7)	5 (83.3)	NT	NT
Cefodoxime	0	3 (100)	1 (16.7)	5 (83.3)	NT	NT
Cefoperazone	0	3 (100)	2 (33.3)	4 (66.7)	0	2 (100)
Ceftriaxone	1 (33.3)	2 (66.7)	1 (16.7)	5 (83.3)	0	2 (100)
p-value	**0.03**		**0.000001**		**0.06**	

S – sensitive, R – resistant, NT – not tested

Gram-negative isolates showed maximum sensitivity for imipenem (81.8%), polymixin-B (81.8%), followed by amikacin (69.2%), whereas high antibiotic resistance was observed for amoxicillin-clavulanate (100%), followed by cephalosporins (81.8%), fluoroquinolones (72.7%), cotrimoxazole (72.7%), piperacillin-tazobactam (50%), gentamicin (50%). E.coli showed statistically significant difference between antibiotic sensitivity and resistance pattern, whereas no statistically significant difference was observed in other gram-negative isolates [Table 5].

Table 5: Antibiogram of Gram-negative bacteria isolates in surgical site infections

Antibiotics	**Organisms**									
	Escherichia coli **(n=10) (%)**		***Klebsiella*** **species (n=06) (%)**		***Citrobacter*** **species (n=02) (%)**		***Pseudomonas aeruginosa*** **(n=02) (%)**		***Acinetobacter*** **species (n=02) (%)**	
	S	**R**	**S**	**R**	**S**	**R**	**S**	**R**	**S**	**R**
Amikacin	9 (90)	**1 (10)**	2 (33.3)	**4 (66.7)**	1 (50)	1 (50)	2 (100)	0	1 (90)	1 (50)
Gentamycin	4 (40)	**6 (60)**	2 (33.3)	**4 (66.7)**	2 (100)	0	2 (100)	0	1 (50)	1 (50)
Ciprofloxacin	1 (10)	**9 (90)**	2 (33.3)	**4 (66.7)**	1 (50)	1 (50)	2 (100)	0	0	2 (100)

	S	R	S	R	S	R	S	R	S	R
Ofloxacin	1 (10)	**9 (90)**	2 (33.3)	**4 (66.7)**	1 (50)	**1 (50)**	2 (100)	**0**	0	**2 (100)**
Levofloxacin	2 (20)	**8 (80)**	3 (50)	**3 (50)**	1 (50)	**1 (50)**	2 (100)	**0**	0	**2 (100)**
Cotrimoxazole	2 (20)	**8 (80)**	2 (33.3)	**4 (66.7)**	1 (50)	**1 (50)**	0	**2 (100)**	1 (50)	**1 (50)**
Amoxycillin-clavulanate	0	**10 (100)**	0	**6 (100)**	0	**2 (100)**	0	**2 (100)**	0	**2 (100)**
Piperacillin-Tazobactam	4 (40)	**6 (60)**	2 (33.3)	**4 (66.7)**	2 (100)	**0**	2 (100)	**0**	1 (50)	**1 (50)**
Cefepime	1 (10)	**9 (90)**	2 (33.3)	**4 (66.7)**	1 (50)	**1 (50)**	1 (50)	**1 (50)**	0	**2 (100)**
Cefpodoxime	0	**10 (100)**	2 (33.3)	**4 (66.7)**	0	**2 (100)**	2 (100)	**0**	0	**2 (100)**
Cefoperazone	0	**10 (100)**	2 (33.3)	**4 (66.7)**	1 (50)	**1 (50)**	1 (50)	**1 (50)**	0	**2 (100)**
Ceftriaxone	0]	**10 (100)**	2 (33.3)	**4 (66.7)**	1 (50)	**1 (50)**	1 (50)	**1 (50)**	0	**2 (100)**
Imipenem	9 (90)	**1 (10)**	5 (83.3)	**1 (16.7)**	1 (50)	**1 (50)**	2 (100)	**0**	1 (50)	**1 (50)**
Polymyxin B	9 (90)	**1 (10)**	4 (66.7)	**2 (33.3)**	1 (50)	**1 (50)**	2 (100)	**0**	2 (100)	**0**
p value	**0.0000001**		0.5		0.8		0.09		0.3	

S – sensitive, R – resistant

DISCUSSION

Despite the advances in surgical techniques and infection control, SSI remains to be third most frequently reported nosocomial infection. SSI although preventable varies globally and from hospital to hospital ranging from 2.5% - 41.9% [6, 7]. In the present study prevalence rate of SSI is found to be 3.4% which is comparable with the study conducted by Shah KH et al (3.38%) [10], whereas a study by Prabhakar H [11] from developing countries has reported (76.9%) very high infection rate.

