Section: Microbiology

Original Research Article

COLISTIN MIC PROFILES OF MULTI-DRUG-RESISTANT GRAM-NEGATIVE PATHOGENS OF BLOODSTREAM INFECTIONS

S. Meenakshi[1], Usha Krishnan K[2], Movaphia A[1], Thasneem Banu S[3]

[1]Assistant Professor, Institute of Microbiology, Madras Medical College
[2]Professor, Institute of Microbiology, Madras Medical College
[3]Professor and Head of Microbiology, Madras Medical College

Received : 14/08/2026
Received in revised form : 12/09/2026
Accepted : 26/09/2026

Keywords:
Bloodstream infections, antimicrobial resistance, multidrug resistance, Colistin MIC, Broth microdilution, agar dilution.

Corresponding Author:
Dr. Usha Krishnan K,
Email: ushakrishnan72@gmail.com

DOI: 10.47009/jamp.2026.8.5.172

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (5); 1086-1092

ABSTRACT

Background: This study aimed to determine the microbiological profile of blood culture isolates and their associated antimicrobial resistance patterns, assess the prevalence of Carbapenem-Resistant Enterobacterales (CRE) and Carbapenem-Resistant Acinetobacter species, and determine the minimum inhibitory concentration (MIC) of colistin against carbapenem-resistant pathogens isolated from bloodstream infections. **Materials and Methods:** This cross-sectional study was conducted at the Institute of Microbiology, Rajiv Gandhi Government General Hospital, Chennai, from March 2025 to April 2026. Blood culture samples received from inpatients wards and intensive care units were processed using both automated and conventional methods. Organisms were identified by standard microbiological techniques, and antimicrobial susceptibility testing was performed according to standard guidelines. Carbapenem-resistant isolates were identified, and the colistin minimum inhibitory concentration was determined for multidrug-resistant Gram-negative pathogens isolated from BSI. **Result:** The overall culture-positivity rate was 7.7%. Gram-negative isolates predominated (72.4%), with Klebsiella species, Acinetobacter species, Escherichia coli, and Pseudomonas species identified as the primary pathogens. Extended-spectrum β-lactamase (ESBL)-producing organisms were the most common MDR pathogens, with 351 isolates (60%). Carbapenem-resistant Enterobacterales (CRE) were identified in 220 isolates (38%), while carbapenem-resistant Acinetobacter species constituted 111 isolates (72%). Escherichia coli isolates had a Colistin MIC of ≤1 µg/mL, for Klebsiella species and Pseudomonas species it is ≤1 µg/mL -≤2 µg/mL. For Acinetobacter species it is ≤1 µg/mLto 4 µg/mL. **Conclusion:** Bloodstream infections in this study were predominantly caused by Gram-negative bacilli, with a high prevalence of CRE and Carbapenem-resistant Acinetobacter species. Colistin remained active against most multidrug-resistant Gram-negative isolates, although the emergence of colistin resistance is a significant concern. Routine surveillance of pathogen distribution, antimicrobial susceptibility, and colistin MICs is essential for guiding appropriate empirical therapy. Continued monitoring of resistance trends is crucial to optimize patient outcomes and limit the spread of multidrug-resistant organisms in healthcare settings.

INTRODUCTION

Bloodstream infections (BSIs) are a major cause of morbidity and mortality worldwide and continue to pose significant challenges to healthcare systems despite advances in antimicrobial therapy and critical care management. BSIs can range from transient asymptomatic bacteremia to severe sepsis, septic shock, multi-organ dysfunction syndrome, and disseminated intravascular coagulation, all of which contribute substantially to increase in patient mortality.[1,2] Early identification of the causative pathogen and appropriate antimicrobial therapy are crucial for improving clinical outcomes.

