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Research Article

A STUDY ON BACTERIOLOGICAL PROFILE AND ANTIBIOTIC SUSCEPTIBILITY PATTERN OF SURGICAL SITE INFECTIONS IN A TERTIARY CARE HOSPITAL

PURIMITLA USHARANI*

Department of Microbiology, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Rangareddy, Telangana, India.
E-mail: purimitlausha2@gmail.com

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ABSTRACT

Objective: The present study was aimed to evaluate the prevalence, microbiological profile, and antibiograms of pathogenic microorganisms causing surgical site infections.

Methods: The present study was conducted in the Department of Microbiology, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Telangana. The study was conducted from the period of April 2020 to April 2021. Three hundred pus samples were analyzed for culture isolation and identification using standard protocols. Antibiotic susceptibility pattern of each isolate was performed by standard disc diffusion method by following The Clinical and Laboratory Standard Institute guidelines.

Results: A total of monomicrobial isolates 165 (55%) and polymicrobial isolates 13 (4.4%) were obtained from 300 pus samples and remaining 122 (40.6%) pus samples were sterile. The predominant bacteria were *Staphylococcus aureus* 50 (30.3%) followed by *Pseudomonas aeruginosa* 39 (23.6%) in monomicrobial infection and *Klebsiella oxytoca* + *P. aeruginosa* 3 (23%) in polymicrobial infection. The results of antibiogram of *S. aureus* which showed the highest sensitivity to antibiotics like linezolid 47 (94%) and doxycycline 42 (80%) compared to other antibiotics used for antibiotic susceptibility testing. Among the Gram-negative bacteria, the prevalent organism was *Klebsiella* species which showed the highest sensitivity to antibiotic meropenem 32 (86.5%).

Conclusion: The predominant bacterium isolated was *S. aureus* followed by *P. aeruginosa* in monomicrobial infection and *K. oxytoca* + *P. aeruginosa* in polymicrobial infection. Controlling the morbidity of surgical site infections is aided by meticulous surgical procedures, careful sterilization, judicious use of antibiotics, improved operating theater and ward conditions, control of malnutrition and obesity, management of infective foci, and diseases such as diabetes.

Keywords: Surgical site infections, Demographic variables, Culture, Monomicrobial infection, Polymicrobial infection, Antibiotic susceptibility.

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INTRODUCTION

Surgical site infections are marked by intense local inflammation and the development of pus. It is when a pathogenic microorganism infiltrates and multiplies in a bodily component or tissue, causing tissue damage and progressing to overt disease through a range of cellular or toxic mechanisms, usually triggered by one of the pus producing bacteria [1,2]. Pus is white to yellow colored fluid composed of dead white blood cells, tissue debris, and pathogenic organisms. Both aerobic and anaerobic bacteria have been associated with surgical site infections which habitually present in the hospital environment and lead to significant morbidity, prolonged hospital stay, and great economic grievance. The emerging antibiotic resistance and its expedition spread among the pathogenic bacteria and regarded as engrave threats to the public health worldwide [3]. This is particularly true in case of infections caused by Enterobacteriaceae members such as *Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa,* that were ever-increasingly related with pus forming infections underneath hospital settings due to extensive misprescription and using an insufficient dosage of antibiotics regimens [3].

