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ORIGINAL ARTICLE

Bacteriological Profile and Antibiogram of Aerobic Blood Culture Isolates from Intensive Care Units in a Teaching Tertiary Care Hospital

[1]Ashima Katyal, [2]Deepinder Singh, [3]Madhu Sharma, [4]Uma Chaudhary

ABSTRACT

Context: Infection rates in the intensive care unit (ICU) have been found to be the highest among all hospital-acquired infections.

Aim: To determine the prevalence of current bacteriological profile in blood cultures along with their antibiogram from ICU patients.

Settings and design: The present study was conducted in the Department of Microbiology, over a period of 1 year, i.e., from September 2016 to August 2017.

Materials and methods: A total of 2,028 blood cultures were received from various ICUs. The isolates were identified by standard microbiological procedures, and antibiogram was determined by Clinical and Laboratory Standards Institute (CLSI) guidelines.

Statistical analysis: Qualitative data were presented as mean and standard deviation and quantitative data as proportions. Association was tested using chi-squared test. Statistical significance was considered when $p < 0.05$. Statistical Package for the Social Sciences version 20.0 software was used for analysis.

Results: Total positive cultures were obtained in 504 (24.86%) cases. Among the Gram-positive (GP) isolates 288 (57.14%), coagulase-negative *Staphylococci* (CoNS) 55.5% was the most common followed by *Staphylococcus aureus* 34% and *Enterococcus* spp. 10.4%. *Acinetobacter baumannii* 52.3% was the most common Gram-negative (GN) isolate, 216 (42.85%), followed by *Escherichia coli* 27.7%, *Klebsiella pneumoniae* 14.35%, and *Pseudomonas aeruginosa* 5.5%. Most of the GP isolates were susceptible to vancomycin and linezolid and GN isolates to imipenem and meropenem.

Conclusion: This study shows the high number of positive blood cultures in ICUs, which can be attributed to increasing use of intravenous devices, interventions, and immunosuppression. Hence, this study may be a useful guide for initiating early empiric therapy for ICU patients and will help in formulation of antibiotic policy in our institute.

[1]Senior Resident, [2]Postgraduate Student, [3]Professor, [4]Senior Professor and Head

[1-4]Department of Microbiology, Pt. Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India

Corresponding Author: Ashima Katyal, Senior Resident Department of Microbiology, Pt. Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, Haryana, India Phone: +919466676878, e-mail: docak07@gmail.com

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INTRODUCTION

Bloodstream infection (BSI) is a devastating, preventable infectious complication in critical care units. The impacts of BSIs have far-reaching consequences, resulting in increased mortality rate, prolonged stay in ICUs, and high cost to the individual.[1] The crude mortality rate in Indian surveys ranged from 35.2 to 44.9%, which is quite higher as compared with the developed nations like the Untied States.[2] It is alarming that 30% patients of BSI receive inappropriate empirical therapy, which further adds to their poor outcome.[3,4]

Studies have shown that there is a wide range of bacteria, both GP and GN, which are associated with these infections. The advent of antimicrobial resistance among ICU microorganisms is another issue of public health concern.[5-8] The diagnosis for such infections can be made with blood cultures, which has a high positive predictive value. Early diagnosis and start of appropriate antibiotic therapy can reduce the burden of BSI in ICU.

Therefore, this study was designed to know the current spectrum of aerobic blood culture isolates from ICU patients and the trend of resistance prevalent among these isolates in our institute.

MATERIALS AND METHODS

Study Design

Ours was a hospital-based retrospective study carried out in a teaching tertiary care hospital, India. The data were collected by reviewing the records of 2,028 patients admitted to various ICUs of the hospital from September 2016 to August 2017.

Setting

Various ICUs of a teaching tertiary care center in India.

Patient Data

The blood samples from these patients were routinely processed for blood culture in the Department of Microbiology. Data collection included age and sex of the patients, the results of the blood culture, and antimicrobial susceptibility testing (AST).

