Research Article

Blood Stream Infections in Intensive Care Units and its Antibiogram

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Abstract

Introduction: Early diagnosis and appropriate treatment of blood stream infections can make the difference between life and death. It would reduce mortality from septicaemia, reduce turn around time and improve patient management. This study aims at the microbiological characteristics and antibiotic susceptibility of BSI in intensive care units.

Materials and Methods: A total of 670 blood samples received in the bacteriology laboratory 112 samples showed culture positivity.

Results: Coagulase negative *Staphylococcus*, represent the most commonly isolated organisms. Among the gram negative organisms *Pseudomonas* species, *Escherichia coli, Klebsiella* and *Enterococcus* species were commonly isolated.

Conclusion: Bacteriological etiology of sepsis along with the antibiogram of septicemic isolates provide necessary information for the formulation of antibiotic policy in effective management of such cases in intensive care units.

Keywords: BSI; Antimicrobial Susceptibility; Bacteremia; ICU

Abbreviations

BSI: Blood Stream Infections; Spp: Species; ICU: Intensive Care Unit; CLSI: Clinical and Laboratory Standards Institute Guidelines; MICU: Medical Intensive Care Unit; SICU: Surgical Intensive Care Unit; PICU: Paediatric Intensive Care Unit; NICU: Neonatal Intensive Care Unit; CONS: Coagulase Negative *Staphylococcus;* GPC: Gram Positive Cocci

Introduction

Bacteremia is related to the presence of viable bacteria in the blood confirmed by cultures in which contamination has been effectively ruled out [1,2]. Critically ill patients are particularly predisposed to the acquisition of BSIs, which occur in approximately 7% of all patients within the first month of hospitalization in Intensive Care Unit (ICU) [3]. The Extended Prevalence of Infection in the ICU Study (EPIC II) conducted in 2007 showed that in ICU approximately 15% of patients had a BSI on the day of the study [4]. The extensive use of intravascular catheters is recognized as the most important factor contributing to the occurrence of BSI [5,6].

Central venous catheters, in particular, represent the intravascular devices that are most frequently associated with the acquisition of a BSI, although arterial catheters can be also involved [7-9].

Catheter-related BSIs (CR-BSIs) (defined as the growth of the same pathogen from catheter tip and peripheral blood culture), which represent up to 30% of cases, and primary BSIs, accounting for around 35% of cases, are the most common types of BSI in ICU [10,11]. Ventilator-Associated-Pneumonia (VAP), which is a frequent complication when mechanical ventilation is required, is bacteremic in around 15% of cases, and represent the most common source of secondary bacteremia in critically ill patients [11,12]. The most common bacteria that cause bacteremia include members of *Staphylococcus, Streptococcus, Enterococcus, Escherichia coli, Klebsiella, Pseudomonas, Enterobacter, Haemophilus* and *Neisseria* genera [13-15]. Blood culture remains the highly specific indicator of bacteremia and antimicrobial susceptibility test assist a great deal in precise identification of the most appropriate choice of drug to be administer.

Materials and Methods

The study was conducted in the Department of Microbiology, Central Laboratory, School of Medical Sciences and Research, Sharda Hospital, Greater Noida. It is a prospective study which was conducted for a period of 6 months. All the isolates from blood culture positive samples collected over period of six months were assessed. In this study we adopted automated method i.e. (BACT-ALERT system) in order to culture the bottles received in the bacteriology laboratory. The bottles were put inside the automated machine, when there was a signal the bottles were removed and the blood from the positive blood culture bottles was subjected to subculture on 5% sheep blood agar and MacConkey agar. The growth on culture plates was identified on the basis of colony morphology, Gram stain, and various biochemical tests. Antimicrobial susceptibility testing were performed for all blood cultures isolated on Muller Hinton agar by Kirby- Bauer disc diffusion method as recommended in the CLSI (Clinical And Laboratory Standards Institute guidelines) 2019. Commercially available antibiotics disks (Hi media) were used for antimicrobial susceptibility testing. A total of 670 blood samples were received in the bacteriology lab for culture out of which 112 samples showed culture positivity. All the isolates were identified on the basis of culture characteristics, Gram stain and biochemical reactions. The isolates were then subjected to antimicrobial susceptibility testing.