Despite advancements in microbiological methods, antibiotics, and surgical care, surgical site infections continue to be seen frequently in developing countries, and treatment remains a significant challenge. It is important to locate and treat the source of infection to ensure proper and effective treatment. However, highly virulent strains and their ability to become accustomed quickly to changing environment can degenerate the situation [4]. The most common pathogens causing surgical site infections include coagulase-negative Staphylococci, *Staphylococcus aureus*, Enterococci, Enterobacteriaceae members, and Beta-hemolytic Streptococci [5]. Source control drainage or surgical excision of contaminated or necrotic material, as well as antibiotic therapy aimed at the most likely or laboratory-confirmed pathogens, is needed for the treatment of pus-oriented infections. Fever is less likely to occur in superficial infections than in infections involving deep tissue, and they are normally treated with debridement alone, while deep-seated infections are treated differently depending on the type of infection [6]. Localized collections, such as abscesses, may also be treated with only drainage, although more diffuse involvement in deep tissues should be treated with antimicrobial therapy as soon as possible. Now-a-days, surgical site infections are often difficult to manage due to multidrug-resistant bacteria probably due to the widespread use of prophylactic and empiric antibiotics, increased the severity of illness, and greater numbers of immune-compromised patients [7]. The present study was intended to evaluate the microbiological profile of aerobic pyogenic microorganisms along with their antibiograms and plan to bridge the gap in the knowledge and also to make it available for the clinicians with the tools to give safe and effective empirical therapy.

METHODS

Study design

The present study is a retrospective study conducted in the Department of Microbiology, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Telangana.

Study duration

The study was conducted from the period of April 2020 to April 2021.

Sample size
Three hundred pus samples were sent to the microbiological laboratory from various clinical departments for culture and sensitivity.

Ethics clearance
A proposal regarding the study's aims and objectives was submitted to the Institutional Ethics Committee, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Telangana and permission was obtained from the Institutional Ethics Committee regarding data collection.

Inclusion criteria: Samples from the infected surgical site wound were taken for the study. The study comprised patients of both sexes, aged >14 years, who had surgical wound pus discharge with serous or seropurulent discharge and indications of sepsis (warmth, erythema, induration, soreness, pain, and elevated local temperature). Patients provided a thorough history of their age, gender, kind of illness, diagnosis, type of surgery performed, antibiotic medication, and associated comorbid conditions.

Exclusion criteria
The following criteria were excluded from the study:
1. Patients of HIV and other immunological disorder.
2. Patient who had taken antibiotics.

Methodology
Socioeconomic demographic variables such as age, sex, in-patient, and out-patient, departments from where the pus samples were obtained were included in the study. Gram staining is often used to investigate the clinical isolates' morphological characteristics [8]. Blood agar, Mac Conkey agar, and Mannitol salt agar plates, among others, were inoculated with pus samples and incubated aerobically at 37°C for 24 h. The microorganisms and pigment development were tentatively described by colony morphology, and the isolated bacteria were subjected to various biochemical tests for confirmation. The tests included carbohydrate fermentation with glucose, lactose, xylose, and mannitol, detection of indoleproduction, citrate utilization, nitrate reduction, gelatin hydrolysis, amino acid decarboxylation, methyl red, Voges-Proskauer, triple sugar iron, and Hughs-Leifsons (O/F) tests. The isolated organisms were also observed for the production of enzymes such as urease, coagulase, oxidase, and catalase [8].

Antibiotic susceptibility testing
As an inoculum, an overnight broth culture of the isolated bacteria was used. On Muller-Hinton agar, antibiotic susceptibility testing was performed using the disc diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines [8]. The inhibition zone was measured according to the CLSI guidelines (CLSI Catalog, 2016) [8].

Extended-spectrum beta-lactamase (ESBL) production
ESBL production was tested with the CLSI confirmatory test using ceftazidime (30 µg) disc alone and in combination with clavulanic acid (10 µg). Between the discs, a distance of at least 3 cm was maintained. When the growth-inhibitory zone around the ceftazidime disc with clavulanic acid increased by 5 mm or more than the diameter of the disc containing ceftazidime alone, the test was considered positive. The plates were incubated at 37°C for 18 h [9].

Statistical analysis
SPPS software version 20.0 was used to perform statistical analysis on the data. For categorical and ordinal variables, frequency and percentages were determined. The Chi-square test was used, and results with $P < 0.05$ were considered statistically important.

RESULTS

Table 1 shows total frequency of samples collected. Out of 300 pus samples collected, male subject within age group 91–100 years was 1 (100%) followed by 61–70 years 33 (79%) while female subject within age groups 81–90 years had (50%) followed by age groups 21–30 years 20 (48%).

