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Original Research Article

Blood stream infections: Bacteriological profile & Antibiogram of bacterial isolates of blood culture from ICU patients at tertiary care hospital Valsad, Gujarat

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Abstract

Background: Blood stream infections (BSI) are the major cause of morbidity & mortality among patients admitted in Intensive care units. So early identification of etiological agents & their antibiotic sensitivity pattern as well as & surveillance of etiological agents are useful to reduce mortality, improve clinical outcome of the patients & their prevention.
Aim: To estimate the bacteriological profile of BSIs.
Objective: To estimate Antibiotic sensitivity pattern of bacterial isolates of blood culture.
Materials and Methods: A retrospective study conducted in microbiology laboratory at tertiary care hospital. Blood samples received in microbiology laboratory from ICUs. Blood culture samples were processed by standard microbiological techniques for isolation and identification of etiological agent. Antimicrobial sensitivity testing was performed according to Clinical laboratory Standard Institute guideline by using Modified Kirby-Bauer disk diffusion method.
Result: A total number of 1184 blood culture samples from ICU received in bacteriology laboratory, out of which 217 were positive (18.32%) & 967 (81.67%) were negative. The most frequently isolated organism was Coagulase-negative Staphylococci (CoNS), which accounted for 28.98% followed by *Enterococcus spp*. and *Pseudomonas spp*. were also commonly isolated (13.04% each),& *Acinetobacter spp*. (12.07%). Both *Acinetobacter spp*. and *Pseudomonas spp*. have shown high resistance to multiple antibiotic classes.
Conclusion: This study underscores the importance of continuous surveillance of bacteriological profiles and antimicrobial resistance patterns in ICU settings. The findings will aid in guiding empiric therapy, formulation of hospital antibiotic policies, and infection control strategies.

Keywords: Blood stream infection, Antibiogram, ICU.

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1. Introduction

Blood stream infections (BSI) are the major cause of morbidity & mortality among patients admitted in Intensive care units. Several studies noted that critically ill patients in ICU are at high risk of getting the hospital acquired infections. The risk of acquiring Nosocomial infections is increase up to 5 to 10 times in ICU patients where it is compared to patient from general ward which resulting in increase of hospital stay and health related cost.[1-5] So early identification of etiological agents & their antibiotic sensitivity pattern as well as & surveillance of etiological agents are useful to reduce mortality, improve clinical outcome of the patients & their prevention.

BSIs are the 3rd most common infection in ICUs worldwide. BSIs (Septicaemia) accounts for 19% of total ICU infections, being third after urinary and respiratory infections. Excessive use of broad-spectrum antibiotics, patients being immunocompromised, the use of indwelling catheters, a multiplicity of invasive procedures make ICU patients most susceptible to colonisation by highly resistant pathogens which results increase in hospital stay.[4,5,]

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However bacteriological culture of blood specimen and antimicrobial sensitivity testing by conventional method takes 3-5 days for results. In ICUs most of the patients are on higher antibiotics so the place is also common for multi drug resistant organisms.[6-8,14] Therefore providing updated knowledge to clinicians about bacteriological profile and its antibiotic susceptibility pattern assumes greater importance in initiation of empiric therapy.

2. Materials and Methods

A retrospective study conducted in microbiology laboratory at tertiary care hospital where retrospective analysis done for Blood culture received during July 2023 to June 2024(1year) in microbiology laboratory from various ICUs. Data collected from WHONE which were already entered & Data analysis done by WHONET 2024 for age and sex of the patients, the results of the blood culture; isolated organism & its antimicrobial susceptibility testing (AST).

2.1. Inclusion criteria

Blood culture samples received in Microbiology laboratory.

2.2. Exclusion criteria

Unlabelled or mislabeled.