Blood Culture

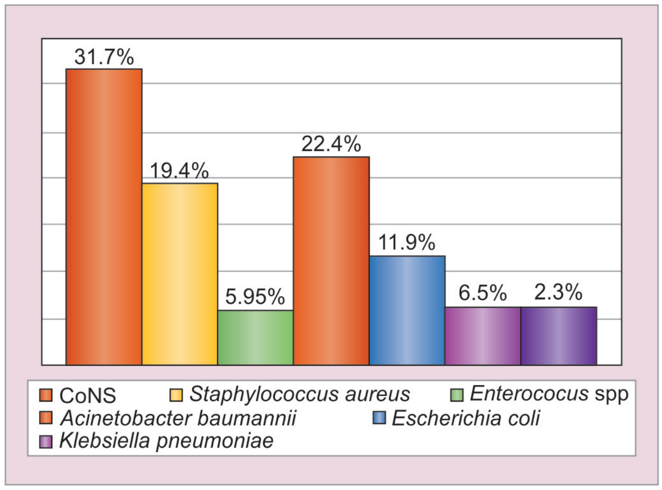
Blood samples from each patient were collected taking all aseptic precautions. For all the samples, phlebotomy was performed after achieving antisepsis of vein puncture site with 70% alcohol followed by 2% tincture iodine. About 5 to 10 mL of blood from adults and 2 mL for pediatric age group was collected, which was then inoculated in brain heart infusion broth of 50 and 10 mL respectively. Blood culture bottles were incubated at 37°C aerobically for 24 hours followed by subcultures on blood agar and MacConkey agar. Blood culture bottles that do not show signs of growth (turbidity or hemolysis) were again subcultured on 2nd, 3rd, and 7th day and were reported negative on 7th day after final subculture. Isolates were identified by standard microbiological procedures including Gram's stain, colony morphology, and biochemical reactions.[9] These were also confirmed by automated identification and antimicrobial susceptibility system, i.e., B.D. Phoenix. The results of AST were interpreted as per CLSI guidelines 2016.[10] The multidrug resistance (MDR) was defined as resistance to at least one agent in three or more categories of antimicrobial agents.[11]

RESULTS

A total of 2,028 blood samples of the patients suspected of bacteremia, admitted to critical care units of the hospital, were routinely processed for blood culture in the Department of Microbiology from September 2016 to August 2017. Out of these patients, 1,258 (62.03%) were males. Male:female ratio was approximately 1.6:1. Median age of the patient was 34 years with range of 1 day to 85 years. The predominant sources of blood culture samples were neonatal ICU (NICU) 1,716 (84.6%), followed by respiratory ICU 276 (13.6%), and pediatrics ICU 36 (1.77%). Total positive cultures in the present study were obtained in 504 (24.86%) cases. Among the culture-positive isolates, 288 (57.14%) were GP and 216 (42.85%) were GN. The most common isolate was CoNS 160 (31.7%) followed by *A. baumannii* 113 (22.4%) and *S. aureus* 98 (19.4%) (Table 1 and Graph 1). All the BSIs in the present study were due to single organism only.

Table 1: Distribution of microorganisms according to source of isolation

Organisms	*NICU (n = 432)*	*RICU (n = 60)*	*PICU (n = 12)*	*Total (n = 504) (%)*
CoNS	144	14	2	160 (31.7)
S. aureus	96	0	2	98 (19.4)
Enterococcus spp.	24	6	0	30 (5.9)
E. coli	60	0	0	60 (11.9)
K. pneumoniae	12	11	8	31 (6.15)
A. baumannii	84	29	0	113 (22.4)
P. aeruginosa	12	0	0	12 (2.3)



Graph 1: Distribution of microorganisms isolated from blood cultures

The antibiotic susceptibility profile of blood culture isolates is depicted in Table 2 (for GP isolates) and Table 3 (for GN isolates). Among the GP bacterial isolates, 100% of CoNS, 84% of *Enterococcus* spp., and 82% of *S. aureus* were resistant to penicillin group of antibiotics. However, most of the GP isolates were susceptible to vancomycin, linezolid, and clindamycin.