The increasing prevalence of antimicrobial resistance (AMR) has further complicated the management of bloodstream infections. AMR is recognized as one of the greatest global public health threats, with projections estimating up to 10 million deaths annually by 2050 if effective interventions are not implemented.[1,3] Gram-negative bacilli (GNB) have emerged as important causes of BSIs, particularly in hospitalized and critically ill patients. Among these,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

multidrug-resistant Gram-negative organisms such as carbapenem-resistant Enterobacterales (CRE), carbapenem-resistant Acinetobacter baumannii (CRAB), and difficult-to-treat resistant Pseudomonas aeruginosa (DTR-P. aeruginosa) shows increase in prevalence and are associated with prolonged hospitalization, restricted therapeutic options, and increase in mortality.[4]

Recognizing the threat posed by these pathogens, the World Health Organization (WHO) has categorized carbapenem-resistant Gram-negative bacteria as critical-priority pathogens requiring urgent need and development of new antimicrobial agents.[5] Resistance among Enterobacterales, particularly Klebsiella pneumoniae, is commonly mediated by carbapenemase-producing genes such as blaNDM and blaOXA-48, along with other mechanisms including extended-spectrum β-lactamase production, reduced outer membrane permeability, and efflux pump overexpression.[6,7] In Acinetobacter baumannii, carbapenem resistance is predominantly associated with oxacillinase genes such as blaOXA-23 and blaOXA-51, whereas resistance in Pseudomonas aeruginosa is mainly attributed to porin loss, efflux pumps, and other permeability-related mechanisms.[6,8]

The rapid emergence of carbapenem resistance has revived the use of older antimicrobial agents such as colistin (polymyxin E). Colistin is a cyclic polypeptide antibiotic with potent activity against many MDR Gram-negative organisms, including Klebsiella pneumoniae, Acinetobacter baumannii, and Pseudomonas aeruginosa.[9] Consequently, it is often considered a last-resort therapeutic option for infections caused by carbapenem-resistant pathogens.[10] However, the increased use of colistin has led to the emergence of colistin resistance, further limiting treatment options. Moreover, the clinical use of colistin is constrained by its potential nephrotoxicity and neurotoxicity.[9]

Accurate determination of colistin susceptibility is therefore essential for guiding appropriate therapy. The minimum inhibitory concentration (MIC) is the most reliable measure of antimicrobial susceptibility and plays a critical role in assessing the effectiveness of colistin against MDR pathogens. Several methods are available for colistin MIC determination, including broth microdilution, agar dilution, and commercial susceptibility testing systems. Previous studies have demonstrated that agar dilution methods provide reliable, reproducible, and robust results for colistin MIC determination and may serve as a practical approach for screening carbapenem-resistant isolates.[11,12]

Given the increasing burden of MDR Gram-negative bloodstream infections and the reliance on colistin as a last-line therapeutic agent, continuous surveillance of pathogen profiles, antimicrobial resistance patterns, and colistin susceptibility is essential. On this background the present study aims to evaluate the Colistin minimum inhibitory concentration (MIC) profiles of multidrug-resistant Gram-negative pathogens isolated from bloodstream infections.

Objectives: This study aimed to determine the microbiological profile of blood culture isolates and their associated antimicrobial resistance (AMR) patterns, assess the prevalence of Carbapenem-Resistant Enterobacterales (CRE) and Carbapenem-Resistant Acinetobacter species, and determine the minimum inhibitory concentration (MIC) of colistin against carbapenem-resistant pathogens isolated from bloodstream infections.

MATERIALS AND METHODS

Study Design and Setting: A cross-sectional study was conducted in the Institute of Microbiology, Rajiv Gandhi Government General Hospital, Chennai, over a period of one year from March 2025 to April 2026.

Study Population and Sample Size: A total of 363 carbapenem resistant blood culture isolates were included in the study. The sample size was calculated based on the prevalence of 36.53% carbapenem resistant blood stream isolates reported by Bhat PN et al,.[13]

Inclusion and Exclusion Criteria

All blood culture samples received from inpatients admitted to various wards and intensive care units (ICUs) during the study period were included. Repeat isolates from the same patient and cultures yielding mixed microbial growth were excluded from the analysis.

Ethical Clearance: The study protocol was reviewed and approved by the Institutional Ethics Committee of Rajiv Gandhi Government General Hospital, Chennai.

Blood Culture Processing and Identification of Isolates

Blood culture samples were processed using both automated (BACT/ALERT) and conventional blood culture methods. Positive blood culture bottles flagged by the automated system or showing evidence of growth by conventional methods were subcultured onto Blood agar and MacConkey agar plates and incubated aerobically at 35–37°C for 18–24 hours.

