ORIGINAL RESEARCH

Antibiotic Sensitivity and Resistance Pattern of Bacterial Isolates from Blood Culture in Intensive Care Unit Patients of TertiaryCare Hospital In North India

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ABSTRACT
Introduction: Bloodstream infections (BSIs) are a major cause of morbidity and mortality in critically ill patients. This study aimed to analyze the microbiological profile and antibiotic susceptibility patterns of bacterial isolates from blood cultures in ICU patients of a tertiary care hospital in North India.**Methods:** A retrospective analysis of blood culture reports of ICU patients from January2022toDecember 2022 was conducted. The identification of bacterial isolates and their antibiotic susceptibility patterns were performed using standard microbiological techniques.**Results:** The study analyzed 66 bacterial isolates from ICU patients' blood cultures. The study found that MRSA was highly prevalent and exhibited resistance to several commonly used antibiotics, including Penicillin G, Oxacillin, Trimethoprim/Sulfamethoxazole, Erythromycin, Clindamycin and Rifampin. However, Doxycycline, linezolid, Vancomycin and Daptomycin were found to be highly effective against MRSA. The study also found that S. Aureus was resistant to Penicillin G and Erythromycin but showed sensitivity to Oxacillin, Trimethoprim/Sulfamethoxazole, Doxycycline, Clindamycin, Linezolid, Vancomycin, Daptomycin and Rifamycin. For E. coli, the study found that several antibiotics, including Amoxicillin Clavulanic Acid, Ciprofloxacin, Cefixime, Cefepime, Imipenem, and PipercillinTazobactum, exhibited resistance against all strains. However, Trimethoprim/Sulfamethoxazole, Gentamicin, Amikacin, Polymyxin B, Colistin, and Tigecycline were found to be effective and sensitive against different strains of E. coli.**Conclusion:** The study found a high prevalence of S. aureus, E. coli, and MRSA, with varying resistance patterns to commonly used antibiotics. The findings of this study provide valuable information for the appropriate management of BSIs in ICU patients.

Keywords: blood culture, ICU patients, bacterial isolates, antibiotic susceptibility, Staphylococcus aureus, Escherichia coli, Methicillin-resistant Staphylococcus aureus, antibiotic resistance,

INTRODUCTION

Antibiotic resistance is a major public health concern worldwide, and it is an issue that is particularly concerning in intensive care unit (ICU) settings. Patients admitted to ICUs are often critically ill and require the use of antibiotics to treat or prevent infections. However, the widespread use of antibiotics has led to the emergence of antibiotic-resistant bacterial strains, which can cause serious infections and complicate patient care.

According to the World Health Organization (WHO), antibiotic resistance is one of the top ten global public health threats facing humanity in the 21st century(1). Antibiotic resistance not only increases the risk of treatment failure but also prolongs hospital stays, increases healthcare costs, and increases the risk of mortality(2). Infections caused by antibiotic-resistant bacteria have been estimated to cause 700,000 deaths annually worldwide, and this number is expected to rise to 10 million by 2050 if measures are not taken to address the issue(3).

Several global studies have been conducted to understand the antibiotic sensitivity and resistance patterns of bacterial isolates from ICU patients. A

study done on the antibiotic susceptibility patterns of bacterial isolates from ICUs in 65 countriesfound that resistance to antibiotics such as carbapenems, colistin, and cephalosporins was increasing globally (4). Another study analyzed the antibiotic resistance patterns of bacterial isolates from ICUs in 18 countries in Africa, Asia, and South America (5). The study found that multidrug-resistant bacteria were prevalent in all countries, with carbapenem-resistant bacteria being particularly concerning.

In India, antibiotic resistance is also a significant public health issue. The widespread use of antibiotics, often without appropriate prescription or guidance, has led to the emergence of antibiotic-resistant bacterial strains. According to a study, the prevalence of carbapenem-resistant bacteria in Indian hospitals is alarmingly high, with rates as high as 70% reported in some hospitals (6).

Several studies have been conducted in India to understand the antibiotic sensitivity and resistance patterns of bacterial isolates from ICU patients. A study on the antibiotic resistance patterns of bacterial isolates from ICU patients in a tertiary care hospital in North India found that multidrug-resistant bacteria were prevalent, with resistance to antibiotics such as carbapenems, fluoroquinolones, and cephalosporins being particularly concerning (7). Another study analyzed the antibiotic resistance patterns of bacterial isolates from ICU patients in a tertiary care hospital in South India (8). The study found that resistance to carbapenems, a last resort antibiotic, was increasing in the hospital, highlighting the urgent need for appropriate antibiotic use and infection control measures.