Out of 300 pus samples collected, more pus samples were collected from males 189 (63%) comparatively to females 111 (37%) (Table 1). Table 1 denotes sample collected and higher samples were collected among out-patients within age groups 91–100 years 1 (100%) followed by age groups 1–10 years with 4 (67%) while in-patient age groups 71–80 years had 11 (92%) followed by age groups 41–50 years with 56 (89%). It was statistically significant ($p<0.05$) (Table 1).

Among the samples obtained from various clinical departments, maximum pus samples 198 (66%) were recorded from general surgery 198 (66%) and 81–90 years had highest sample 2 (100%) followed by 51–60 years age groups 65 (84%), general medicine 37 (12.3%), and orthopedics 25 (8.3%) (Table 2).

A total of monomicrobial isolates 165 (55%) and polymicrobial isolates 13 (4.4%) were obtained from 300 pus samples and remaining 122 (40.6%) pus samples were sterile (Fig. 1).

From Table 3, it was observed that the predominant bacteria were *S. aureus* 50 (30.3%) followed by *P. aeruginosa* 39 (23.6%) in monomicrobial infections whereas in polymicrobial infections *K. oxytoca*+ *P. aeruginosa* showed more incidence 3 (23%). This was statistically significant $p<0.05$. The mean values for antibiotic resistance and sensitivity were compared by Chi-square test analysis.

The results of antibiogram of isolated Gram-positive bacteria in monomicrobial infection showed that the most predominant organism was *S. aureus* which showed highest sensitivity to antibiotics such as linezolid 47 (94%) and doxycycline 42 (80%) and the least prevalent organism Enterococci showed analogous sensitivity to cefepime, doxycycline, gentamycin, and vancomycin 2 (100%) (Table 4).

Among the Gram-negative bacteria, the most prevalent organism was *Klebsiella* species which showed the highest sensitivity to antibiotic meropenem 32 (86.5%) (Table 5) while *P. aeruginosa* showed maximum sensitivity to antibiotic imipenem 32 (82%) (Table 6). The less common isolate of Gram-negative bacteria *Providencia* species showed the highest sensitivity to antibiotic amikacin 2 (100%) (Table 5) whereas non-fermenting Gram-negative bacilli like *Acinetobacter* species showed the highest sensitivity to amikacin 3 (100%) (Table 7). In polymicrobial isolates, the highest number of mixed culture was reported from *K. oxytoca*+ *P. aeruginosa* showed maximum sensitivity to antibiotics such as gentamycin (%), imipenem (%), meropenem (%), and tetracycline (%) (Table 8).

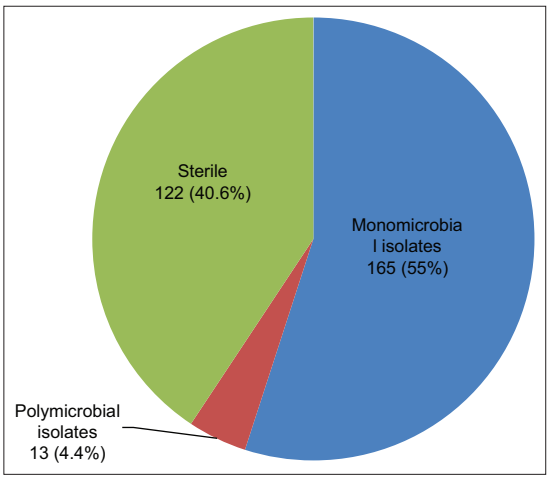

Fig. 1: Distribution of culture-positive cases (monomicrobial and polymicrobial) and sterile samples of pus infections