Preliminary identification was performed based on Gram staining characteristics and colony morphology. Definitive identification of bacterial isolates was carried out using standard biochemical tests according to established microbiological procedures.

Antimicrobial Susceptibility Testing: Antimicrobial susceptibility testing (AST) was performed by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar following Clinical and Laboratory Standards Institute (CLSI) guidelines. Phenotypic detection of specific resistance mechanisms, including extended-spectrum β-lactamase (ESBL) production was carried out using conventional microbiological methods.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Detection of Carbapenem Resistance: Gram-negative isolates exhibiting resistance to carbapenems on routine AST were categorized as carbapenem-resistant pathogens and were included for further colistin susceptibility testing.

Determination of Colistin Minimum Inhibitory Concentration: Colistin MIC testing was performed for 363 carbapenem-resistant Gram-negative isolates. For carbapenem-resistant Enterobacterales, MIC determination was carried out using the agar dilution method as described in the CLSI.

Colistin agar dilution required Mueller-Hin-ton agar plates containing final concentrations of colistin sulfate (Sisco Research Laboratories, Maharashtra,India) of 0, 1, 2, and 4 µg/mL. A 0.5 McFarland bacterial suspension (approximately 1–2 × 108 CFU/mL of E. coli ATCC 25922) was prepared from three to five colonies obtained from a fresh (18–24 hours) nonselective agar plate and suspended in sterile saline. The suspension was then diluted 1:10 in sterile saline (approximately 1–2 × 107 CFU/mL) (8). Colistin agar test plates were streaked with 10 µL of the diluted suspension (approximately 1–2 × 105 CFU per inoculum) using a calibrated sterile loop. Plates were incubated at 35°C for 16–20 hours under aerobic conditions. A maximum of 10 isolates were tested on each plate set, including control strains. MIC is determined as the lowest concentration of Colistin that completely inhibits growth.

For carbapenem-resistant Acinetobacter spp., colistin MIC testing was performed using the broth microdilution (BMD) method according to the CLSI recommendations. Two-fold serial dilutions of colistin sulfate (0.25–16 µg/mL) were prepared in cation-adjusted Mueller–Hinton broth in sterile, non-treated polystyrene microtiter plates. A standardized bacterial inoculum equivalent to 5×10^5 CFU/mL was added to each well, and the plates were incubated at 35 ± 2°C for 16–20 hours. The MIC was defined as the lowest concentration of colistin showing complete inhibition of visible growth.

Quality control for colistin susceptibility testing was performed with Escherichia coli ATCC 25922 and Pseudomonas aeruginosa ATCC 27853. MIC values obtained for the quality control strains were required to fall within the acceptable ranges recommended by CLSI before interpretation of test results.

Colistin MIC results were interpreted according to CLSI M100, breakpoints. Isolates with MIC values ≤2 µg/mL were categorized as susceptible, whereas isolates with MIC values > 4 µg/mL were categorized as resistant.

RESULTS

Out of a total of 16,907 blood culture samples received during the study period, 1,303 (7.7%) were positive for growth. The majority of isolates were observed in females, accounting for 64% (n=866) [Table 1], while males accounted for 34% (n=437). The most affected age group was 41–60 years, with 617 cases (47.4%), followed by the 61–80 years category with 301 cases (23.1%).

A significant majority of these infections originated from General Wards n=1,123; 86.2%, while ICUs accounted for 180 cases (13.8%).

Microbiological Profile: The pathogens isolated were predominantly Gram-Negative Bacilli (GNB), which represented 72.4% (n=944) of the total isolates, followed by Gram-Positive Cocci (GPC) at 25.9% (n=338) and Candida species at 1.6% (n=21) [Table 2].

Among the Gram-negative bacilli the most frequent isolate was Klebsiella spp. (n=477; 50.5%), followed by Acinetobacter spp. (n=159; 16.8%), Escherichia coli (n=106; 11.2%), and Pseudomonas spp. (n=159; 17%) [Table 3].

Antimicrobial Susceptibility Testing (AST) [Table 4]: Susceptibility profiles varied significantly across major pathogens.