Despite the growing concern over antibiotic resistance in ICU settings, there is a lack of comprehensive data on the antibiotic sensitivity and resistance patterns of bacterial isolates from ICU patients in India. Existing studies have mostly focused on single-center analyses and have not provided a comprehensive understanding of the situation of different regions of the country.

Given the unique context of J&K, it is essential to understand the antibiotic sensitivity and resistance patterns of bacterial isolates from ICU patients in the state. The use of antibiotics in the region may differ from other parts of the country, and the prevalence of antibiotic-resistant bacterial strains may be different due to the unique healthcare infrastructure and geography. Existing studies on antibiotic resistance in J&K have mostly focused on community-acquired infections and have not provided a comprehensive understanding of the situation in ICU settings. Conducting research on antibiotic sensitivity and resistance patterns of bacterial isolates from blood culture in ICU patients in J&K state is essential to understand the unique context of the region and guide appropriate treatment and infection control measures.

The study aims to analyze the antibiotic sensitivity and resistance pattern of bacterial isolates from blood cultures of patients admitted to the intensive care unit (ICU) in a tertiary care hospital in Jammu and Kashmir, India. The study seeks to identify the common bacterial pathogens causing bloodstream infections in ICU patients and to determine the prevalence and patterns of antibiotic resistance among these pathogens. The study aims to provide valuable information on the current scenario of antibiotic resistance in ICU patients in Jammu and Kashmir, which will aid in the development of appropriate antibiotic treatment strategies and infection control measures to improve patient outcomes and reduce the spread of antibiotic-resistant bacteria in healthcare settings.

MATERIAL & METHODS

STUDY DESIGN

This is a retrospective observational study of bacterial isolates from blood cultures of patients admitted to the ICU in a tertiary care hospital in Jammu and Kashmir, India.

This cross-sectional investigation was conducted at the Department of Anesthesiology and Critical Care atAcharya Shri Chander College of Medical Sciences& Hospital Jammu.

STUDY UNIT

In our study, a total of 66 ICUs patients in total were analysed using MRD data. Retrospective information on the culture reports of patients admitted to the ICU of the ASCOMS Jammu between jan 2022 toDecember 2022was gathered. Out of 66 patients 21 patients had postive blood culture.

PROCEDURE

A total of 176 patients were admitted to the ICU throughout the research period; 66 of these patients had hospital acquired infections (HAIs) as evidenced by the discovery of culture-positive clinical specimens in their case reports. The study did not include the other ICU patients whose samples were not taken for culture. The research did not include patients whose case records were lacking.

The Department of Microbiology routinely performed the culture and identification on clinical specimens obtained from ICU patients in accordance with the department's Standard Operating Procedures (SOP). These organisms were isolated using culture media such as blood agar, MacConkey agar, and chocolate agar. Based on colony morphology and biochemical testing, identification was made. Using the Kirby-Bauer disk-diffusion technique, antimicrobial susceptibility testing was carried out and reported in accordance with Clinical Laboratory Standards Institute (CLSI) recommendations (9).

For all gram-negative bacterial isolates, the antimicrobial drugs examined were gentamycin (10 g), amikacin (30 g), ceftriaxone (30 g), ceftazidime (30 g), cefoperazone+sulbactam (75/10 g), ciprofloxacin (5 g), and meropenem (10 g). Penicillin (10 units), erythromycin (15 mg), clindamycin (2 mg),

ciprofloxacin (5 mg), gentamycin (10 mg), cefoxitin (30 mg), and co-trimoxazole (25 mg) were examined for Staphylococcus aureus. High level Gentamycin (120 g), ampicillin (10 g), tetracycline (30 g), and vancomycin (30 g) were used to treat enterococci. According to the SOP handbook, methicillin resistance among Staphylococci was screened using oxyacillin screen agar and cefoxitin disc diffusion tests, while vancomycin resistance among Staphylococci and Enterococci was screened using vancomycin screen agar.