Table 1: Age, gender, OP, and IP basis distribution of study population

Age (Years)	Number of cases	Males		Females		OP		IP	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1–10	6 (2%)	4/300	1.3	2/300	0.6	4/300	1.3	2/300	0.6
11–20	24 (8%)	14/300	4.6	10/300	3.3	9/300	3	15/300	5
21–30	42 (14%)	22/300	7.3	20/300	6.6	10/300	3.3	32/300	10.6
31–40	31 (10.3%)	18/300	6	13/300	4.3	5/300	1.6	26/300	8.6
41–50	63 (21%)	38/300	12.6	25/300	8.3	7/300	2.3	56/300	18.6
51–60	77 (25.6%)	50/300	16.6	27/300	9	9/300	3	68/300	22.6
61–70	42 (14%)	33/300	11	9/300	3	7/300	2.3	35/300	11.6
71–80	12 (4%)	8/300	2.6	4/300	1.3	1/300	0.3	11/300	3.6
81–90	2 (0.6%)	1/300	0.3	1/300	0.3	1/300	0.3	1/300	0.3
91–100	1 (0.3%)	1/300	0.3	0	0	1/300	0.3	0	0
Total	300 (100%)	189 (63%)		111 (37%)		54 (18%)		246 (82%)	
p-value		0.52^{NS}				$<0.01^{HS}$			

NS: Not significant, HS: Highly significant, OP: Out patients, IP: In patients

Table 2: Departmental distribution of pus samples

Age	Number	ped	DVL	GS	GYN	Ortho	Obst	GM	ICU	ENT	Neurology
<20	30	1	6	15	2	4	2	0	0	0	0
		3%	20%	50%	7%	13%	7%	0%	0%	0%	0%
21–30	42	0	2	29	2	2	4	3	0	0	0
		0%	5%	69%	5%	5%	10%	7%	0%	0%	0%
31–40	31	0	0	17	4	7	0	3	0	0	0
		0%	0%	55%	13%	23%	0%	10%	0%	0%	0%
41–50	63	0	0	41	4	3	0	14	1	0	0
		0%	0%	65%	6%	5%	0%	22%	2%	0%	0%
51–60	77	0	4	65	0	5	1	1	0	1	0
		0%	5%	84%	0%	6%	1%	1%	0%	1%	0%
61–70	42	0	0	20	2	3	0	15	0	1	1
		0%	0%	48%	5%	7%	0%	36%	0%	2%	2%
71–80	12	0	1	9	0	1	0	1	0		
		0%	8%	75%	0%	8%	0%	8%	0%	0%	0%
81–90	2	0	0	2	0	0	0	0			
		0%	0%	100%	0%	0%	0%	0%	0%	0%	0%
>91	1	0	0	0	0	0	0	0	0	1	
		0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Total	300	1 (0.4%)	13 (4.3%)	198 (66%)	14 (4.6%)	25 (8.3%)	7 (2.3%)	37 (12.3%)	1 (0.4%	3 (1%)	1 (0.40%)

Chi-square value=224.54, p<0.01: Highly significant. Paed: Pediatric, DVL: Dermatology, venereology and leprosy, GS: General surgery, GYN: Gynecology, ortho: Orthopedics, obst: Obstetric, GM: General medicine, ICU: Intensive care, ENT: Ear, nose and throat, Neur: Neurology

Table 3: Distribution of monomicrobial, polymicrobial, and sterile pus samples of pyogenic infections

Monomicrobial infection	Number and percentage	Polymicrobial infection	Number and percentage
Staphylococcus aureus (MSSA+MRSA+CONS)	50 (30.3%)	*E. coli* + Entercocci	1 (7.7%)
Acinetobacter baumannii + A. lowfii	3 (1.8%)	*E. coli + Pseudomonas aeruginosa*	1 (7.7%)
Proteus mirabilis	4 (2.4%)	Candida *+ Pseudomonas aeruginosa*	1 (7.7%)
Enterococcus faecalis	2 (1.2%)	*Klebsiellaoxytoca + Pseudomonas aeruginosa*	3 (23%)
Escherichia coli	20 (12.1%)	*E. coli + Proteus mirabilis*	1 (7.7%)
Pseudomonas aeruginosa	39 (23.6%)	*Proteus vulgaris + Pseudomonas aeruginosa*	1 (7.7%)
Providencia spp.	2 (1.2%)	*Klebsiellaoxytoca + Proteus mirabilis*	1 (7.7%)
Klebsiella spp.	37 (22.4%)	*Klebsiella* spp. + MRSA	1 (7.7%)
(K. oxytoca + K. pneumoniae)			
Citrobacter spp.	7 (4.2%)	Citrobacter spp. *+ Pseudomonas aeruginosa*	1 (7.7%)
Candida spp.	1 (0.6%)	Citrobacter + MRSA	1 (7.7%)
		Klebsiella pneumoniae + P. aeruginosa	1 (7.7%)
Total :			
Total pus samples (n): 300	165 (55%)		13 (4.3%)
Number of sterile samples: 122 (40.6%)			