Klebsiella spp showed high sensitivity to Meropenem (58.7%), but low sensitivity to Amoxicillin/Clavulanic acid (20.5%). Escherichia coli demonstrated high sensitivity to Meropenem (80.0%) and Gentamicin (75.9%) but was highly resistant to Ciprofloxacin (13.9% sensitivity).

AMR Patterns: Among 944 Gram negative pathogens in bloodstream infection (BSI), a high prevalence 682(72%) of multidrug-resistant (MDR) organisms was observed. Extended-spectrum β-lactamase (ESBL)-producing organisms were the most common with 351 isolates (60%). Carbapenem-resistant Enterobacterales (CRE) were identified in 220 isolates (38%), while carbapenem-resistant Acinetobacter species constituted 111 isolates (70%), indicating a substantial burden of antimicrobial resistance among BSI pathogens.

Colistin MIC Profile [Table 5 & 6]: The distribution of Colistin minimum inhibitory concentrations (MICs), determined by the agar dilution method and Microbroth dilution method among 363 isolates including Klebsiella spp, (198) E. coli (22), Acinetobacter spp (111) and Pseudomonas spp (32). All 22 (100%) E.coli isolates had a MIC of ≤1 µg/mL. Among 198 Klebsiella spp. isolates, 190 (96%) demonstrated a MIC of ≤1 µg/mL, while 8 (4%) had a MIC of ≤2 µg/mL. Similarly, among 32 Pseudomonas spp. isolates, 31 (97%) had a MIC of ≤1 µg/mL and 1 (3%) had a MIC of ≤2 µg/mL

Among the 111 Acinetobacter spp. isolates tested by the colistin microbroth dilution method, 1(1%) had a colistin MIC of 0.5 µg/mL, 93(84%) had an MIC of 1 µg/mL, 15(13%) had an MIC of 2 µg/mL, and 2(2%) had an MIC of 8 µg/mL. The majority of isolates showed MIC values of 1–2 µg/mL.

Table 1: Age-wise distribution of patients constituting the study population

Age group yrs	No. of males	No. of females	Total No/ %
14 – 20	36	69	105(8)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

21 – 40	124	142	266(21)
41 – 60	132	485	617(47)
61 – 80	139	162	301(23)
81 – 100	6	8	14(1)
Total	437	866	1303

Table 2: Spectrum of organisms isolated from BSI

Types of organisms	No / %
Gram Positive Cocci	338(26)
Gram Negative Bacilli	944(72)
Candida	21(2)
Total	1303

Table 3: Distribution of GNB in the study (n=944).

S. No.	Name of the organism	No. of isolates (%)
1	Klebsiella pneumoniae ss. Pneumonia	412 (43.6)
2	Klebsiella oxytoca	65 (6.8)
3	Escherichia coli	106 (11.2)
4	Other Enterobacterales (Enterobacter sp, Citrobacter sp., Serratia marcescens Proteus mirabilis, Salmonella sp.)	30(3)
5	Acinetobacter sp.	159 (16.8)
6	Pseudomonas sp.	109 (11.5)
7	Pseudomonas aeruginosa	50 (5.2)
8	Other Non-fermenters (Burkholderia cepacia, Sphingomonas sp, Stenotrophomonas maltophilia, Elizabethkingia meningoseptica)	13(1.4)
	TOTAL	944

Table 4: AST pattern of the pathogens of BSI (n=9)

Antibiotics	Klebsiella species (n=477) No. (%)	Escherichia coli (n=106)	Acinetobacter sp. (n=159)	Pseudomonas sp. (n=159)
Ampicillin	-	7(7.1)	-	-
Amoxicillin/Clavulanic acid	98(20.5)	31(29.9)	-	-
Piperacillin/Tazobactam	259(54.3)	75(71.2)	70(44.0)	153(96.2)
Ceftriaxone	169(35.5)	38(36.4)	-	-
Cefotaxime	204(42.8)	28(26.6)	-	-
Cefepime	160(33.6)	43(40.5)	-	-
Ertapenem	115(24.3)	73(69.2)	-	-
Meropenem	279(58.7)	84(80.0)	44(27.6)	127(80.0)
Amikacin	273(57.4)	78(73.7)	60(37.7)	92(57.7)
Gentamicin	295(62.0)	80(75.9)	70(44.0)	115(72.5)
Ciprofloxacin	194(40.8)	14(13.9)	50(32.6)	131(82.4)
Trimethoprim/Sulfamethoxazole	251(52.8)	50(47.0)	69(44.5)	-
Ceftazidime	-	-	122(76.7)	131(82.6)
Minocycline	-	-	68(44.2)	-
Ampicillin/Sulbactam	-	-	49(32.0)	-