Hospital Information System (HIS) reports on cultural sensitivity for patients admitted to ICUs over the course of a year (1year) were gathered. Just the reports that met the requirements for inclusion were used for the data analysis. From the hospital records that were accessible, information on each research subject's gender, age, infecting organism, site of infection, type of HAIs, and pattern of antibiotic resistance, including distinct co-resistances, was collected.

ETHICAL CONSIDERATIONS

Informed consent was obtained from all patients or their legal guardians, and the study protocol was approved by the Institutional Ethics Committee of the Acharya Shri Chander College of Medical Sciences & Hospital Jammu.

DATA CONFIDENTIALITY

The patient information collected was kept confidential, and only the investigators had access to the data. The data was anonymized to maintain patient privacy.

DATA COLLECTION AND ANALYSIS

The data collected included demographic details of the patients, clinical diagnosis, bacterial isolates, and their antibiotic susceptibility patterns. Data was entered into a Microsoft excel spreadsheet and analyzed using appropriate statistical methods to determine the prevalence and patterns of antibiotic resistance among the bacterial isolates.

METHODS

The study analyzed a total of 66 bacterial isolates from blood cultures in intensive care unit (ICU) patients. The age of the patients ranged from 34 to 97 years, with a mean age of 64.59±14.89 years. The majority of cases were from individuals aged 51-70 years (48.48%) and 71-90 years (31.81%). There was a nearly equal distribution of gender, with 51.51% male and 48.48% female patients.

Table 1: Socio demographic Characteristics of study population

Socio-Demographic Characteristics	Total Number (%)
Total Cases	66
Age (Mean) Range Age distribution 31-50 51-70 71-90 91-100	64.59±14.89 34-97 12 (18.18) 32 (48.48) 21 (31.81) 1 (1.51)
Gender Male Female	 34 (51.51) 32 (48.48)

The bacterial isolates identified in the study were Staphylococcus aureus (S. aureus) (15.15%), Escherichia coli (E. coli) (9.09%), Methicillin-resistant Staphylococcus aureus (MRSA) (7.57%), and no growth (68.18%). (Table 2)

Table 2: Organisms Isolated from the ICU patients.

Organism	n (%)
Staphylococcus aureus (S. aureus)	10 (15.15)
Escherichia coli (E. coli)	6 (9.09)
Methicillin-resistant Staphylococcus aureus (MRSA)	5 (7.57)
No growth	45 (68.18)
Total	**66 (100.00)**

Table 3 provides information on the sensitivity and resistance of various antibiotics against MRSA, S. aureus, and E. coli bacteria. The values within the table represent the samples of bacterial strains that are either sensitive or resistant to the respective antibiotic.

Table 3: Antibiotic sensitivity testing of the samples isolated from the admitted ICU patients.

Name of the Antibiotic	MRSA		S. Aureus		E Coli	
	Resistant	Sensitive	Resistant	Sensitive	Resistant	Sensitive
Penicillin G	5	0	10	0	0	0

Amoxicillin Clavulanic Acid	0	0	0	0	5	0
Oxacillin	5	0	2	8	0	0
Gentamicin	0	0	0	0	3	3
Amikacin	0	0	0	0	3	3
Trimethoprim/Sulfamethoxazole	5	0	0	10	3	0
Doxycycline	0	5	0	10	0	0
Erythromycin	5	0	10	0	0	0
Polymyxin B	0	0	0	0	0	6
Ciprofloxacin	0	0	0	0	3	0
Cefixime	0	0	0	0	6	0
Cefepime	0	0	0	0	0	0
Ceftazidime	0	0	0	0	3	3
Ceftriaxone	0	0	0	0	3	0
Clindamycin	5	0	9	1	0	0
Linezolid	0	5	0	10	0	0
Vancomycin	0	5	0	10	0	0
Imipenem	0	0	0	0	6	0
PipercillinTazobactum	0	0	0	0	6	0
Cefuroxime	0	0	0	0	4	0
Colistin	0	0	0	0	0	6
Tigecycline	0	0	0	0	0	6
Cefoxitin	0	0	0	0	0	0
Cefpodoxime	0	0	0	0	3	0
Daptomycin	0	5	0	10	0	0
Rifampin	5	0	2	8	0	0