Results

A total of 670 blood samples were received in the bacteriology lab for culture out of which 112 samples showed culture positivity. All the isolates were identified on the basis of culture characteristics, Gram stain and biochemical reactions. The isolates were then subjected to antimicrobial susceptibility testing. Out of 112 positive samples obtained, 74 were male patients and 38 were females indicating higher rates of blood stream infections in males as compared to females. The maximum number of samples was obtained from patients between age 60 - 70 years in MICU (Table 1 and figure 1). Maximum number of cases were obtained from medical ICU approximately 46% followed by surgical ICU approximately 26%. Gram positive staphylococci constituted maximum proportion of isolates followed by *Pseudomonas* species and *E. coli*. (Table 8 and figure 8). Amongst all the antibiotics, Linezolid (100%) and vancomycin (100%) emerged as most sensitive drug against *Staphylococcus aureus*. Strains of *Staphylococcus aureus* showed high resistance for erythromycin (75%) and cefoxitin (62%). Amongst all the antibiotics, linezolid (83%). Gentamicin (66%), Levofloxacin (66%), vancomycin (66%), ciprofloxacin (66%) emerged as most sensitive drug against *Enterococcus* spp (Table 4 and figure 6). Strains of *Enterococcus* spp showed high resistance for ampicillin

(83%) followed by penicillin (66%). Gentamycin (94%) emerged as most sensitive drug against *E. coli* (Table 5 and figure 7) followed by meropenem (92%), and cotrimoxazole (82%). Strains of *Escherichia coli* showed high resistance for cefuroxime (65%) followed by ceftriaxone (65%) and ampicillin (53%). Imipenem (89%) meropenem (77%) emerged as most sensitive drug against *Klebsiella* followed by cotrimoxazole (67%). Strains of *Klebsiella* (Table 6 and figure 8) showed high resistance for cefepime (89%) followed by ceftriaxone (78%) and Ampicillin (78%). Gentamicin (87%) emerged as most sensitive drug against *Citrobacter* followed by imipenem (75%) and cotrimoxazole (75%). Strains of *Citrobacter* showed high resistance for cefepime (75%) followed by ampicillin (62%). Amongst all the antibiotics, Piperacillin + Tazobactam (87%) emerged as most sensitive drug against *Pseudomonas* followed by piperacillin (75%) and ciprofloxacin (75%). Strains of *Pseudomonas* (Table 7 and figure 9) showed high resistance for Aztreonam (63%) followed by ceftazidime (51%) and tobramycin (33%). Gentamicin (71%), Levofloxacin (71%) emerged as most sensitive drug against *Acinetobacter* followed by piperacillin - tazobactam (57%) and cotrimoxazole (42%). Strains of *Acinetobacter* spp showed high resistance for tetracycline (85%) followed by ceftriaxone (71%).

ICU	Total cases	Males	Females
Medical ICU	52 (48%)	36	16
Surgical ICU	26 (23%)	17	9
Pead. ICU	23 (20.5%)	13	10
Neonatal ICU	11 (10%)	8	3

