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Study Of Antibiotic Sensitivity Pattern In Blood Stream Infections.

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ABSTRACT

Bloodstream infections are a critical medical concern, and the emergence of antibiotic resistance complicates their treatment. This study aimed to investigate the antibiotic susceptibility patterns of Gram-negative bacilli (GNB) in bloodstream infections, focusing on Enterobacteriaceae and nonfermenters, as well as the prevalence of Extended-Spectrum Beta-Lactamase (ESBL) producers among K. pneumoniae isolates. We collected and analyzed data on antibiotic susceptibility patterns from clinical isolates of GNB, specifically Escherichia coli, Klebsiella pneumoniae, Citrobacter spp, and Enterobacter spp (Enterobacteriaceae), as well as Pseudomonas aeruginosa and Acinetobacter species (nonfermenters). The isolates were subjected to antibiotic susceptibility testing using various antibiotics, and the presence of ESBL producers was determined among K. pneumoniae isolates. K. pneumoniae displayed high resistance to Ampicillin (47%), Ciprofloxacin (47%), Cefotaxime (40%), and Ceftriaxone (47%). It exhibited sensitivity to Levofloxacin (47%) and Doxycycline (47%). All isolates, regardless of the organism, were universally sensitive to Imipenem (100%). P. aeruginosa demonstrated resistance to Ampicillin (50%) and Amoxiclavulanic acid (38%) but had sensitivity to Doxycycline (50%), Cefotaxime (50%), and Ceftriaxone (50%). Both nonfermenters showed high sensitivity to Amikacin. ESBL producers were identified in 53% of K. pneumoniae isolates. The high resistance rates observed in K. pneumoniae and nonfermenters underscore the importance of antibiotic stewardship, prudent empirical treatment, and the judicious use of carbapenems. The prevalence of ESBL producers among K. pneumoniae isolates necessitates enhanced surveillance and infection control measures. Alternative antibiotics, such as Levofloxacin and Doxycycline, may be considered in cases of confirmed susceptibility. This study provides valuable insights into antibiotic resistance patterns in bloodstream infections, emphasizing the urgency of proactive measures to combat the growing threat of multidrug-resistant pathogens.

Keywords: bloodstream infections, antibiotic susceptibility, Gram-negative bacilli, ESBL producers.

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INTRODUCTION

Bloodstream infections, often referred to as bacteremia or sepsis, constitute a critical medical challenge with profound implications for patient health and healthcare systems worldwide [1. 2]. These infections can be caused by a wide array of pathogenic microorganisms, including bacteria, viruses, and fungi, with bacteria being the most common culprits [3]. Among the bacterial pathogens responsible for bloodstream infections, Gram-positive organisms like Staphylococcus aureus and Streptococcus species, as well as Gram-negative bacteria such as Escherichia coli and Klebsiella pneumoniae, play a significant role [4]. The emergence of multidrug-resistant strains of these pathogens has amplified the complexity of treating bloodstream infections, raising serious concerns about patient outcomes and healthcare costs [5, 6].

The study of antibiotic sensitivity patterns in bloodstream infections is indispensable for several reasons. Firstly, it guides clinicians in selecting appropriate antibiotic therapies, ensuring the best possible outcomes for patients. Secondly, it aids in the surveillance of antibiotic resistance, helping to detect trends and emerging resistance mechanisms. Thirdly, it provides essential data for the development and modification of clinical guidelines and antibiotic stewardship programs. Lastly, it contributes to a deeper understanding of the epidemiology and risk factors associated with bloodstream infections, allowing for more effective preventive measures [6-8].

This study aims to investigate the antibiotic sensitivity patterns of bacteria causing bloodstream infections in a specific patient population, shedding light on the prevalence of resistance and the potential implications for patient management [9, 10]. Through an in-depth analysis of these patterns, we can foster improved patient care, optimize antibiotic use, and combat the escalating threat of antibiotic resistance.