In our study, majority of the patients were in the age group of >50 yrs with a female preponderance. This could be due to existing morbidity causing conditions of old age, poor immune response, and reduced compliance with the treatment. Similar observations were reported by other studies in India [7, 12, 13].

In this study, gram-negative bacilli (61.1%) dominated the gram-positive cocci (33.3%). Similar findings were reported by other studies [14, 15]. The high prevalence of gram-negative bacilli in SSI can be attributed to acquisition from patient's normal endogenous flora.

The most common bacteria isolated in our study was *E.coli* (27.8%) followed by *Klebsiella* (16.6%) and CONS (16.6%). Few other studies also reported E.coli as the most frequently isolated organism [10, 15-20]. Kaur et al [21] reported *Klebsiella pneumoniae* as the most common organism in their study, whereas few studies have mentioned S. aureus as the most common isolated organism [17, 22]. CONS being normal skin flora of patient as well as a healthcare worker, environmental contaminant could be the reason for its predominance among gram-positive cocci in SSI patients in our study. According to CDC, *S. aureus,* CoNS, and *E.coli* were the most prevalent organisms associated with surgical wound infections [23].

In our study, the gram-positive cocci showed better sensitivity to linezolid and vancomycin which is in agreement with other studies [17, 19, 21, 24]. Ineffectiveness of penicillin against gram-positive cocci has also been reported by various studies [16-18, 24] and less sensitivity to other commonly prescribed antibiotics like fluoroquinolones, macrolides, cotrimoxazole, third and fourth generation cephalosporins, amoxicillin-clavulanate, piperacillin-tazobactam, aminoglycosides which can be explained by injudicious use of antibiotics. S.aureus isolates (66.7%) showed methicillin resistance (MRSA) which is in concordance with Ramesh Rao et al [22], who reported

66.3% MRSA from SSI, however this is in contrast with the study conducted by Negi et al [19] and Naik et al [24], who reported 15.7% and 9.6% MRSA from SSI respectively. We observed methicillin resistance (83.3%) in CONS isolates whereas Kaur et al [21] reported 21.05%.

In this study, the gram-negative bacilli showed better sensitivity to imipenem, and polymixin B. This is comparable with other studies [19, 25, 26]. All the gram-negative bacilli showed resistance to amoxicillin-clavulanate. This is in agreement with another study conducted by More et al [27]. Majority of the gram-negative bacilli showed less sensitivity to the other commonly prescribed antibiotics like cephalosporins, fluoroquinolones, cotrimoxazole, piperacillin-tazobactam, gentamicin which can be associated with inappropriate use of these antibiotics, and probably extended-spectrum beta-lactamase (ESBL) producers. Similar findings were reported by other studies also [15, 20, 21]. In the present study, one *Acinetobacter* isolate and one *Klebsiella* species isolate was found to be sensitive only to polymixin-B. One isolate of *Klebsiella* species was only sensitive to imipenem. This shows increasing multidrug resistance among these bacteria.

Conclusion

The overall prevalence rate of SSI was found to be 3.4%, in our study. It is quite low when compared with other hospitals in developing countries, indicating satisfactory hospital infection control measures in our place. *E.coli* (27.8%) was the most commonly isolated organism. Gram negative bacilli showed better sensitivity to imipenem and polymixin B whereas gram-positive cocci showed better sensitivity to linezolid and vancomycin. However, knowledge of common pathogens and their resistance status can guide clinicians to choose appropriate antibiotics for the empirical treatment of patients. Emerging multidrug resistance among bacteria warns us against the inappropriate and prolonged use of antibiotics.

Limitations of the study

The tests for phenotypic detection of ESBL, MBL production of gram-negative isolates have not been done in the present study.

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How to cite this article : Palange P, Ambade V, Wilson V, Mohan Rao B. Prevalence, bacteriological profile and antibiogram of surgical site infections at tertiary care teaching hospital, south India: A cross sectional study. Perspectives in Medical Research 2019; 7(2):43-49

Sources of Support: Nil,Conflict of interest:None declared