Table 1: Department wise distribution of samples.
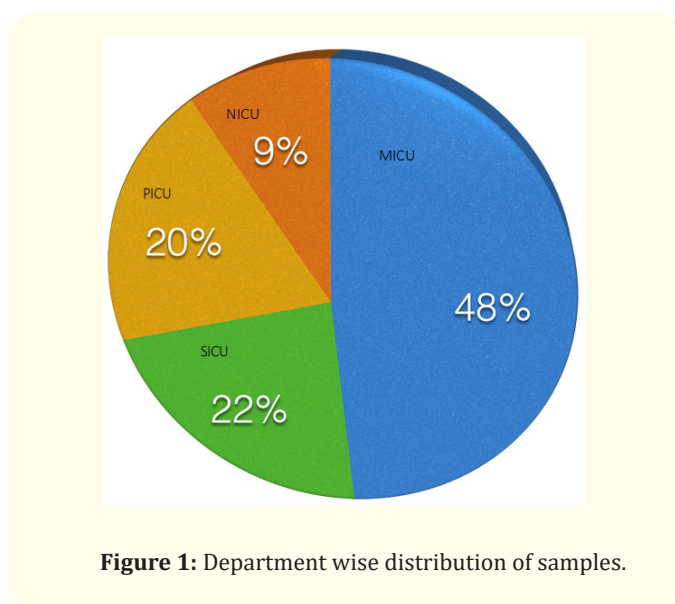
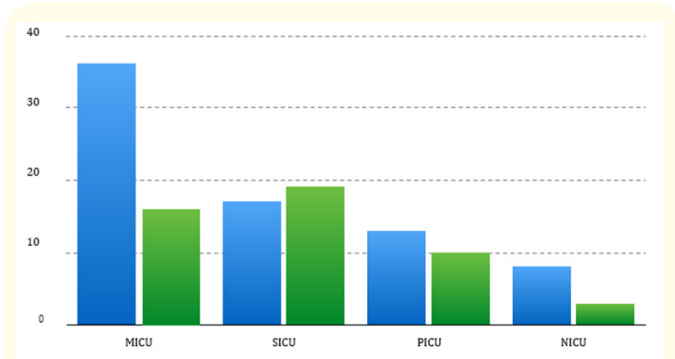**Figure 1:** Department wise distribution of samples.

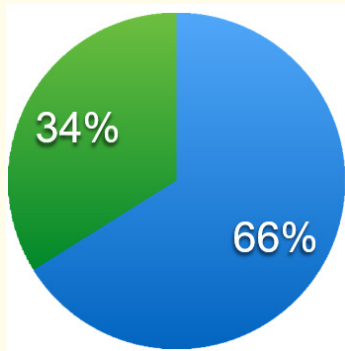**Figure 2:** Number of positive cases based on gender in various ICUs.

Figure 3: Male to female ratio of positive case in our study.

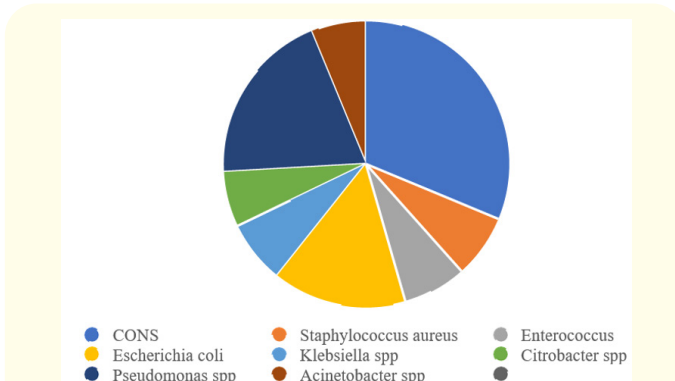| Organism	Number	Percentage
Staphylococcus aureus	8	7.1
Enterococcus	8	7.1
E. coli	17	15.2
Klebsiella spp	8	7.1
Citrobacter spp	7	6.2
Pseudomonas spp	22	19.6
Acinetobacter spp	7	6.2
CONS	35	31.2

Table 2: Distribution of organisms in positive samples.

Figure 4: Distribution of organisms in positive samples.

Antibiotics	Sensitive %	Resistant %
Vancomycin	100	0
Linezolid	90	9.3
Gentamicin	78	23
Ciprofloxacin	40	59
Levofloxacin	54	54
Erythromycin	23	76
Penicillin	34	65
Clindamycin	55	44
Cefotaxime	46	53

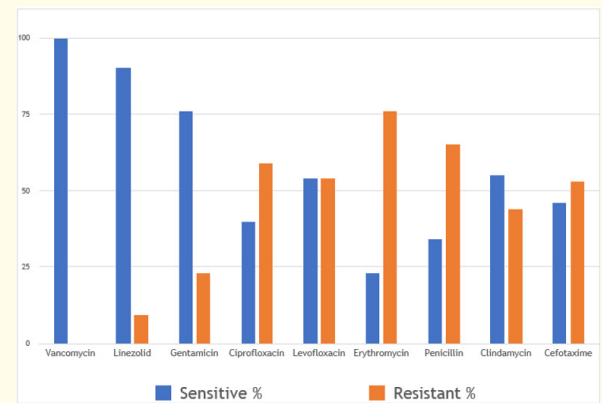**Table 3:** Antibiotic susceptibility pattern of coagulase negative Staphylococcus (CoNS).