Among the GN isolates, *Acinetobacter* spp. (52.3%) and *E. coli* (27.7%) were dominant species. Third-generation

Table 2: Antimicrobial susceptibility profile of GP isolates

Isolates	*E*	*P*	*CX*	*Co*	*CD*	*LZ*	*VA*
CoNS (n = 160)	17 (10.62%)	0	78 (48.75%)	54 (33.75%)	115 (71.87%)	156 (97.5%)	NA
S. aureus(n = 98)	22 (22.44%)	18 (18.36%)	67 (68.36%)	67 (68.36%)	88 (89.79%)	95 (96.93%)	NA
Enterococcus spp. (n = 30)	10 (33.33%)	5 (16.66%)	12 (40%)	19 (63.33%)	23 (76.66%)	29 (96.66%)	28 (93.33%)

E: Erythromycin; P: Penicillin; Cx: Cefoxitin; Co: Cotrimoxazole; CD: Clindamycin; Lz: Linezolid; Va: Vancomycin; NA: Not applicable; According to CLSI guidelines 2017 routine testing with vancomycin disk is no more recommended for *Staphylococcus* spp.

Table 3: Antimicrobial susceptibility profile of GN isolates

	Antibiotic susceptibility pattern (%)								
Isolate (n = 216)	*AK*	*AC*	*G*	*PIT*	*CIP*	*DO*	*COT*	*IMP*	*MRP*
E. coli (n = 60)	0	11 (18.3%)	24 (40%)	29 (48.3%)	38 (63.3%)	18 (30%)	45 (75%)	55 (91.6%)	54 (90%)
K. oxytoca (n = 31)	15 (48.4%)	8 (25.8%)	12 (38.7%)	11 (35.5%)	19 (61.3%)	12 (38.7%)	23 (74.2%)	27 (87.1%)	25 (80.6%)
P. aeruginosa (n = 12)	4 (33.3%)	1 (8.3%)	5 (41.6%)	4 (33.3%)	6 (50%)	9 (75%)	9 (75%)	8 (66.6%)	11 (91.6%)
Acinetobacter spp. (n = 113)	28 (24.7%)	12 (10.6%)	10 (8.8%)	16 (14.2%)	32 (28.3%)	57 (50.4%)	78 (69%)	99 (87.6%)	87 (76.9%)

Ak: Amikacin; AC: Amoxyclav; G: Gentamicin; PIT: Piperacillin-Tazobactam; CIP: Ciprofloxacin; Do: Doxycycline; COT: Cotrimoxazole; IMP: Imipenem; MRP: Meropenem

cephalosporins showed a very weak activity against them. Carbapenems showed good activity against all the isolates with susceptibility of 87% for *Acinetobacter* spp. and *Klebsiella oxytoca* and 91% for *E. coli* and *P. aeruginosa.* Moreover, 100% isolates showed susceptibility to colistin and polymyxin B. However, the majority of the isolates were MDR.

DISCUSSION

Patients admitted to ICUs tend to develop nosocomial BSIs, which lead to increase in morbidity and mortality among these patients. The present study provides information regarding distribution of aerobic bacterial isolates along with their antibiogram in patients admitted to ICUs, which play a crucial role in effective management of these patients. The blood culture positivity rate in our study was 24.86%, which is comparable with various studies from India and abroad. Similar findings were observed in a study done in Ethiopia by Ali and Kebede[12] (24.2%). Studies from India by Gill and Sharma[13] (24.8%), Arora and Devi[14] (20.02%), and Sharma et al[15] (33.9%) also showed comparable results. Slight variation may be due to various factors like geographical location, timing, and number of blood cultures or difference in blood culture identification systems.