Table 5: Distribution of Colistin MIC among the isolates by Colistin agar dilution method

Organism	Colistin MIC by agar dilution method no(%)		
	<1 µg/mL	<2 µg/mL	4 µg/mL
E.coli (22)	22(100)	0	0
Klebsiella sp (198)	190(96)	8(4)	0
Pseudomonas sp (32)	31(97)	1(3)	0

Table 6: Distribution of Colistin MIC among the Acinetobacter Species

Organism	Colistin MIC by Microbroth Dilution method no(%)			
	0.5 µg/mL	1 µg/mL	2 µg/mL	8 µg/mL
Acinetobacter sp. (111)	1 (1%)	93(84%)	15 (13%)	2(2%)

DISCUSSION

Bloodstream infections (BSIs) remain one of the leading causes of sepsis-associated morbidity and mortality worldwide, particularly when caused by multidrug-resistant (MDR) Gram-negative pathogens. The increasing prevalence of carbapenem-resistant organisms has substantially narrowed therapeutic options, leaving polymyxins, including colistin, as one of the few remaining agents for treatment of severe infections. The 2024 WHO Bacterial Priority Pathogens List continues to classify carbapenem-resistant Acinetobacter baumannii and carbapenem-resistant Enterobacterales (CRE) among the highest-priority pathogens because of their rapid dissemination, limited treatment options, and association with poor clinical outcomes,

ISSN (O): 2687-5365; ISSN (P): 2753-6556

underscoring the importance of local epidemiological surveillance such as the present study.[14]

The blood culture positivity rate in this study was 7.7%, lower than the 14.5% reported by Kaur and Sharma.[15] Several factors may explain this finding. Empirical administration of broad-spectrum antibiotics before blood collection remains common in referred patients and significantly reduces blood culture yield. Additionally, delayed sample collection, inadequate blood volume, intermittent bacteremia, and differences in blood culture protocols can influence positivity rates. These observations highlight the importance of obtaining blood cultures before initiation of antimicrobial therapy and implementing standardized blood culture collection practices to improve diagnostic yield.

The majority of bloodstream infections occurred in patients aged 41–60 years, consistent with Gohel et al,[16] Individuals in this age group frequently has multiple comorbidities, other immunocompromising conditions requiring repeated healthcare exposure and invasive procedures, thereby increasing susceptibility to bloodstream infections explaining the higher burden observed among middle-aged and elderly hospitalized patients.

Most bloodstream infections in the present study originated from general wards (86.2%), considerably higher than the 57% reported by Datta et al,.[1] In contrast, only 13.8% of isolates were recovered from intensive care units compared with 78.2% reported by Araujo de et al.[17] These differences probably reflect institutional variations in patient referral pathways, ICU bed availability, case-mix, antimicrobial prescribing practices, and infection prevention policies. Importantly, the predominance of ward-acquired infections suggests that antimicrobial resistance is no longer confined to critical care units but has disseminated throughout hospital settings, emphasizing the need for hospital-wide antimicrobial stewardship and infection-control interventions.

Gram-negative bacilli constituted 72.4% of bloodstream isolates, followed by Gram-positive cocci (25.9%) and Candida species (1.6%), consistent with previous reports from tertiary care centres.[1,4] The predominance of Gram-negative pathogens reflects the changing epidemiology of healthcare-associated bloodstream infections, driven by increasing utilization of invasive devices, prolonged hospitalization, broad-spectrum antibiotic exposure, and selective antimicrobial pressure. Gram-negative bacteria possess remarkable genomic plasticity, enabling acquisition of resistance determinants through plasmids, integrons, transposons, and other mobile genetic elements, thereby facilitating rapid dissemination of multidrug resistance within healthcare environments.[18] These characteristics explain their increasing dominance in contemporary bloodstream infections and their major contribution to sepsis-related mortality.