DISCUSSION

Surgical site infections are characterized by severe local inflammation, usually with pus formation produced by several pyogenic bacteria and few fungi. These infections prolong hospitalization, delay wound healing, and increase the overall cost and morbidity. Population-based studies have revealed that male gender and young and elderly individuals are at increased risk of infections. The risk factors include any surgical invasive procedures, comorbidities such as diabetes, obesity, and cancer; immunodeficiency diseases such as HIV, intravenous drug use, and alcohol abuse, and any classic pre-disposing factors encompass

Table 4: Antibiogram of Gram-positive monomicrobial bacterial isolates

Antibiotics	*Staphylococcus aureus* (n=50)		Enterococci spp. (n=2)	
	Sensitivity (Number and %)	Resistance (Number and %)	Sensitivity (Number and %)	Resistance (Number and %)
Ampicillin	1 (2%)	49 (98%)	0 (0%)	2 (100%)
Cefepime	27 (54%)	23 (46%)	2 (100%)	0 (0%)
Cefoxitin	23 (46%)	27 (54%)	1 (50%)	1 (50%)
Cefuroxime	21 (42%)	29 (58%)	1 (50%)	1 (50%)
Ciprofloxacin	10 (20%)	40 (80%)	0 (0%)	2 (100%)
Cotrimoxazole	19 (38%)	31 (62%)	1 (50%)	1 (50%)
Doxycycline	42 (80%)	8 (16%)	2 (100%)	0 (0%)
Erythromycin	17 (34%)	33 (66%)	1 (50%)	1 (50%)
Gentamycin	36 (72%)	14 (28%)	2 (100%)	0 (0%)
Linezolid	47 (94%)	3 (6%)	1 (50%)	1 (50%)
Penicillin	1 (2%)	49 (98%)	0 (0%)	2 (100%)
Rifampicin	24 (48%)	26 (52%)	1 (50%)	1 (50%)
Tetracycline	34 (68%)	16 (32%)	0 (0%)	2 (100%)
Vancomycin	30 (60%)	20 (40%)	2 (100%)	0 (0%)
p-value	$<0.01^{HS}$		0.25^{NS}	