PEN G =Penicillin G; AMOX=Amoxicillin; AMK=Amikacin; AM0XCLAV=Amoxicillin Clavulanic Acid; OX=Oxacillin; GENT=Gentamicin; CLOX=Cloxacillin; AMK=Amikacin; NET Netilmicin; TMZ=Trimethoprim/Sulfametho0azole; DOXY=Doxycycline; TETRA=Tetracycline; ERYTH=Erythromycin; AZM=Azithromycin; AZT=Aztreonam; TOBRA=Tobramycin; NAL=Nalidixic acid; PB=Polymyxin-B; CIPRO=Ciprofloxacin; OFL=Ofloxacin; GAT=Gatifloxacin; LEVO=Levofloxacin; CHL=Chloramphenicol; CEFAZ=Cefazolin; CEFAD=Cefadroxil; CEFUR=Cefuroxime; CEFEP=Cefepime; CDR=Cefdinir; CEFTAZ=Ceftazidime; CEFTRA=Ceftriaxone; CEFOT=Cefotaxime; CPZ=Cefoperazone; CB=Carbicillin; PIP=Piperacillin; CLIND=Clindamycin; LNZ=Linezolid; TEICO=Teicoplanin; VANC=Vancomycin; IMI= Imipenem; MRP=Meropenem; CEFTAZ-T=CeftazidimeTazobactum; CPZ-S=Cefoperazone Sulbactam PIPTAZ=PipercillinTazobactum; TIC-C=Ticarcillin Clavulanic Acid; COL=Colistin; TIG=Tigecycline; CEFOX=Cefoxitin; CFTR0-T=Ceftriaxone Tazobactum; POD=Cefpodoxime; DAPTO=Daptomycin; RIF=Rifampin; CEFI=Cefixime

For MRSA, Penicillin G, Oxacillin,Trimethoprim/Sulfamethoxazole, Erythromycin, Clindamycin and Rifampin were completely ineffective as they showed resistance to all strains of MRSA. However, Doxycycline, linezolid, Vancomycin and Daptomycin was found to be highly sensitive against MRSA.

For S. Aureus, Penicillin G and Erythromycin were completely ineffective as they showed resistance to all strains ofS. Aureus. Antibiotics like Oxacillin, Trimethoprim/Sulfamethoxazole, Doxycycline, Clindamycin, Linezolid, Vancomycin, Daptomycin and Rifampin were found to be sensitive against the organism respectively.

For E. coli, Amoxicillin Clavulanic Acid, Ciprofloxacin, Cefixime, Cefepime, Imipenem andPipercillinTazobactumwere found to be resistant against all strains. Ceftazidime Gentamicin, Amikacin, were effective against 50% of strains. However, Polymyxin B, Colistin and Tigecycline was found to be effective and sensitive against all strains of E. coli.Overall, the table 3 highlights the varying levels of effectiveness of different antibiotics against different bacterial strains. This information is critical in guiding the selection of appropriate antibiotics for treatment and can help in preventing the development of antibiotic resistance. It is important to note that the sensitivity and resistance patterns may vary across different geographic regions and may change over time due to various factors, such as antibiotic usage and bacterial evolution.

DISCUSSION

The present study aimed to analyze the microbiological profile and antibiotic susceptibility patterns of bacterial isolates from blood cultures in ICU patients. The study found that the majority of bacterial isolates from blood cultures were

Staphylococcus aureus (15.15%), Escherichia coli (9.09%), and Methicillin-resistant Staphylococcus aureus (7.57%). These findings are consistent with other studies from India and globally (10-13).

In India, studies have reported a high prevalence of gram-negative bacteria, particularly Klebsiellapneumoniae and Acinetobacterbaumannii, in ICU patients (14,15). However, studies have also reported a high prevalence of S. aureus and E. coli, which is consistent with our findings (16,17). A study conducted in a tertiary care hospital in North India reported a higher prevalence of MRSA in blood cultures, ranging from 21.1% to 38.5%, compared to our study (18). This difference could be attributed to variations in the study population and geographical location.

Globally, studies have reported varying patterns of bacterial isolates and their antibiotic sensitivity and resistance patterns in ICU patients. A study conducted in a hospital in Turkey reported a higher prevalence of E. coli and Klebsiellapneumoniae, but a lower prevalence of S. aureus, compared to our study (19). Another study conducted in a hospital in China reported a higher prevalence of gram-negative bacteria, particularly Pseudomonas aeruginosa and Acinetobacterbaumannii, and a lower prevalence of S. aureus and E. coli, compared to our study (20). However, similar to our study, these studies have reported varying levels of antibiotic resistance among bacterial isolates.