Figure 5: Antibiotic susceptibility pattern of CoNS.

Antibiotics	Sensitive n %	Resistant n %
Ampicillin	01 (16%)	05 (83%)
Ciprofloxacin	04 (66%)	02 (33%)
Gentamicin	04 (66%)	02 (33%)
Levofloxacin	04 (66%)	02 (33%)
Linezolid	05 (83%)	01 (16%)
Penicillin	02 (33%)	04 (66%)
Streptomycin	03 (50%)	03 (50%)
Tetracycline	03 (50%)	03 (50%)
Vancomycin	04 (66%)	02 (33%)
Teicoplanin	04 (66%)	02 (33%)

Table 4: Antibiotic susceptibility pattern of *Enterococcus spp.*

Discussion

In this study among total microorganisms causing BSI, 54% were Gram-negative and 45% were Gram-positive which correlates with study of Vincenzo Russotto, Andrea Cortegiani., *et al.* [16], in which total microorganisms causing BSI, 57.6% were
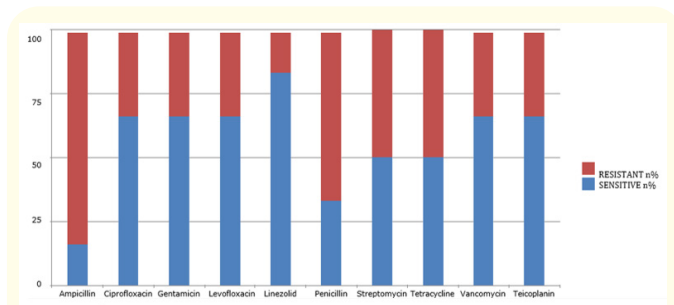
Figure 6: Antibiotic susceptibility pattern of *Enterococcus* spp.

Antibiotics	Sensitive n %	Resistant n %
Ampicillin	08 (47%)	09 (53)
Amoxyclav	09 (53%)	8 (47%)
Cefepine	13 (76%)	4 (24%)
Cefotaxime	08 (47%)	9 (53%)
Ceftriaxone	06 (35%)	11 (65%)
Cefuroxime	06 (35%)	11 (65%)
Gentamicin	16 (94%)	1 (6%)
Imipenem	14 (82%)	3 (18%)
Levofloxacin	11 (65%)	6 (35%)
Meropenem	13 (92%)	4 (8%)
Cotrimoxazole	14 (82%)	3 (18%)

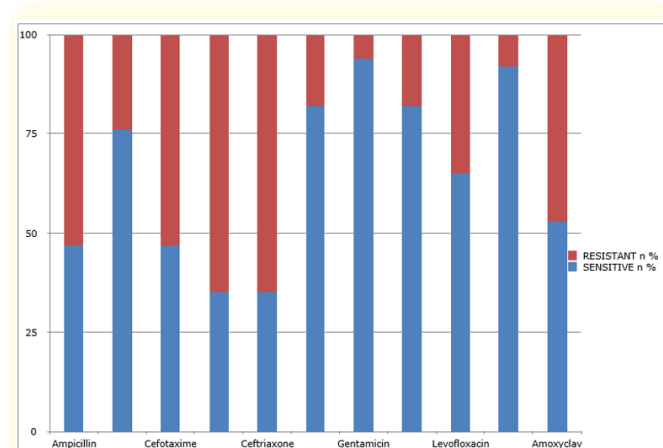**Table 5:** Antibiotic susceptibility pattern of *Escherichia coli.*

Figure 7: Antibiotic susceptibility pattern of *Enterococcus* spp.