Blood culture samples for culture were received in Brain Heart Infusion broth 70ml & 30ml (Conventional Blood Culture bottle), for Adult and Pediatric patients respectively. Blood culture bottles were incubated at 37℃ aerobically for 24 hours followed by 1st subculture on Blood agar & MacConkey agar on 2nd day followed by alternate day subculture for 5 days. If turbidity observed any of 5-day incubation than prepared a gram stain and made subculture on solid media like Blood agar and MacConkey agar. Identification of isolates was done by manual method according to standard protocol by using standard biochemical tests.[1,8,11] Antimicrobial sensitivity testing was performed according to Clinical laboratory Standard Institute guideline by using Modified Kirby-Bauer disk diffusion method. Within 30 minutes of applying the discs, invert the plate and incubate it aerobically at 35°C for 16–18 hours.[1,8-11,13] Antibiotic discs for Gram positive and Gram-negative bacteria were as per CLSI guideline M100 (**Table 4&6**).MIC by Colistin agar dilution & Micro broth dilution for Colistin. Vancomycin Screen agar & Microbroth dilution for Vancomycin sensitivity. [16]

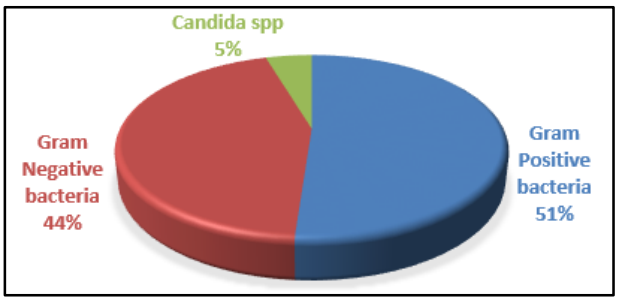

Figure 1: Distribution of positive culture

Table 1: Frequency of Bacterial isolates in positive samples

Organisms	**Frequency (Total 207)***
Coagulase Negative Staphylococci	60 (28.98%)
Staphylococcus aureus	24 (11.6%)
Enterococcus sp.	27 (13.04%)
Acinetobacter sp.	25 (12.07%)
Pseudomonas sp.	27 (13.04%)
Klebsiella sp.	31 (14.97%)
E.coli	8 (3.86%)

3. Result

A total number of 1184 blood culture samples from ICU received in bacteriology laboratory, out of which 217 were positive (18.32%) & 967 (81.67%) were negative. Of these 51% were Gram positive bacteria (GP), most common was Coagulase Negative Staphylococcus (28.98%) followed by Gram negative bacteria (GN) (44%), most common was *Klebsiella sp.*(14.97%) and Candida isolates were 5%. (**Figure 1** & **Table 1**) and one Samonella Paratihi B (0.5%) is isolated from SNCU.

Maximum samples were received from PICU followed by SNCU and MICU while among all ICUs high positivity noted from NICU (28.67%) followed by SNCU (22.42%) and SICU (21.73%). (

Enterobacter sp.	2 (0.96%)
Salmonella para typhi B	1 (0.5%)
Burkholderia cepecia complex	2 (0.96%)

*It Excludes Candida sp. (10, 4.60%) isolates of Blood culture.

Among GN most common isolates like Klebsiella sp. (14.97%), *Pseudomonas sp*. (13.04%), and Acinetobacter sp. (12.07%) were 100% sensitive to Colistin. No other Antibiotic agent was sensitive >80% which one is ideally selected for empirical therapy. Acinetobacter sp were more resistant than other. All GN isolates were MDR. (**Table 3** & **Figure 2,4**)

The Antibiotic Sensitivity pastern of Gram-positive isolates indicated 100% Sensitive to linezolid for all isolates were as CoNS and *Staphylococcus aureus* were 100% sensitive to Vancomycin and 89% sensitivity of *Enterococcus sp.* High Sensitivity were noted >80% in all Staphylococcus isolates for Chloramphenicol, Doxycycline & Rifampin. Enterococcus was more resistant than Staphylococcus. 27% MRSA were isolated from blood samples of ICU. (**Table 5** & **6,7**)