The results revealed that MRSA and E. coli were resistant to several antibiotics, including penicillin G, oxacillin, trimethoprim/sulfamethoxazole, and clindamycin. Meanwhile, S. aureus showed resistance to penicillin G, oxacillin, erythromycin, and clindamycin. On the other hand, amoxicillin clavulanic acid, gentamicin, amikacin, doxycycline, ciprofloxacin, cefixime, cefepime, ceftazidime, ceftriaxone, linezolid, vancomycin, imipenem, piperacillin-tazobactam, cefuroxime, colistin, tigecycline, cefoxitin, cefpodoxime, daptomycin, and rifampin were found to be effective against the tested isolates.

The high resistance rate of MRSA to oxacillin (100%) and penicillin G (100%) is consistent with previous studies conducted in Bangladesh, where MRSA resistance rates to these antibiotics ranged between 80.6% and 100% and between 92.3% and 100%, respectively (21,22). The high resistance rate of E. coli to trimethoprim/sulfamethoxazole (100%) in this study is also consistent with previous studies conducted in Bangladesh, where resistance rates ranged between 84% and 100% (23,24). In contrast, the susceptibility rate of S. aureus to oxacillin (75%) was higher than previous studies conducted in Bangladesh, where susceptibility rates ranged between 11.5% and 37.5%.

The findings of this study are consistent with those of other studies conducted in India, which have reported high rates of resistance to commonly used antibiotics such as penicillin, erythromycin, and trimethoprim/sulfamethoxazole among bacterial pathogens (25,26). A study conducted in Mumbai, India, reported a prevalence of MRSA of 42% among clinical isolates of S. aureus, which is higher than that observed in the present study (27). However, a study conducted in a tertiary care hospital in Delhi, India, reported a lower prevalence of MRSA (9.6%) (28). In comparison with global studies, a study conducted in Nigeria reported a prevalence of MRSA of 44.9% among clinical isolates of S. aureus, which is higher than that observed in the present study (29). A study conducted in Saudi Arabia reported a higher rate of resistance to penicillin G (100%) among clinical isolates of S. aureus (30).

The varying patterns of bacterial isolates and their antibiotic resistance patterns could be attributed to several factors, such as differences in the study population, geographical location, antibiotic usage, and infection control measures (31). The emergence and spread of antibiotic-resistant bacteria pose a significant threat to public health and can lead to increased morbidity, mortality, and healthcare costs (32). Therefore, it is crucial to monitor the trends of bacterial isolates and their antibiotic resistance patterns and formulate appropriate antibiotic policies and infection control measures to prevent the emergence and spread of antibiotic-resistant bacteria (33).

The present study provides valuable information on the prevalence of bacterial isolates and their antibiotic sensitivity and resistance patterns in ICU patients. The study findings are consistent with previous studies conducted in India and globally, highlighting the need for appropriate antibiotic policies and infection control measures to prevent the emergence and spread of antibiotic-resistant bacteria.The high rates of resistance observed in this study highlight the need for regular surveillance of antibiotic resistance patterns in healthcare facilities. This information is essential for the development of appropriate treatment guidelines and the implementation of infection control measures. The high prevalence of MRSA in this study is of particular concern, as this pathogen is associated with increased morbidity, mortality, and healthcare costs (34). The high rates of resistance observed in this study could be attributed to the irrational use of antibiotics, poor infection control practices, and the lack of effective antimicrobial stewardship programs in healthcare facilities in India (35).

LIMITATIONS

The present study has some limitations. Firstly, it was a single-center study with a relatively small sample size. Therefore, the findings may not be generalizable to other healthcare facilities and regions. Secondly, the study did not analyze the molecular epidemiology of the bacterial isolates, which could provide insights into the spread of resistant strains.

CONCLUSION

In conclusion, the present study provides valuable information on the microbiological profile and antibiotic susceptibility patterns of bacterial isolates from blood cultures in ICU patients. The study found a high prevalence of S. aureus, E. coli, and MRSA, with varying resistance patterns to commonly used antibiotics. Therefore, regular surveillance of antibiotic resistance patterns is essential to guide empirical therapy and prevent the emergence of resistant strains.

CONFLICT OF INTEREST

None

SOURCE OF FUNDING

None

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