Gram-negative and 33.4% were Gram-positive. Gram positive bacteria accounted for 46% of the isolates. Among gram positive bacteria Coagulase negative *Staphylococcus* (CONS) was isolated in most samples (69%) than *Staphylococcus aureus* (15.6%) which is consistent with study of David K. Warren, Jeanne E Zack., *et al.*

Antibiotics	Sensitive (n %)	Resistant (n %)
Ampicillin	02 (22%)	07 (78%)
Amoxyclav	04 (45%)	05 (55%)
Cefepime	01 (11%)	08 (89 %)
Cefotaxime	03 (33%)	06 (67%)
Ceftriaxone	02 (22%)	07 (78%)
Cefuroxime	04 (45%)	05 (55%)
Gentamicin	04 (45%)	05 (55%)
Imipenem	08 (89%)	01 (11%)
Levofloxacin	06 (65%)	03 (35%)
Meropenem	07 (77%)	02 (22%)
Cotrimoxazole	06 (67%)	03 (33%)

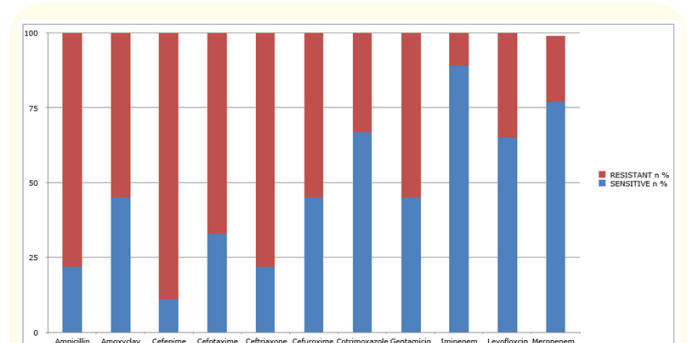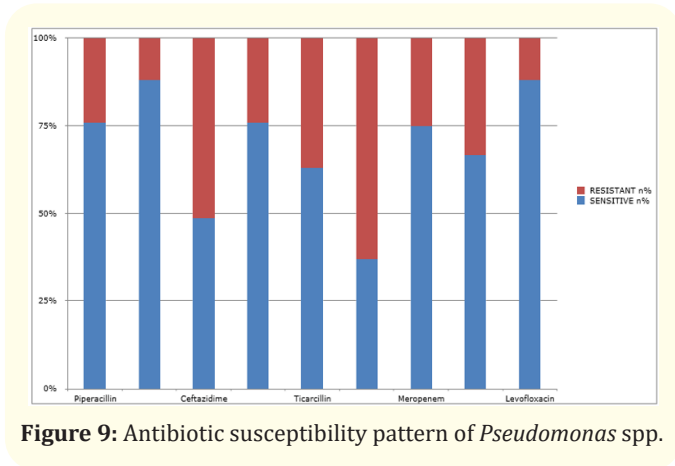**Table 6:** Antibiotic susceptibility pattern of Klebsiella spp.

Figure 8: Antibiotic susceptibility pattern of *Klebsiella* spp.

Antibiotics	Sensitive (n %)	Resistant (n %)
Aztreonam	08 (37%)	14(63%)
Ceftazidime	10 (48%)	12 (51%)
Ciprofloxacin	17 (75%)	05 (24%)
Levofloxacin	19 (87%)	03 (12%)
Meropenem	17 (75%)	05 (25%)
Piperacillin	17 (75%)	05 (25%)
Piperacillin-tazobactam	19 (87%)	03(12%)
Tobramycin	14 (66%)	08 (33%)
Ticarcillin	13 (59%)	09 (41%)

Table 7: Antibiotic susceptibility pattern of *Pseudomonas spp.*

2001 who observed that CONS were most commonly isolated microorganism among BSIs in ICU about 47% [17]. In a similar study done by Rello., *et al*. [18] and Valles., *et al.* [19] CONS accounted for 49.8% of the isolates. In the present study Gram negative bacilli accounted for 54% of BSIs in ICU and *Pseudomonas aeruginosa* accounted for 37% of these. This is in contrast to study by Cheol-

Figure 9: Antibiotic susceptibility pattern of *Pseudomonas* spp.

