Original Research Article

Microbiological study of blood stream infections among patients admitted to critical care units at a tertiary hospital

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Abstract

Background: Patients hospitalized in Intensive Care Unit (ICUs) are at particularly high risk of blood stream infections (BSIs) because of their debilitated condition as a result of underlying disease and frequent invasive diagnostic and therapeutic procedures. In present study, we aimed to analyse various organisms causing BSI and their prevalence and antibiotic resistance pattern in patients admitted to critical care units at our tertiary hospital. **Material and Methods:** Present study was prospective, descriptive study, conducted in patients >18 years old, admitted to critical care units, diagnosed with Blood stream infection. **Results:** A total of 459 blood samples were received in the microbiology lab for culture out of which 54 samples (11.7%) showed culture positivity in suspected patients with BSIs. Mean age was 50.45 ± 11.45 years, male (59.3 %) outnumbered female (40.7 %) patients. Most of patients were from medical ICUs (64.8 %) as compares to Surgical ICUs (35.2 %). Most of patients were on ventilatory support (75.9 %), with central catheter (85.2 %), Endotracheal tubes (75.9 %). Diabetes (38.9 %), Renal disease (27.8 %) and Cardiac disease (25.9 %) were common underlying comorbid conditions noticed. Single micro-organism was isolated in 72.2% patients' blood sample. Mortality was noted in 42.6 % patients. In present study Gram-negative (68.5 %) organisms were more common than Gram-positive (51.9 %) organisms and Fungi (7.4 %). Among Gram-negative organisms *Klebsiella pneumoniae* (20.4 %) and *Pseudomonas aeruginosa* (18.5 %) were common and others were *Escherichia coli* (16.7 %), *Acinetobacter spp.* (9.3 %) and *Enterobacter spp.* (3.7 %). In Gram-positive organisms *Coagulase-negative Staphylococci* (20.4 %), *MRSA* (9.3 %) and *MSSA* (7.4 %) were common and others were *Enterococcus spp.* (5.6 %), *Staphylococcus epidermidis* (5.6 %) and *Streptococcus pneumoniae* (3.7 %). Fungi such as *Candida spp* (5.6 %) and *Aspergillus* (1.9 %) were also noted. Vancomycin (100.0 %), Linezolid (100.0 %) and Amikacin (100.0 %) were most sensitive antibiotics for *Coagulase-negative Staphylococcus,* other antibiotics were Clindamycin (63.6 %), Cefoxitin (63.6 %) and Ciprofloxacin (54.5 %), Imipenem (100.0 %) was most sensitive antibiotics for *Klebsiella,* other sensitive antibiotics were Piperacillin/tazobactam (81.8 %), Amikacin (72.7 %) and Cefoperazone/sulbactam (63.6 %). **Conclusion:** Bloodstream infection is a life-threatening challenge; hence, timely detection, identification, and antimicrobial susceptibility testing of blood-borne pathogens is mandatory to reduce mortality and morbidity in patients admitted to critical care units.

Keywords: Bloodstream infection, antimicrobial susceptibility testing, critical care units. antimicrobial resistance

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INTRODUCTION

Patients hospitalized in Intensive Care Unit (ICUs) are at particularly high risk of blood stream infections (BSIs) because of their debilitated condition as a result of underlying disease and frequent invasive diagnostic and therapeutic procedures.[1,2] Approximately 7% of all patients within the first month of hospitalization in Intensive Care Unit (ICU) are diagnosed with BSIs annually.[3] The case fatality rate associated with BSI reaches 35-50% when associated with admission to ICU.[3] The changing epidemiology and susceptibility patterns of microorganisms in India threaten the effectiveness of most,

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if not all; antibiotics frequently used to prevent and treat bacterial infections.[4] Many bacterial pathogens have developed resistance to most of the antibiotics and are creating a serious health crisis with many economic and social inferences all over the worlds. High incidence of multidrug-resistant bacteria leads to increased stay in hospital, rise in financial burden on the patient, and in many instances, loss of life.[5] The excessive and irrational use of antibiotics has led to an increase in the multidrug-resistant bugs and thus worsened the condition. Bloodstream infections have serious consequences like shock, disseminated intravascular coagulation, multiple organ failure, and even death. The detection of microorganisms in a patient's blood has great diagnostic and prognostic significance.[6] Blood culture provides essential information for the evaluation of a variety of diseases like endocarditis, pneumonia, and pyrexia of unknown origin particularly, in patients with suspected sepsis. In present study, we aimed to analyse various organisms causing BSI and their prevalence and antibiotic resistance pattern in patients admitted to critical care units at our tertiary hospital.

MATERIAL AND METHODS

Present study was prospective, descriptive study, conducted in department of Microbiology, at a tertiary care hospital, Bengaluru, India. Study period was from January 2020 to December 2020. Study was approved by institutional ethical committee.

Inclusion criteria –

Patients >18 years old, admitted to critical care units, diagnosed with Blood stream infection.