METHODOLOGY

This study, entitled "Bacterial Etiology of Blood Stream Infections and Their Antibiogram at a Tertiary Hospital," followed a prospective study design and was conducted in the Department of Microbiology at Vijayanagar Institute of Medical Sciences, Bellary. The study duration spanned one year, from January 2018 to December 2018.

Inclusion and Exclusion Criteria

The study included all blood culture samples sent to the central laboratory of the Department of Microbiology at VIMS, Bellari. Exclusion criteria comprised patients already on antibiotic therapy, contaminated blood cultures, fungal isolates, and anaerobic bacterial isolates.

Blood Sample Collection and Culture

Blood samples were collected from patients suspected of having bloodstream infections, ideally before the administration of antimicrobial therapy. Approximately 5-10 ml of blood from adult patients and 2 ml of blood from pediatric patients were aseptically collected from peripheral veins. These samples were then transferred into blood culture bottles containing Brain Heart Infusion broth. Subsequently, the samples were immediately transported to the laboratory for further processing.

Culturing of the blood samples was initiated by incubating the inoculated blood culture bottles at 37°C under aerobic conditions overnight. Subcultures were performed on days 2, 3, 4, and finally on day 7, involving the use of Blood agar, Chocolate agar, and MacConkey agar. Bacterial pathogens were specifically identified through a series of steps, including microscopic morphology examination, staining characteristics assessment, and the application of standard laboratory techniques to analyze cultural and biochemical properties. Initially, colonies on Blood/Chocolate and MacConkey agar were subjected to Gram staining for further identification.

180 blood samples were collected from patients clinically suspected of bacterial BSIs. It included patients attending to outpatient department as also those admitted to various departments. The study was done in the Department of Microbiology, Vijayanagar Institute of Medical Sciences, Bellary. The

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following tables and graphs illustrate the results in detail. A detailed analysis of the results was performed.

RESULTS

Table 1: Antibiotic Susceptibility Pattern of GNB – Enterobacteriaceae

Organism		Ak	Gen	Dox	Cip	Caz	CTX	CTR	AMP	AMC	IMP	LE	PIT	TOB
E Coli	S	1	2	2	0	0	1	1	0	0	1	1	1	1
	R	2	1	1	2	4	2	2	4	3	0	0	0	1
K. Pneumoniae	S	2	2	5	0	3	1	0	0	0	8	7	3	4
	R	5	5	2	7	4	6	7	7	7	0	1	5	4
Citrobacter spp	S	3	3	5	1	1	1	2	0	4	2	1	1	2
	R	4	4	2	6	6	6	5	7	3	0	1	1	0
Enterobacter	S	2	2	4	2	2	3	0	0	3	1	1	0	1
Spp	R	5	5	3	5	5	4	7	7	4	0	0	1	0

Klebsiella pneumoniae shows high resistance to Ampicillin (47%), Ciprofloxacin (47%), Cefotaxime (40%) and ceftriaxone(47%). It showed sensitivity Levofloxacacin (47%) and Doxycyline(47%).

All the isolates were uniformly sensitive to Imepenem (100%)

Table 2: Antibiotic Susceptibility Pattern of GNB – Non-fermenters

Organism		Ak	Gen	Dox	Cip	Caz	CTX	CTR	AMP	AMC	IMP	LE	PIT	TOB
P aeruginosa	S	4	3	4	2	2	4	4	2	3	2	2	2	1
	R	2	3	2	4	4	2	2	4	3	0	0	0	1
Acinetobacter	S	5	3	6	3	3	4	4	2	2	3	2	2	2
	R	2	4	1	4	4	3	3	5	5	0	1	1	1

P. aeruginosa was resistant to Ampicillin(50%) and Amoxy-clavulanic acid(38%). It showed 50% sensitivity to Doxycycline, 50% sensitivity to Cefotaxime and Ceftriaxone. Both Non-fermenters showed high sensitivity to Amikacin.

It showed 100% sensitivity to Imepenem and Levofloxacin .

Table 3: ESBL producers among the *K. pneumoniae* isolates.