NS: Not significant, HS: Highly significant

Table 5: Antibiogram of Gram-negative monomicrobial bacterial isolates

Antibiotics	*Escherichia coli* (n=20)		*Proteus* spp. (n=4)		*Providencia* spp. (n=2)		*Klebsiella* pp. (n=37)		*Citrobacter* Spp. (n=7)	
	Sensitivity (Number and %)	Resistance (Number and %)	Sensitivity (Number and %)	Resistance (Number and %)	Sensitivity (Number and %)	Resistance (Number and %)	Sensitivity (Number and %)	Resistance (Number and %)	Sensitivity (Number and %)	Resistance (Number and %)
Ampicillin	0 (0%)	20 (100%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	2 (5.4%)	35 (94.6%)	1 (14.2%)	6 (85.8%)
Cefepime	3 (15%)	17 (85%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	8 (21.6%)	29 (78.4%)	2 (28.5%)	5 (71.5%)
Ceftriaxone	2 (10%)	18 (90%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	3 (8.1%)	34 (91.9%)	0 (0%)	7 (100%)
Cefuroxime	1 (5%)	19 (95%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	2 (5.4%)	35 (94.6%)	0 (0%)	7 (100%)
Ciprofloxacin	5 (25%)	15 (75%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	4 (10.9%)	33 (89.1%)	1 (14.2%)	6 (85.8%)
Cotrimoxazole	3 (15%)	17 (85%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	12 (32.4%)	25 (67.6%)	2 (28.5%)	5 (71.5%)
Amikacin	13 (65%)	7 (35%)	0 (0%)	4 (100%)	2 (100%)	0 (0%)	20 (54%)	17 (46%)	4 (57%)	3 (43%)
Imipenem	12 (60%)	8 (40%)	3 (75%)	1 (25%)	1 (50%)	1 (50%)	30 (81%)	7 (19%)	6 (85.7%)	1 (14.3%)
Gentamycin	12 (60%)	8 (40%)	0 (0%)	4 (100%)	1 (50%)	1 (50%)	14 (37.9%)	23 (62.1%)	5 (71.5%)	2 (28.5%)
Ceftazidime	0 (0%)	20 (100%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	5 (13.5%)	32 (86.5%)	0 (0%)	7 (100%)
Ceftazidime/ clavulanic acid	1 (5%)	19 (95%)	0 (0%)	4 (100%)	1 (50%)	1 (50%)	7 (19%)	30 (81%)	0 (0%)	7 (100%)
Ampicillin/ sulbactam	1 (5%)	19 (95%)	1 (25%)	3 (75%)	0 (0%)	2 (100%)	5 (13.5%)	32 (86.5%)	2 (28.55)	5 (71.5%)
Tetracycline	3 (15%)	17 (85%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	8 (21.6%)	29 (78.4%)	1 (14.2%)	6 (85.8%)
Ertapenem	10 (50%)	10 (50%)	0 (0%)	4 (100%)	1 (50%)	1 (50%)	9 (24.3%)	28 (75.7%)	3 (42.8%)	4 (57.2%)
Chloramphenicol	4 (20%)	16 (80%)	0 (0%)	4 (100%)	0 (0%)	2 (100%)	7 (19%)	30 (81%)	1 (14.2%)	6 (85.8%)
Meropenem	13 (65%)	7 (45%)	3 (75%)	1 (25%)	1 (50%)	1 (50%)	32 (86.5%)	5 (13.5%)	7 (100%)	0 (0%)
p-value	$<0.01^{HS}$		$<0.01^{HS}$		$<0.01^{HS}$		$<0.01^{HS}$		$<0.01^{HS}$	

HS: Highly significant

Table 6: Antibiogram of *Pseudomonas* spp.

Antibiotics (n=39)	Sensitivity (Number and %)	Resistance (Number and %)
Cefepime	6 (15.3%)	33 (84.7%)
Amikacin	23 (58.9%)	16 (41.1%)
Ciprofloxacin	13 (33.3%)	26 (66.7%)
Cotrimoxazole	11 (28.2%)	28 (71.8%)
Ceftazidime/clavulanic acid	7 (18%)	32 (82%)
Gentamycin	19 (48.7%)	20 (51.3%)
Ceftazidime	2 (5.1%)	37 (94.9%)
Ampicillin/sulbactam	1 (2.5%)	38 (97.5%)
Imipenem	32 (82%)	7 (18%)
Piperacillin	4 (10.2%)	35 (89.8%)
p-value	$<0.01^{HS}$	

HS: Highly significant

chemotactic defects, defects in phagocytosis, inheritable genetic disorders, incisions, burns etc.