Blood stream infection was labelled if patient has a recognized pathogen cultured from one or more blood cultures and the organism cultured from blood is not related to an infection at another site OR at least one of the Common skin contaminant (e.g., Bacillus sp., micrococci, Coagulase-negative staphylococci or Diphtheroid) is isolated from two or more blood cultures collection on separate occasions. Blood culture Specimen samples were aseptically collected and transferred to the laboratory, cultured in fresh Nutrient Agar Media plates and were incubated within 24 hours of their collection. After incubating for 24 hours at 37°C, cultures were stored at 2-8°C for further examinations. 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. All the isolates were identified on the basis of culture characteristics, Gram stain and biochemical reactions. Selective media were used. Such as, MacConkey Agar was used to identify the organisms such as Staphylococcus aureus, Staphylococcus epidermidis and others. The isolates were then subjected to antimicrobial susceptibility testing. on Muller Hinton agar medium by disk diffusion technique according to National Committee for Clinical Laboratory Standards (NCCLS). Data was collected in Microsoft excel sheet and statistical analysis was done using descriptive statistics.

RESULTS

A total of 459 blood samples were received in the microbiology lab for culture out of which 54 samples (11.7%) showed culture positivity in suspected patients with BSIs. Mean age was 50.45 ± 11.45 years, male (59.3 %) outnumbered female (40.7 %) patients. Most of patients were from medical ICUs (64.8 %) as compares to Surgical ICUs (35.2 %). Most of patients were on ventilatory support (75.9 %), with central catheter (85.2 %), Endotracheal tubes (75.9 %). Diabetes (38.9 %), Renal disease (27.8 %) and Cardiac disease (25.9 %) were common underlying comorbid conditions noticed. Single micro-organism was isolated in 72.2% patients' blood sample. Mortality was noted in 42.6 % patients.

Table 1: General characteristics

Parameters	Number of patients (N = 54)	Percentage
Mean age (years)	50.45 ± 11.45	
Gender		
Male	32	59.3
Female	22	40.7
Location		0.0
Surgical ICUs	19	35.2
Medical ICUs	35	64.8
Severity score		0.0
On ventilatory support	41	75.9
On oxygen therapy	13	24.1
Presence of indwelling device		0.0

Urinary catheter	53	98.1
Central catheter	46	85.2
Endotracheal tubes	41	75.9
Dialysis line	11	20.4
Presenting complaints		0.0
Breathlessness	17	31.5
Fever	35	64.8
Cough	13	24.1
Underlying comorbid conditions		0.0
Diabetes	21	38.9
Renal disease	15	27.8
Cardiac disease	14	25.9
Hypertension	11	20.4
Lung disease	9	16.7
Liver disease	8	14.8
On dialysis	6	11.1
Malignancy	4	7.4
Final clinical outcome		0.0
Discharged (stable)	31	57.4
Deceased	23	42.6
Micro-organisms isolated		
Single	39	72.2
Multiple	15	27.8

In present study Gram-negative (68.5 %) organisms were more common than Gram-positive (51.9 %) organisms and Fungi (7.4 %). Among Gram-negative organisms *Klebsiella pneumoniae* (20.4 %) and *Pseudomonas aeruginosa* (18.5 %) were common and others were *Escherichia coli* (16.7 %), *Acinetobacter spp.* (9.3 %) and *Enterobacter spp.* (3.7 %). In Gram-positive organisms *Coagulase-negative Staphylococci* (20.4 %), *MRSA* (9.3 %) and *MSSA* (7.4 %) were common and others were *Enterococcus spp.* (5.6 %), *Staphylococcus epidermidis* (5.6 %) and *Streptococcus pneumoniae* (3.7 %). Fungi such as *Candida spp* (5.6 %) and *Aspergillus* (1.9 %) were also noted.

Table 2: Microorganisms isolated

Microorganism	Number of patients (N = 54)	Percentage
Gram-positive	28	51.9
Coagulase-negative Staphylococci	11	20.4
MRSA	5	9.3
MSSA	4	7.4
Enterococcus spp.	3	5.6
Staphylococcus epidermidis	3	5.6
Streptococcus pneumoniae	2	3.7
Gram-negative	37	68.5
Klebsiella pneumoniae	11	20.4
Pseudomonas aeruginosa	10	18.5
Escherichia coli	9	16.7
Acinetobacter spp.	5	9.3
Enterobacter spp.	2	3.7
Fungi	4	7.4
Candida spp.	3	5.6
Aspergillus	1	1.9

(MRSA-methicillin-resistant Staphylococcus aureus; MSSA -methicillin-sensitive Staphylococcus aureus)

Vancomycin (100.0 %), Linezolid (100.0 %) and Amikacin (100.0 %) were most sensitive antibiotics for *Coagulase-negative Staphylococcus,* other antibiotics were Clindamycin (63.6 %), Cefoxitin (63.6 %) and Ciprofloxacin (54.5 %),

Table 3: Antibiotic sensitivity pattern of *Coagulase-negative Staphylococcus*.

Antibiotics	Coagulase-negative Staphylococcus species (n = 11)	Percentage
Vancomycin	11	100.0
Linezolid	11	100.0
Amikacin	11	100.0
Clindamycin	7	63.6
Cefoxitin	7	63.6
Ciprofloxacin	6	54.5
Penicillin G	0	0.0
Erythromycin	0	0.0

Imipenem (100.0 %) was most sensitive antibiotics for *Klebsiella,* other sensitive antibiotics were Piperacillin/tazobactam (81.8 %), Amikacin (72.7 %) and Cefoperazone/sulbactam (63.6 %).