Table 2: ICU & Gender wise distribution of Total samples and Positive samples

ICU	Male	Female	Total (n=1184)	Culture positive
MICU	161	112	273 (23.05%)	40 (14.65%)
SICU	37	9	46 (3.88%)	10 (21.73%)
PICU	201	129	330 (27.87%)	51 (15.45%)
NICU	86	57	143 (12.07%)	41 (28.67%)
SNCU	190	131	321 (27.11%)	72 (22.42%)
Obs ICU	--	71	71 (6%)	3 (4.22%)

Table 3: Antibiogram of Gram-Negative Organisms isolated from Blood specimen of ICU (Sensitivity %)

Organism	Number of patients	SAM	AMC	CXM	CTX	CAZ	CIP	LVX	GEN	DOX	SXT	AMK	TOB	TZP	CRO	FEP	ATM	MEM	IPM	ETP	MNO	COL	NET
Klebsiella sp.	31	17	7	13	13	21	29	38	47	68	50	48	-	8	20	25	-	29	42	24	31	100*	-
Pseudomonas sp.	27	-	-	-	-	-	26	30	22	-	-	26	24	8	-	-	6	15	23	-	-	100*	22
Acinetobacter sp.	25	0	-	-	-	0	8.7	47.4	20	-	52.9	25	-	9.5	-	9.5	-	12.5	9.5	-	68.4	100*	-

Table 4: Gram negative antibiotics

Code	Antibiotic	Disc Content	Code	Antibiotic	Disc Content	Code	Antibiotic	Disc Content
SAM	Ampicillin/Sulbactam	10/10 µg	DOX	Doxycycline	30 µg	FEP	Cefepime	30 µg
AMC	Amoxicillin/Clavulanic acid	20 /10 µg	SXT	Trimethoprim/Sulfamethoxazole	1.25/23.75 µg	ATM	Aztreonam	30 µg
CXM	Cefuroxime	30 µg	AMK	Amikacin	30 µg	MEM	Meropenem	10 µg
CTX	Cefotaxime	30 µg	TOB	Tobramycin	30 µg	IPM	Imipenem	10 µg
CAZ	Ceftazidime	30 µg	TZP	Piperacillin/Tazobactam	100/10 µg	ETP	Ertapenem	10 µg
CIP	Ciprofloxacin	5 µg	CRO	Ceftriaxone	30 µg	MNO	Minocycline	30 µg
LVX	Levofloxacin	5 µg				COL	Colistin	MIC*
GEN	Gentamicin	10 µg				NET	Netilmicin	30 µg

*Cloistin MIC done by Colistin agar dilution & Micro broth Dilution Method.

Table 5: Antibiogram of gram-positive organisms isolated from blood specimen of ICU (Sensitivity %)

Organism	Number of patients	AMP	CIP	LVX	GEN	TCY	DOX	SXT	CHL	FOX	ERY	CLI	GEH	VAN	TEC	LNZ	RIF	OFX
Enterococcus sp.	27	19	4	12		48	50				4		23	89	96	100	63	
Staphylococcus, coagulase negative	59		24		66	83	92	77	97	17	11	27		100*		100	100	55
Staphylococcus aureus	24		57		74	95	95	80	100	73	27	50		100*		100	34	40

*Vancomycin MIC done by Vancomycin Screening Agar & Microbroth dilution

Table 6: Gram positive antibiotics

Code	Antibiotic	Disc Content	Code	Antibiotic	Disc Content	Code	Antibiotic	Disc Content
AMP	Ampicillin	10 µg	CHL	Chloramphenicol	30µg	VAN	Vancomycin	30µg
CIP	Ciprofloxacin	5 µg	FOX	Cefoxitin	30µg	TEC	Teicoplanin	30µg
LVX	Levofloxacin	5 µg	ERY	Erythromycin	15µg	LNZ	Linezolid	30µg
GEN	Gentamicin	10 µg	CLI	Clindamycin	2µg	RIF	Rifampin	5µg
TCY	Tetracycline	10 µg	GEH	Gentamicin-High	120µg	OFX	Ofloxacin	5µg
DOX	Doxycycline	30 µg						
SXT	Trimethoprim/ Sulfamethoxazole	1.25/23.75 µg						