In the present study, males preponderance 63% was seen among the 300 collected pus samples. Men were at higher risk for pyogenic infections possibly due to differences in propensity for skin colonization or other anatomical differences, type of surgery, and incision site. The results coincide with the findings of the previous studies [10,11]. Zhang *et al*. [10] reported among 274 patients, 225 were males and 49 were females. Naz *et al*. [11] reported that males (60%) were more commonly affected than females. Age was one of the most significant factors on the rate of infection and in the present study, male subject within age groups >91 years had highest 1 (100%) percentage of infection which was in coincidence to the results of Fatemaa *et al*. and Ahmed *et al*. [12,13]. The effect of a high infection rate on these age groups may be attributed to a decrease in immunity, a slow healing

Table 7: Antibiogram of non-fermentative Gram-negative bacilli *Acinetobacter* spp.

Antibiotics (n=3)	Sensitivity (Number and %)	Resistance (Number and %)
Ampicillin	0 (0%)	3 (100%)
Cefepime	0 (0%)	3 (100%)
Amikacin	3 (100%)	0 (0%)
Cefuroxime	0 (0%)	3 (100%)
Ciprofloxacin	0 (0%)	3 (100%)
Cotrimoxazole	2 (66.7%)	1 (33.3%)
Ertapenem	1 (33.3%)	2 (66.7%)
Ceftazidime/clavulanic acid	0 (0%)	3 (100%)
Gentamycin	2 (66.7%)	1 (33.3%)
Ceftazidime	0 (0%)	3 (100%)
Ampicillin/sulbactam	0 (0%)	3 (100%)
Imipenem	2 (66.7%)	1 (33.3%)
Tetracycline	0 (0%)	3 (100%)
p-value	$<0.01^{HS}$	

HS: Highly significant

rate, increased catabolic processes, and the emergence of comorbidities such as diabetes, obesity, and chronic obstructive pulmonary disease. By observing the cases based on in-patient and out-patient strategy, more samples were obtained from inpatients.

In general, infected in-patients had on average a 3 times longer hospital stay, 3 times greater charges, and a 5 times greater risk for in-hospital death. Among the department distribution of pus samples, more samples were recorded from general surgery 66% which was similar to the reports of Rawat *et al*. who reported 50% samples were from general surgery [4]. These infections may be community acquired or hospital acquired infections and may originate after an operation but commonly between 5th and 10th days of after surgery or during the operation or may occur after the operation from sources in the ward or as a result of some complications, that is, secondary wound infections [14]. A total of monomicrobial isolates 55% and polymicrobial isolates 4.4% were obtained from 300 pus samples and remaining 40.6% pus samples were sterile. The predominant bacteria were *S. aureus* 30.3% followed by *P. aeruginosa* 23.6% in monomicrobial infection. The incident rate of mixed culture *K. oxytoca + P. aeruginosa* was high 23% in polymicrobial infection similar to Santosh *et al*. [15]. Similar study by Poonam (2012) had showed that *S. aureus* 24.29% was the predominant organism followed by *P. aeruginosa* 21.49% [16]. These findings also agree with the studies of Nwachukwu who reported 42.3% incident rate of *S. aureus* and 32.9% of *P. aeruginosa* infection [17]. The study followed the results of many previous studies had reported that *S. aureus* was the prevalent organism of pyogenic infections [18-21]. Dinda *et al*. [18] found out that the major pathogen involved in SSI was *S. aureus* (30.8%). Anguzu and Olila [19] reported *that S. aureus* (45.1%) was the major isolate in their study whereas Mahmood [20] reported 50.32*% S. aureus* and Ahmed *et al*. [21] showed 57.98% *S. aureus*. The results of antibiogram of isolated Gram-positive bacteria in monomicrobial infection showed that the most predominant organism was *S. aureus* which showed the highest sensitivity to antibiotics such as linezolid 94% and doxycycline 80%. It was reported earlier that *S. aureus* showed maximum sensitivity to linezolid 60% [22]. Doxycycline was one of the most effective antimicrobial agents for *S. aureus* [23]. Among the Gram-negative bacteria, the prevalent organism was *Klebsiella* species which showed the highest sensitivity to antibiotic meropenem 86.5% whereas *P. aeruginosa* showed sensitivity to antibiotic imipenem 82% coincides with the results of Mehta *et al*. [22] showed 69.4% sensitivity to imipenem. *Acinetobacter* species showed the highest sensitivity to amikacin 100% parallel to the reports of Abdelraouf and Elmanama [23]. In polymicrobial isolates, the highest number of mixed culture was reported from *K. oxytoca + P. aeruginosa* showed maximum sensitivity to antibiotics such as gentamycin (%), imipenem (%), meropenem (%), and tetracycline (%), similar to the studies of Adegoke *et al*. reported that the Gram-negative bacteria showed highly sensitive