ORGANISM	ESBL PRODUCER	ESBL NONPRODUCER	TOTAL
K.pneumoniae	8(53%)	7(47%)	15(100%)

DISCUSSION

The results from the antibiotic susceptibility patterns of Gram-negative bacilli (GNB), particularly Enterobacteriaceae and nonfermenters, as presented in Tables 17 and 18, provide valuable insights into the prevalence of antibiotic resistance in bloodstream infections. Additionally, the identification of Extended-Spectrum Beta-Lactamase (ESBL) producers among K. pneumoniae isolates in Table 19 is of

significant concern, as ESBL-producing strains are associated with heightened resistance to critical antibiotics [11].

The data reveal that Escherichia coli, Klebsiella pneumoniae, Citrobacter spp, and Enterobacter spp, all belonging to the Enterobacteriaceae family, exhibit varying degrees of antibiotic resistance. K. pneumoniae, in particular, demonstrated substantial resistance to multiple antibiotics, including Ampicillin (47%), Ciprofloxacin (47%), Cefotaxime (40%), and Ceftriaxone (47%). The emergence of multidrug-resistant K. pneumoniae strains is a matter of serious concern, as these pathogens are known to cause a wide range of healthcare-associated infections, including those related to the bloodstream. These high resistance rates underscore the need for stringent antibiotic stewardship programs and the importance of considering susceptibility data when prescribing antibiotics [12, 13].

Levofloxacin and Doxycycline showed a sensitivity rate of 47% for K. pneumoniae. This suggests that these antibiotics may still be viable options in cases where susceptibility is confirmed, though clinicians should exercise caution and weigh the risk of resistance against potential benefits. Furthermore, Imipenem exhibited universal sensitivity (100%) across all tested isolates, which highlights the crucial role of carbapenems in treating infections caused by these resistant strains. It is essential, however, to use carbapenems judiciously to avoid the development of carbapenem-resistant organisms.

Among the Gram-negative nonfermenters, Pseudomonas aeruginosa and Acinetobacter species displayed both resistance and sensitivity to various antibiotics. P. aeruginosa exhibited resistance to Ampicillin (50%) and Amoxiclavulanic acid (38%). While this level of resistance to Ampicillin was expected due to its well-established inefficacy against Pseudomonas species, the susceptibility to Amikacin (50%) is noteworthy and implies that this aminoglycoside could be a suitable treatment option in cases involving P. aeruginosa.

Moreover, the sensitivity of P. aeruginosa to Doxycycline, Cefotaxime, and Ceftriaxone (all at 50%) suggests potential utility in certain cases, provided susceptibility is confirmed. Acinetobacter species exhibited resistance to various antibiotics, indicating the need for vigilant antibiotic stewardship and proper infection control measures in healthcare settings where Acinetobacter infections are prevalent.

Both nonfermenters, P. aeruginosa and Acinetobacter species, were found to have 100% sensitivity to Imipenem and Levofloxacin. This finding underscores the significance of these antibiotics as reliable treatment options in cases involving nonfermenting Gram-negative pathogens. However, given the high resistance rates observed in other antibiotics, these broad-spectrum agents should be reserved for serious infections and used judiciously to mitigate the risk of resistance development.

Table 2 highlights a concerning aspect of this study, with 53% of K. pneumoniae isolates being identified as ESBL producers. Extended-Spectrum Beta-Lactamases are enzymes capable of hydrolyzing extended-spectrum beta-lactam antibiotics, including third-generation cephalosporins and monobactams, rendering them ineffective. The high prevalence of ESBL producers among K. pneumoniae isolates is alarming, as it limits the therapeutic options for treating infections caused by these strains.

The emergence of ESBL producers is a testament to the adaptability and resilience of bacteria, as these enzymes represent a significant mechanism of antibiotic resistance. The situation is further compounded by the fact that ESBL-producing K. pneumoniae isolates also showed resistance to a range of other antibiotics, such as Ampicillin, Ciprofloxacin, Cefotaxime, and Ceftriaxone, as indicated in Table.