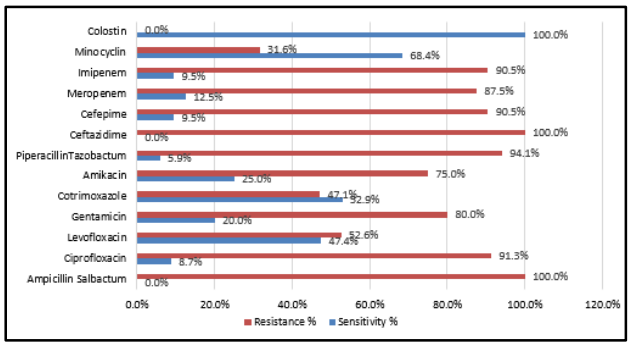

Figure 2: Antibiotic Susceptibility pattern of *Acinetobacter sp*.

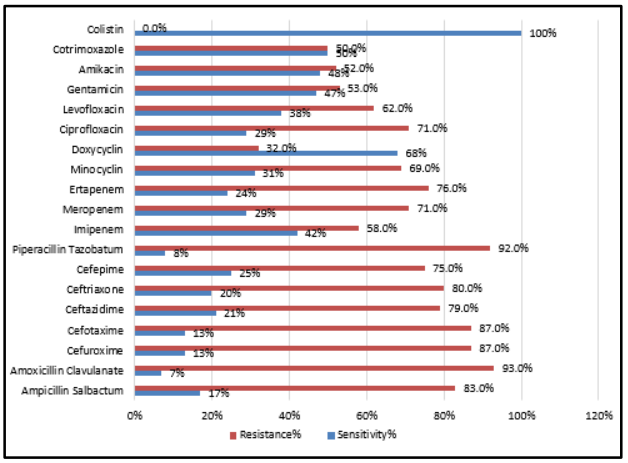

Figure 3: Antibiotic susceptibility pattern of *Klebsiella sp*

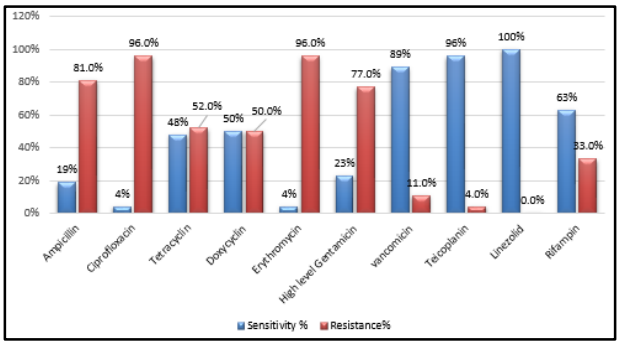

Figure 4: Antibiotic Susceptibility pattern of Enterococcus sp.