Klebsiella spp. emerged as the predominant Gram-negative pathogen (50.5%), followed by Pseudomonas spp. (17%), Acinetobacter spp. (16.8%) and Escherichia coli (11.2%). This distribution differs from studies by Chen et al,.[19] and Oyekale et al,[20] where E. coli predominated. Globally, Klebsiella pneumoniae has evolved into one of the most successful high-risk clones because of its ability to acquire carbapenemase genes such as blaNDM, blaOXA-48-like, and together with virulence determinants that enhance persistence and transmission within healthcare facilities. Recent WHO reports further highlight the emergence of carbapenem-resistant hypervirulent K. pneumoniae as an important global public health threat.[21]

One of the most important findings of the present study was the high prevalence of carbapenem resistance. CRE accounted for (38%) of Enterobacterales isolates, while (70%) of Acinetobacter isolates were carbapenem resistant. These findings are comparable with those reported by Aggarwal et al,[10] and are consistent with global reports demonstrating the continued expansion of CRE and CRAB in tertiary-care hospitals. Carbapenem resistance is primarily mediated through production of carbapenemases, including New Delhi metallo-β-lactamase (NDM), oxacillinase (OXA)-type enzymes, Klebsiella pneumoniae carbapenemase (KPC), and Verona integron-encoded metallo-β-lactamase (VIM), often accompanied by porin loss and efflux pump overexpression. The combination of multiple resistance mechanisms not only compromises carbapenem efficacy but also facilitates persistence under antimicrobial selection pressure. These findings reinforce the urgent need for comprehensive antimicrobial stewardship programmes, rapid laboratory detection of carbapenemase-producing organisms, and strengthened infection prevention measures.[22]

The antimicrobial susceptibility profile demonstrated that Klebsiella spp retained relatively higher susceptibility to meropenem (58.7%) but exhibited poor susceptibility to amoxicillin-clavulanic acid (20.5%). In comparison, Chen et al,[19] reported higher carbapenem susceptibility (72.1–74.0%), suggesting regional differences in antimicrobial selection pressure and resistance mechanisms. Escherichia coli isolates in our study remained highly susceptible to meropenem (80%) and gentamicin (75.9%) but showed marked resistance to ciprofloxacin, with only 13.9% susceptibility. The widespread fluoroquinolone resistance observed is likely attributable to cumulative mutations in gyrA and parC genes together with plasmid-mediated quinolone resistance determinants, reflecting extensive fluoroquinolone use in both community and hospital settings. These findings support continued reliance on susceptibility-guided therapy and underscore the importance of preserving carbapenems for appropriately selected patients.

Accurate determination of colistin susceptibility has become increasingly important because colistin represents one of the last therapeutic options against carbapenem-resistant Gram-negative pathogens.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Unlike most antimicrobial agents, colistin diffuses poorly in agar, making routine disc diffusion and gradient diffusion methods unreliable. Consequently, broth microdilution remains the international reference standard recommended by CLSI and EUCAST for colistin susceptibility testing. Precise MIC determination is essential for detecting heteroresistance, optimizing pharmacokinetic/pharmacodynamic target attainment, preventing therapeutic failure, and monitoring emergence of plasmid-mediated mcr genes responsible for transferable colistin resistance. Recent evaluations continue to demonstrate significant discrepancies between commercial susceptibility methods and reference broth microdilution, highlighting the need for standardized MIC testing in clinical microbiology laboratories.[23]

In the present study, agar dilution demonstrated colistin MICs of ≤1 µg/mL for Escherichia coli and ≤1–2 µg/mL for Klebsiella spp. and Pseudomonas spp. Among carbapenem-resistant Acinetobacter isolates tested by broth microdilution, most MIC values ranged between 0.5 and 2 µg/mL, while only 2% of isolates were colistin resistant. These findings closely resemble those reported by Kumudini Panigrahi et al,[24] and are lower than resistance rates described in several recent international systematic reviews, suggesting that colistin susceptibility remains largely preserved in our institution despite widespread carbapenem resistance. Nevertheless, even low levels of colistin resistance warrant careful attention because resistance may emerge during therapy through chromosomal modifications affecting lipid A biosynthesis or by acquisition of plasmid-mediated mcr genes, which facilitate horizontal dissemination across bacterial species. Continuous surveillance using standardized MIC methods therefore remains essential to preserve the effectiveness of this last-resort antimicrobial.