This combination of resistance mechanisms underscores the importance of proactive surveillance, infection control measures, and targeted antibiotic therapies in managing infections involving ESBL producers.

light of these results, several critical implications and recommendations emerge:

Antibiotic Stewardship: The high resistance rates observed in K. pneumoniae and nonfermenters emphasize the urgency of robust antibiotic stewardship programs within healthcare settings. Such programs are essential for controlling the spread of resistant strains and optimizing antibiotic use.

Empirical Treatment: Clinicians should exercise caution when prescribing empirical antibiotic therapy for bloodstream infections. Knowledge of local antibiotic susceptibility patterns is vital for making informed treatment decisions and reducing the risk of therapeutic failure.

Carbapenem Use: Imipenem showed universal sensitivity against Enterobacteriaceae and nonfermenters, making it an indispensable option for severe infections. However, it is essential to reserve carbapenems for cases where they are truly necessary to limit the development of carbapenem-resistant organisms.

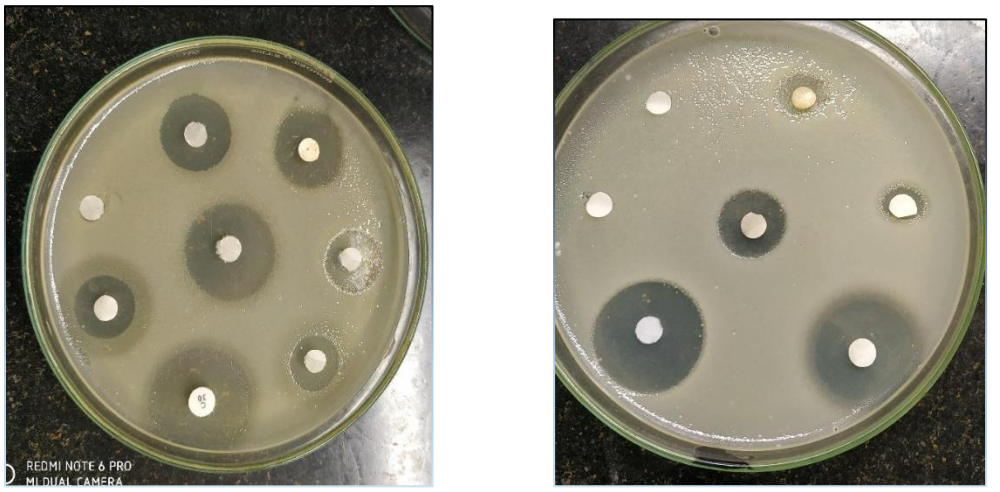
ESBL Surveillance: The high prevalence of ESBL producers among K. pneumoniae isolates calls for enhanced surveillance and infection control measures. Identifying ESBL producers early can help contain their spread and guide appropriate treatment strategies.

Alternative Antibiotics: Given the resistance patterns observed, alternative antibiotics, such as Levofloxacin and Doxycycline, may be considered in cases where susceptibility is confirmed. However, the choice of antibiotics should be individualized based on susceptibility testing.

CONCLUSION

In conclusion, the results of this study shed light on the evolving landscape of antibiotic resistance in bloodstream infections caused by Enterobacteriaceae and nonfermenters. The high prevalence of resistance, especially among K. pneumoniae and ESBL-producing strains, underscores the pressing need for prudent antibiotic use, vigilant surveillance, and the development of novel treatment strategies. As resistance patterns continue to evolve, ongoing research and adaptive clinical practices are vital in the ongoing battle against multidrug-resistant pathogens in the bloodstream.

Figure 1: Antibiotic Susceptibility Test plates of *K. pneumoniae*



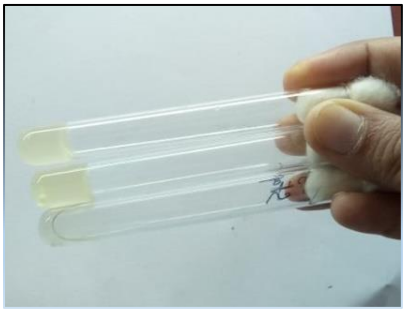


Figure 2 : Antibiotic sensitivity test plates of *S.aureus*

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