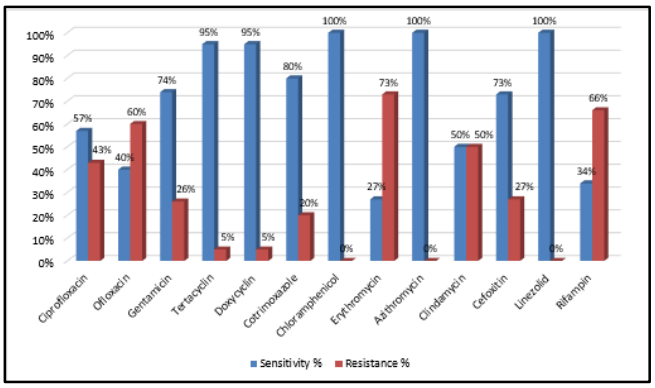

Figure 5: Antibiotic Susceptibility pattern of *Staphylococcus aureus*

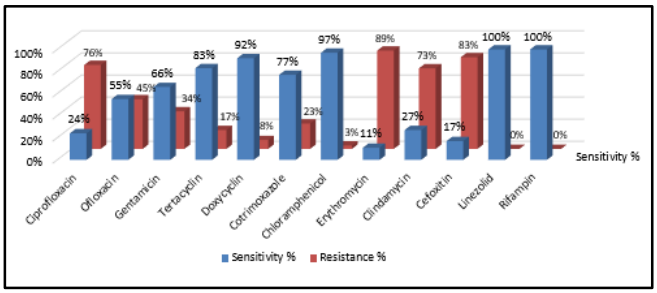

Figure 6: Antibioc Susceptibility pattern of coagulase negative Staphylococcus

4. Discussion

Bloodstream infections (BSIs) are a significant cause of morbidity and mortality in patients, particularly those in Intensive Care Units (ICUs). The identification of etiological agents and their antibiotic susceptibility profiles is critical for effective clinical management, especially given the increasing prevalence of multidrug-resistant organisms (MDROs). This study aimed to bring highlight to the bacteriological profile and antibiotic resistance patterns of blood culture isolates in ICU patients at a tertiary care hospital in Valsad, Gujarat. The findings provide valuable information that will help guide empiric therapy, optimize antibiotic use, and contribute to the formulation of local antibiograms. Given that the spectrum of pathogens and their resistance profiles can vary by location and time, this study serves to update clinicians on current trends in BSIs.

4.1. Bacteriological profile

In our study, *Klebsiella* spp. comprised 14.97% of isolates, which is similar to the finding of Neeta Jangale et al.[7] (15.15%) and somewhat higher than that reported by Tabah A et al.[20] (11.90%). However, it exceeds substantially the proportions documented by Mariyah Yousuf et al.[10] (7.10%) and Ashima Katyal et al.[15] (6.15%). These discrepancies may reflect differences in hospital settings (for example, intensive care units, surgical wards, or mixed wards), patient populations (age, comorbidity, prior antibiotic exposure), and infection control practices.

By contrast, *Escherichia coli* accounted for only 3.86% in our study, markedly lower than the rates in Mariyah Yousuf et al.[10] (15.20%), Ashima Katyal et al.[15] (11.90%), and Wu H-N et al.[19] (9.95%). The low prevalence of *E. coli* in our data may be because of local antimicrobial usage patterns that reduce the survival or presentation of *E. coli* relative to other organisms. However, the potential for these pathogens to emerge with prolonged hospital stays and increased use of broad-spectrum antibiotics remains a concern.

Acinetobacter spp. featured in 12.07% of isolates—close to Tabah A et al.[20] (12.20%) but lower than Neeta Jangale et al. (18.18%) and Ashima Katyal et al. (22.40%). Meanwhile, Mariyah Yousuf et al. reported a much lower figure (6.20%). The relatively moderate prevalence in our study might suggest differing environmental reservoirs or variations in disinfection and colonization pressure in our facility.

Similarly, *Pseudomonas* spp. was isolated in 13.04% of cases in our study, which aligns reasonably with Tabah A et al.[20] (11.40%). Yet, it is considerably lower than the 19.60% reported by Mariyah Yousuf et al.,[10] and above the lower values by Wu H-N et al.[19] (4.19%). This may reflect regional ecological differences, hospital ventilation or water system management, or different patient risk profiles (e.g., ventilated patients or those with burn injuries).

Salmonella Paratyphi B is also isolated from SNCU in 21-day old baby with history of top feeding and this isolate is also sensitive to all drug. This one was important and uncommon finding seen in < 2 year age group. It is important to send blood culture as *Salmonella Paratyphi B* is intrinsically resistant to aminoglycoside so early detection is very useful to treat the case.[16,17]

On the Gram-positive side, *Enterococcus* spp. in our study appeared in 14.04%, notably higher than the 7.10%, 8.12%, and 5.95% reported by Mariyah Yousuf et al., Wu H-N et al., and Ashima Katyal et al., respectively. This raised prevalence could indicate a growing role of *Enterococcus* in device-associated or nosocomial infections in our setting.[10,15,19]

Staphylococcus aureus comprised 11.60% of isolates in our study, which is higher than the 3.03% in Neeta Jangale et al. and 5.50% in Wu H-N et al.,[19] but lower than 19.40% in Ashima Katyal et al.[15] This suggests that while *S. aureus* remains important, its relative dominance may vary with local infection control, patient colonization, and antibiotic selective pressures.