A wide range of organisms are responsible for BSIs and the same has been reported by various researchers. In the present study, among the culture-positive isolates, 288 (57.14%) were GP and 216 (42.85%) were GN. There are various studies from different parts of the world that have previously reported the higher prevalence of Gram-positive bacteria (GPB) over Gram negative bacteria (GNB); a study by Gill and Sharma[13] showed GP (53%) preponderance and Wasihun et al[16] reported 72.2% of bacteremia by GPB and 27.8% by GNB, Dagnew et al[17] also reported 69% GPB and 31% GNB. Among the GP isolates, CoNS 160 (55.5%) was the most common followed by *S. aureus* 98 (34%) and *Enterococcus* spp. 30 (10.4%), and this has also been reported from various parts of the country.[18-20] The higher prevalence of CoNS in the present study could be explained by the fact that most isolates were from the NICU. Although CoNS is a normal skin commensal, but now its pathogenic nature has been well established, especially, in premature infants and with central venous lines. The findings are of significant concern, as in the hospital settings, these are associated with a high degree of antimicrobial resistance and poor patient outcome.[13]

However, on the contrary, many studies from India and other developing countries have reported GNB preponderance in hospitalized patients: studies in India by Gupta and Kashyap[21] with 58.3% GNB and 41.65% GPB, Singh et al[22] with 51.82% GNB and 46.56% GPB, and a Nigerian study by Nwadioha et al[23] with 69.3% GNB and 30.7% GPB. The etiologic profile and antibiotic susceptibility pattern vary in different geographical areas due to variations in the social and environmental conditions. The *A. baumannii* 113 (52.3%) was the most common GN isolate followed by *E. coli* 60 (27.7%), *K. pneumoniae* 31 (14.35%), and *P. aeruginosa* 12 (5.5%).

The irrational use and over-the-counter availability of antibiotics have led to higher prevalence of MDR microorganisms and invasive diseases like sepsis. The antimicrobial resistance profile showed high degree of resistance to GP and GN microorganisms. Most of the isolates (46.5%) in our study were MDR, which is in concordance with previous studies.[14,17,21] Among the GP isolates, methicillin-resistant *Staphylococcus aureus* was found in significant frequency (68.36%), which is quite high as compared with previous studies. Earlier studies have reported increased resistance to erythromycin and penicillin group of antibiotics among GP organisms, a finding also observed in the present study.[14,21] All the GP organisms showed good susceptibility to clindamycin, linezolid, and vancomycin ranging from 71 to 98%.

Among the GN organisms, overall antibiotic profile suggests high degree of MDR (63.4%) organisms in our hospital. All the GNB showed poor susceptibility to beta-lactam antibiotics. The fact that the beta-lactam antibiotics are the most commonly prescribed drugs for both inpatients and outpatients could be the reason for such high level of resistance. Both the members of the family Enterobacteriaceae showed good susceptibility to ciprofloxacin (63%), cotrimoxazole (75%), and carbapenems (87%). Although previous studies have shown good susceptibility to amikacin and combination drugs like cefoperazone/sulbactam, this was not observed in our study.[6,21] Similarly, nonfermenters in the present study were highly susceptible to carbapenems (85%), cotrimoxazole (75%), and doxycycline (70%). In contrast to previous studies,[6,14,18] our study observed poor susceptibility of nonfermenters to amikacin (24%) and piperacillin/tazobactam (20%) combination. The difference in the antibiotic policy prevailing in various hospitals could be the reason for such discordance.

We observed 24 (11.11%) of the GN isolates were resistant to carbapenems, with 15 (62.5%) and 9 (37.5%) isolates among nonfermenters and members of Enterobacteriaceae respectively. The biggest threat with the infections caused by these organisms is the limited antibiotics for available treatment. Worldwide, their incidence is rising with variations due to geological and geographical differences. With the limited options available for treatment and increasing resistance, the clinicians are left with the so-called last resort drugs, i.e., colistin and polymyxin, which could soon lead to the most dreaded condition, viz., pan-drug resistance.

CONCLUSION

The present study showed the prevalence of aerobic bacteria isolated from critically ill patients in ICUs. The study identified both GP and GN organisms to be responsible for causing bacteremia and most of them were MDR. This implies that blood cultures must always be done in suspected cases of bacteremia and septicemia, and once the susceptibility profile of the organism is known, the de-escalation of the high-end antibiotics should be encouraged to reduce antimicrobial pressure. Moreover, stringent hospital infection policy and good antibiotic policy in the hospital with routine surveillance for baseline resistance will go a long way in combating MDR in pathogens.

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