Antibiotics	Sensitive (n %)	Resistant (n %)
Ciprofloxacin	04 (50%)	04 (50%)
Cefoxitin	03 (37%)	05 (63%)
Clindamycin	06 (75%)	02 (25%)
Erythromycin	02 (25%)	06 (75%)
Gentamicin	02 (25%)	06 (75%)
Levofloxacin	05 (63%)	03 (37%)
Linezolid	08 (100%)	0
Penicillin	05 (63%)	03 (37%)
Vancomycin	08 (100%) (MIC)	0

Table 8: Antibiotic susceptibility pattern of
Staphylococcus aureus.
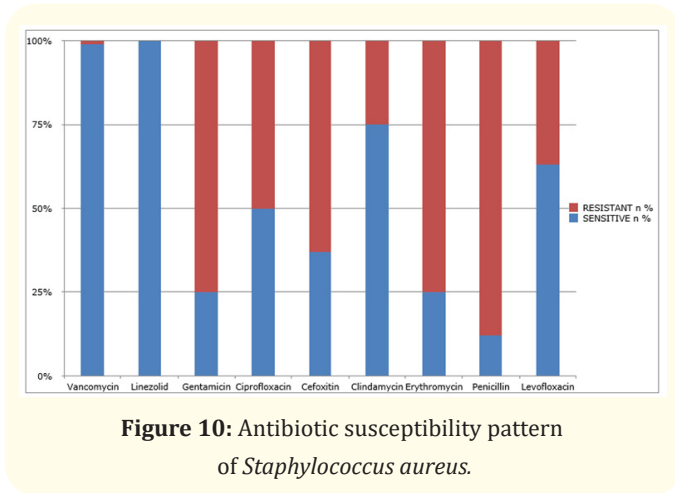
Figure 10: Antibiotic susceptibility pattern
of *Staphylococcus aureus.*

In Kang, Sung-Han Kim., *et al.* [20], who observed that the most common strains isolated from the bloodstream were *Escherichia coli* (39.5%), *Klebsiella pneumoniae* (20.7%), *Enterobacter* species (8.0%) and *P. aeruginosa* (7.5%). From amongst the bacteria isolated in our study, CONS showed 100% sensitivity to Vancomycin,

90% sensitivity to linezolid, 76% to gentamicin, 54% sensitivity to levofloxacin. The organisms were found highly resistant to erythromycin (76%) followed by penicillin (65%). The second common isolate among GPC was *S. aureus* which showed 100% sensitivity to linezolid and vancomycin (100%), followed by clindamycin (75%). The organisms were found highly resistant to Penicillin (87%) followed by erythromycin (75%) and cefoxitin (62%). The antimicrobial susceptibility testing revealed that resistance to penicillin was frequent in *S. aureus* (87%) and CONS (65%) this is consistent with the study of I Roy, A Jain, M Kumar, SK Agarwal [12]. Among gram negative organisms *Pseudomonas aeruginosa* was the most common isolate in which Piperacillin + Tazobactam (87%) emerged as most sensitive drug followed by piperacillin (75%), meropenem (75%) and ciprofloxacin (75%). Imipenem (92%) emerged as most sensitive drug against *Klebsiella* followed by cotrimoxazole (67%). Strains of *Klebsiella* showed high resistance for ceftriaxone (78%), amoxyclav (55%) followed by Ampicillin (33%). In our study we found that *Citrobacter* spp is highly sensitive to imipenem (75%) and appear resistant to ampicillin (62%).

Conclusion

Blood stream infections continue to be a significant source of morbidity among critically ill patients. The results of our study extend knowledge of these infections their causative agents and antibiotic susceptibility. Our findings suggest that, although these infections do not in and of themselves contribute to mortality in the ICU, they may result in increased suffering and costs for patients in the form of prolonged stays and sepsis.

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