Table 4: Antibiotic sensitivity pattern of *Klebsiella*.

Antibiotic Citrobacter (n = 2)	*Klebsiella* (n = 11)	Percentage
Imipenem	11	100.0
Piperacillin/tazobactam	9	81.8
Amikacin	8	72.7
Cefoperazone/sulbactam	7	63.6
Ciprofloxacin	3	27.3
Ceftriaxone	3	27.3
Gentamycin	3	27.3
Cefepime	2	18.2
Chloramphenicol	0	0.0
Ampicillin	0	0.0

DISCUSSION

The intensive care units (ICUs) are often called “the hubs” of infections. Extremely vulnerable population group with reduced host defenses and dysregulated immune responses, multiple procedures, and use of invasive devices such as endotracheal intubation, central venous cannulations, mechanical ventilation (MV), and urinary catheterizations distorting the anatomical integrity-protective barriers of patients are the important reasons.[7,8] Central Venous Catheter (CVC) related bloodstream infection (CRBSI) and central line-associated bloodstream infection (CLABSI) are a major cause of morbidity, mortality and increased cost with prolongation of hospital stay 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. Sepsis and septic shock occur at all ages but most often in elderly patients. At present, most sepsis episodes are observed in patients older than 60 years. Advanced age is a risk factor for acquiring nosocomial blood stream infection in the development of severe forms of sepsis.[9] As per previous studies, common types of bacteria causing bloodstream infections are Gram-positive bacteria such as Staphylococcus aureus, coagulase-negative Staphylococci (CoNS), Streptococcus pyogenes, Streptococcus pneumoniae, Streptococcus agalactiae, and Enterococcus faecium and Gram-negative bacteria such as Escherichia coli, Pseudomonas aeruginosa, and Klebsiella species.[10,11]

Ullas Bhabhor *et al.*,[12] noted that 27.90% samples had positive growth in culture. The incidence of blood stream infection due to gram positive organism was (51.28%). Among them Staphylococcus aureus 72 (45.56%) was most common organism. Gram negative organism were quite low (48.73%) among them Klebsiella spp. (16.45%) was most common. The antimicrobial susceptibility pattern of isolated organisms showed high resistance to routinely used antimicrobial agents. Similar findings were noted in present study. Singh AA *et al.*, [13] showed the preponderance of Gram-negative organisms and the frequently isolated Bacteria were P. aeruginosa (38.17%), K. pneumoniae (23.76%), followed by Acinetobacter anitratus (14.96%), Enterobacter (6%), and E. coli (6%). Gram-positive organisms (S. aureus - 2%, coagulase negative staphylococci [CoNS] - 2%, Enterococcus - 0.6%) constituted a small fraction. In study by Mohd Suhail Lone *et al.*,[14] frequencies of Gram-positive and Gram negative bacteria were 16.83% with yeast recovered in 5.78% of the specimens. Acinetobacter spp and K. pneumoniae were the most common Gram-negative bacteria and S. aureus the most common Gram-positive one. High level resistance to all the antimicrobials was seen; with Acinetobacter spp being the most multidrug resistant GNB isolated in the ICU setting. ESBL production was highest in K. pneumoniae isolates (77.1%). Also 49.6% of Acinetobacter isolates were found to be MBL producers. Methicillin resistance was seen in 95% of S. aureus and 91% of coagulase negative staphylococci

(CoNS) isolates with vancomycin resistance seen in 46% of enterococcal isolates. In another study by Mariyah Yousuf., *et al.*[15] from organisms causing BSI, 54% were Gram-negative and 45% were Gram-positive. Among gram positive bacteria Coagulase negative Staphylococcus (CONS) was isolated in most samples (69%) than Staphylococcus aureus (15.6%). Among Gram negative bacilli Pseudomonas aeruginosa accounted for 37% of these. Candida bloodstream infections (BSI) have become a major problem in tertiary-care hospitals worldwide. Candidemia has been observed particularly among patients hospitalized for long periods, who have been exposed to antibiotics, immunosuppressive therapy, parenteral nutrition, and multiple invasive medical procedures.[16,17] The insufficient antibiotic-prescribing practices, especially the unnecessary use of broad-spectrum antibiotics together with the insufficient hospital infection prevention programme, are considered to be the cause of both a high antimicrobial resistance rate and an increased incidence of BSI. Every hospital must recognize the epidemiology of its microorganisms to recommend initial appropriate presumptive antimicrobial therapy. The application of hospital-wide antibiograms to guide clinicians in the initial choice of antimicrobials is the usual approach adopted.

CONCLUSION

Bloodstream infection is a life-threatening challenge; hence, timely detection, identification, and antimicrobial susceptibility testing of blood-borne pathogens is mandatory to reduce mortality and morbidity in patients admitted to critical care units. Formulation and strict implementation of hospital antibiotic policy is must to control the menacing rise in antimicrobial resistance

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