Overall, our findings demonstrate a substantial burden of carbapenem-resistant Gram-negative bloodstream pathogens, particularly Klebsiella spp. and Acinetobacter spp., while also showing that colistin retains excellent in vitro activity against the majority of these isolates. These data support routine MIC-based colistin susceptibility testing, reinforce the importance of antimicrobial stewardship to limit unnecessary carbapenem and polymyxin exposure, and provide valuable local epidemiological evidence to guide empirical therapy, infection-control strategies, and institutional AMR surveillance programmes.

CONCLUSION

This study demonstrates the predominance of multidrug-resistant Gram-negative bacilli, particularly Klebsiella spp. and Acinetobacter spp., as major causes of bloodstream infections in our tertiary care centre, with an alarmingly high prevalence of carbapenem resistance among Enterobacterales and Acinetobacter isolates. Despite this significant burden of antimicrobial resistance, colistin retained excellent in vitro activity against the majority of carbapenem-resistant isolates, with only a small proportion exhibiting resistance. These findings reaffirm the role of colistin as an important last-resort therapeutic option for severe bloodstream infections caused by carbapenem-resistant Gram-negative pathogens.

Routine determination of Colistin MIC using standardized reference methods is essential for accurate susceptibility reporting, early detection of emerging resistance, and optimization of antimicrobial therapy. Continuous microbiological surveillance, integration of MIC-guided susceptibility testing into routine laboratory practice, implementation of robust antimicrobial stewardship programmes, and stringent infection prevention and control measures are critical to limiting the emergence and spread of carbapenem- and colistin-resistant pathogens. Future multicentre studies incorporating molecular characterization of carbapenemase and plasmid-mediated mcr genes, together with clinical outcome analysis, are warranted to better understand resistance epidemiology and guide evidence-based therapeutic strategies.

REFERENCES

1. Datta S, Kumar A, Chatterjee B. Microbiological profile and antimicrobial resistance patterns of bloodstream infections in a tertiary care hospital in eastern India. Curr Med Res Pract. 2025;15:145-150. https://doi.org/10.4103/cmrp.cmrp_162_24
2. Kaur J, Singh H, Sethi T. Emerging trends in antimicrobial resistance in bloodstream infections: multicentric longitudinal study in India (2017-2022). Lancet Reg Health Southeast Asia. 2024;26:100412.
3. Ombelet S, Barbé B, Affolabi D, Ronat JB, Lompo P, Lunguya O, et al. Best practices of blood cultures in low- and middle-income countries. Front Med (Lausanne). 2019;6:131.
4. Mandal et al. Microbiological profile and antimicrobial susceptibility patterns of bloodstream infections in febrile neutropenic patients with hematological malignancies in a tertiary care hospital, Kolkata. Int J Med Microbiol Trop Dis. 2024;10(2):161-168.
5. Rojas JD, Merejildo Vera MC, Benites Azabache JC, De La Cruz Surco V, Lucas López JR, Pichardo-Rodriguez R. Prevalence of carbapenem-resistant Gram-negative bacilli from intensive care units from Latin America and the Caribbean: a systematic review and meta-analysis. Antibiotics (Basel). 2026;15:209.
6. Sleiman A, Abou Fayad AG, Banna HS, Matar G. Prevalence and molecular epidemiology of carbapenem-resistant Gram-negative bacilli and their resistance determinants in the Eastern Mediterranean Region over the last decade. J Glob Antimicrob Resist. 2021;25:209-221.
7. Logan LK, Weinstein RA. The epidemiology of carbapenem-resistant Enterobacteriaceae: the impact and evolution of a global menace. J Infect Dis. 2017;215(Suppl 1):S28-S36.
8. Boutzoukas A, Doi Y. The global epidemiology of carbapenem-resistant Acinetobacter baumannii. JAC Antimicrob Resist. 2025;7:dlaf134. doi: 10.1093/jacamr/dlaf134. PMID: 40735512; PMCID: PMC12305305.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