Finally, Coagulase-negative staphylococci (CoNS) were the most frequently isolated group in our study at 28.98%. This is comparable to the proportions of around 31.70% and 31.20% reported in Ashima Katyal et al.[15] and Mariyah Yousuf et al.,[10] respectively, and higher than those in Wu H-N et al.[19] (~22.52%) and Tabah A et al. (10.70%). Given CoNS's well-known association with indwelling devices, catheters and lines, and its prevalence in ICU settings, this high frequency may reflect both the patient mix and device usage in our centre. However, in our set up we are doing manual method for identification of organisms so speciation of CoNS is not possible effectively, most of the samples we received from Pediatric department and most of isolates (83%) were Methicillin Resistant Staphylococcus, so we reported it for patient concern that's why the prevalence is high.

4.2. ICU and gender distribution

The distribution of positive blood cultures across different ICU units showed varying rates of infection, with **N**ICU having the highest proportion of positive cultures (28.67%). This finding is consistent with other studies that highlight the vulnerability of neonates and infants in intensive care settings due to their underdeveloped immune systems.[3] SNCU also had a relatively high incidence of BSIs (22.42%), emphasizing the importance of infection control in neonatal and pediatric ICU environments.

Gender distribution revealed a slight male predominance (approximately 60%) in the positive blood culture samples, which aligns with other studies that have reported higher rates of infection in male ICU patients, although the gender-based differences were not statistically significant.[7]

4.3. Antibiotic resistance patterns

The present study evaluated the antimicrobial susceptibility patterns of both Gram-negative and Gram-positive bacterial isolates obtained from blood culture from ICU settings. It demonstrate a high prevalence of multidrug resistance (MDR) among the isolates, consistent with the global escalation of antimicrobial resistance reported in recent years.[21-23]

Table 7: Common organisms isolated in different studies

Various Studies / Organisms	Present Study	Neeta jangale et al[7]	Mariyah Yousuf et al[10].	Wu H-N et al[19]	Ashima Katyal et al[15]	Tabah A et al[20]
Klebsiella sp	14.97%	15.15%	7.10%	11.52%	6.15%	11.90%
E.coli	3.86%	9.09	15.20%	9.95%	11.90%	7.40%
Acinetobacter sp	12.07%	18.18%	6.20%	6.64%	22.40%	12.20%
Pseudomonas sp	13.04%	18.18%	19.60%	4.19%	2.30%	11.40%
Enterococcus sp	14.04%		7.10%	8.12%	5.95%	10.90%
S.aureus	11.60%	3.03%	7.10%	5.50%	19.40%	9%
CoNS *	28.98%		31.20%	*22.52%	31.70%	10.70%
*includes CoNS sp like S.homonis 7.59%, S.epidermidis 9.95%, S.hemolyticus 2.36% & *S.capitis* 2.62%, Total 22.52%)						

Among the Gram-negative organisms, *Klebsiella sp.*, *Pseudomonas sp.*, and *Acinetobacter sp.* exhibited marked resistance to multiple antibiotic classes, including β-lactams, fluoroquinolones, and aminoglycosides.

Klebsiella sp. demonstrated more resistance to most cephalosporins and carbapenems, suggesting possible presence of extended-spectrum β-lactamase (ESBL) and carbapenemase-producing strains among isolates. Carbapenem susceptibility ranged from 29% to 42% (**Figure 3**) which is particularly concerning, as it reflects the emergence of carbapenem-resistant Enterobacteriaceae (CRE). It is difficult to treat infection with CRE because it is resistant to most antibiotics including carbapenems. This finding is consistent with other regional and international studies reporting an increasing trend of CRE infections in hospital settings.[24,29]

Similarly, *Pseudomonas sp.* demonstrated resistance across nearly all tested agents, with susceptibility rates below 30% for most drug classes (**Figure 4**). This extensive drug resistance (XDR) pattern is commonly associated with efflux pump overexpression, porin loss, and metallo-β-lactamase production, which contribute to treatment failures and increased morbidity.[25]

Acinetobacter sp. was the most resistant organism in this study, with carbapenem susceptibility rates below 15%, confirming the presence of carbapenem-resistant Acinetobacter baumannii (CRAB). This kind of isolates have been recognized by the WHO as priority 1 pathogens for research and new drug development.[26]

Among the Gram-positive organisms, Enterococcus sp., Coagulase-negative Staphylococci (CoNS), and Staphylococcus aureus were tested.