Table 8: Antibiotic sensitivity pattern of polymicrobial isolates

Antibiotics	*E. coli* + Enterococci (n=1)	*E. coli* + *P. aeruginosa* (n=1)	Candida (yeast) + *Pseudomonas aeruginosa* (n=1)	*Klebsiella oxytoca* + *Pseudomonas aeruginosa* (n=3)	*E. coli* + *Proteus mirabilis* (n=1)	*Proteus vulgaris* + *Pseudomonas aeruginosa* (n=1)	*Klebsiella oxytoca* + *Proteus mirabilis* (n=1)	Klebsiella spp. + MRSA (n=1)	Citrobacter spp. + *Pseudomonas aeruginosa* (n=1)	Citrobacter + MRSA (n=1)	*K. pneumoniae* + *P. aeruginosa* (n=1)
Amikacin	100	100	100	75	0	100	100	100	100	100	100
Ampicillin	0	0	0	0	0	0	0	0	0	0	0
Ampicillin/sulbactam	0	0	0	0	100	0	100	100	100	0	100
Cefepime	100	100	100	75	0	0	100	0	100	100	0
Ceftazidime	0	0	0	0	0	0	100	0	100	0	0
Ceftazidime/clavulanic acid	0	100	100	100	0	0	100	0	100	100	0
Ceftriaxone	0	0	0	0	0	0	0	0	0	0	0
Cefuroxime	0	0	0	0	0	0	100	0	0	0	0
Ciprofloxacin	100	0	0	0	100	0	0	0	0	0	100
Cotrimoxazole	0	0	0	0	0	0	0	0	0	0	100
Ertapenem	100	0	100	0	0	0	100	100	100	100	100
Gentamycin	100	100	100	0	0	0	100	100	100	100	100
Imipenem	100	100	100	0	100	100	100	100	100	100	100
Meropenem	100	0	100	0	100	100	100	100	100	100	100
Tetracycline	0	100	100	0	100	0	0	0	0	0	100
Linezolid	0	0	0	0	0	0	0	0	0	0	100
Vancomycin	0	0	0	0	0	0	0	0	0	0	0
Penicillin	0	0	0	0	100	0	0	100	0	100	0
Piperacillin	0	0	0	0	0	0	0	0	0	0	0
Nalidixic acid	0	0	0	0	0	0	0	0	0	0	0

to gentamicin and imipenem antibiotics with percentage ranging from 70% to 90% [24] whereas Ahmed *et al*. showed that 27.8% of Gram-negative bacteria were resistant to imipenem [25].

CONCLUSION

Surgical site infections are still recurrently seen in the developing countries and the treatment is a substantial defy to the clinicians regardless of advances in microbiological techniques, antibiotics, and surgical treatments. It is important to locate and treat the source of inflammation to ensure effective treatment. Aspiration or surgical drainage, accompanied by adequate antibiotics, is used to treat a variety of pyogenic infections. *S. aureus* was the most predominant organisms of pyogenic infections in the present study. The most of the isolated bacteria are resistant to the tested antibiotics; hence, it is strongly advised that extensive use of inappropriate antibiotics in empirical therapy can cause the emergence of resistant bacteria strains, especially in health-care centers to be prevented and at the same time, advances of control of infection should be implemented.

AUTHORS' CONTRIBUTION

The author P. Usharani had performed the entire work, wrote the first draft of the manuscript, collected the literature, and performed the statistical analysis.

CONFLICT OF INTEREST

The authors declared no conflict of interest

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