9. Doi Y. Treatment options for carbapenem-resistant Gram-negative bacterial infections. Clin Infect Dis. 2019;69(Suppl 7):S565-S575.
10. Aggarwal P, Saxena S, Amritha A, Kaim M. Modification of CLSI recommended colistin agar test for Enterobacterales to handle large sample load in a high-throughput laboratory. Infect Dis Clin Microbiol. 2026;8(2):139-143.
11. Turlej-Rogacka A, Xavier BB, Janssens L, Lammens C, Zarkotou O, Pournaras S, et al. Evaluation of colistin stability in agar and comparison of four methods for MIC testing of colistin. Eur J Clin Microbiol Infect Dis. 2018;37:345-353.
12. Nordmann P, Jayol A, Poirel L. A universal culture medium for screening polymyxin-resistant Gram-negative isolates. J Clin Microbiol. 2016;54(5):1395-1399.
13. Bhat PN, Nayak GS, Shetty AK, Prabhu K. Gram-negative bacterial bloodstream infections with focus on carbapenem resistance: an experience at a South Indian tertiary care hospital. Online J Health Allied Sci. 2024;23(3):5. Available from: https://www.ojhas.org/issue91/2024-3-5.html
14. World Health Organization. WHO publishes list of bacteria for which new antibiotics are urgently needed. Geneva: World Health Organization; 2017.
15. Kaur, Sharma. Bacteriological profile and their antibiotic susceptibility pattern in bloodstream infections in a tertiary care hospital in North India. J Pure Appl Microbiol. 2022;16(4):2756-2763.
16. Gohel K, Jojera A, Soni S, Gang S, Sabnis R, Desai M. Bacteriological profile and drug resistance patterns of blood culture isolates in a tertiary care nephrourology teaching institute. Biomed Res Int. 2014;2014:153747.
17. de Araujo LG, et al. Carbapenem-resistant Enterobacterales bloodstream infections related to death in two Brazilian tertiary hospitals. BMC Infect Dis. 2025;25:725.
18. Hossen N, Mascellino MT. Molecular insights into antimicrobial resistance in human bacterial pathogens: mechanisms, resistance genes, and translational diagnostic applications. Front Microbiol. 2026;17:1842688.
19. Chen Y, Liu P, Li H, Huang W, Yang C, Kang M, et al. Antimicrobial susceptibility of Gram-negative strains isolated from bloodstream infections in China: results from the study for monitoring antimicrobial resistance trends (SMART) 2018-2020. Epidemiol Infect. 2025;153:e48:1-8.
20. Oyekale OT, Ojo BO, Olajide AT, Oyekale OI. Bacteriological profile and antibiogram of blood culture isolates from bloodstream infections in a rural tertiary hospital in Nigeria. Afr J Lab Med. 2022;11(1):a1807.
21. Chen T, Ying L, Xiong L, Wang X, Lu P, Wang Y, et al. Understanding carbapenem-resistant hypervirulent Klebsiella pneumoniae: key virulence factors and evolutionary convergence. hLife. 2024;2(12):611-624.
22. Zacchaeus NGP, Palanikumar P, Alexander H, Webster J, Nair IK, Sadanshiv M, et al. Establishing an effective antimicrobial stewardship program at four secondary-care hospitals in India using a hub-and-spoke model. Antimicrob Steward Healthc Epidemiol. 2023;3(1):e99.
23. Matuschek E, Åhman J, Webster C, Kahlmeter G. Antimicrobial susceptibility testing of colistin: evaluation of seven commercial MIC products against standard broth microdilution for Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Acinetobacter spp. Clin Microbiol Infect. 2018;24(8):865-870.
24. Panigrahi K, Pathi BK, Poddar N, et al. Colistin resistance among multi-drug resistant Gram-negative bacterial isolates from different clinical samples of ICU patients: prevalence and clinical outcomes. Cureus. 2022;14(8):e28317.

ISSN (O): 2687-5365; ISSN (P): 2753-6556