Enterococcus sp. exhibited high resistance to β-lactams and fluoroquinolones but remained largely susceptible to glycopeptides (vancomycin 89%, teicoplanin 96%) and linezolid (100%), indicating the absence of vancomycin-resistant Enterococci (VRE). This finding contrasts with some regional reports showing increasing VRE prevalence, possibly reflecting effective infection control practices within the study setting.[30]

CoNS isolates demonstrated widespread methicillin resistance (MR) (cefoxitin17% susceptible), corresponding to approximately 83% MR-CoNS prevalence, while *S. aureus* showed a 27% MRSA rate (based on Cefoxitin 73% susceptibility). These rates are within the range reported in previous studies from similar healthcare environments.[27] Despite this, both organisms remained fully susceptible to vancomycin and linezolid, confirming their continued effectiveness as key therapeutic agents against resistant Gram-positive cocci.

Tetracyclines (doxycycline and tetracycline) and chloramphenicol also demonstrated good in-vitro activity against staphylococci, suggesting potential use as alternative agents in cases of β-lactam resistance. However, the observed macrolide and lincosamide resistance (Erythromycine 11–27%, Clindamycin 27–50%) could indicate inducible MLSB resistance, a mechanism commonly reported in *Staphylococcus* spp.[28]

The emergence of MDR pathogens poses a significant threat to the management of BSIs and underscores the need for timely surveillance and appropriate antibiotic stewardship. Resistance to broad-spectrum antibiotics, including cephalosporins and carbapenems, was commonly observed, highlighting the challenges clinicians face in selecting effective empiric therapy.[5,7]

The findings of this study emphasize the necessity of continuous monitoring of antibiotic resistance patterns. Empiric therapy in ICUs should be based on up-to-date antibiograms, and interventions such as antimicrobial stewardship programs are critical to reducing inappropriate antibiotic use and mitigating the spread of MDR pathogens.[10]

5. Limitations

This study has several limitations. First, the retrospective nature of the study relies on the accuracy of hospital records, and only blood culture isolates were analyzed, excluding other potential pathogens (e.g., fungi) that may contribute to BSIs in ICU patients. The study did not include clinical data such as comorbidities, which could provide further insights into the severity of infections and outcomes. Furthermore, the lack of prospective analysis limits the ability to infer causal

relationships between the isolated pathogens and patient outcomes.

6. Implications and Recommendations

This study provides valuable data for the formulation of hospital-specific antibiotic policies and empiric therapy guidelines. The high prevalence of CoNS, *Enterococcus spp*., and *Acinetobacter spp*. necessitates strict infection control practices, regular surveillance of antibiotic resistance patterns, and ongoing education for healthcare providers. Given the dynamic nature of antibiotic resistance, it is essential to perform routine surveillance and periodically update antibiograms to guide empiric therapy effectively.

The study also highlights the need for improved infection control measures, particularly in neonatal and pediatric ICUs, where the rates of BSIs were highest. Future research should focus on prospective studies that include a wider range of pathogens (including fungi) and clinical data to better understand the factors influencing patient outcomes.

7. Conclusion

In conclusion, this study underscores the importance of continuous surveillance of bacteriological profiles and antimicrobial resistance patterns in ICU settings. The findings will aid in guiding empiric therapy, formulation of hospital antibiotic policies, and infection control strategies. Given the significant impact of multidrug-resistant pathogens on the management of bloodstream infections, timely updates to local antibiograms and implementation of antimicrobial stewardship programs are essential for improving patient outcomes and reducing the burden of resistance.

8. Source of Funding

None.

9. Conflict of Interest

None.

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