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Antimicrobial Susceptibility Pattern of Multidrug-Resistant Acinetobacter Species Isolated From Intensive Care Units in a Tertiary Care Hospital

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Abstract

Background: Multidrug-resistant (MDR) Acinetobacter species are important healthcare-associated pathogens, particularly in intensive care units (ICUs), where invasive procedures, prolonged hospitalization, and exposure to broad-spectrum antimicrobial agents may facilitate the emergence and transmission of antimicrobial-resistant organisms. Increasing antimicrobial resistance among Acinetobacter isolates has substantially narrowed therapeutic options, making local antimicrobial susceptibility surveillance important for guiding antimicrobial therapy and infection prevention strategies. This study evaluated the distribution of MDR Acinetobacter isolates and their antimicrobial susceptibility patterns among patients admitted to ICUs of a tertiary care hospital.

Methods: A cross-sectional observational study was conducted on 121 Acinetobacter isolates recovered from clinical specimens of ICU patients at a tertiary care teaching hospital. The isolates were identified using conventional microbiological methods. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar and interpreted according to the Clinical and Laboratory Standards Institute 2024 guidelines.

Results: Among the 121 Acinetobacter isolates recovered from ICU patients, 98 (80.99%) were classified as MDR. *Acinetobacter baumannii* was the predominant species among the MDR isolates, accounting for 92 (93.88%) isolates, followed by *Acinetobacter haemolyticus* (5; 5.10%) and *Acinetobacter lwoffii* (1; 1.02%). Endotracheal tube specimens were the most frequent source of MDR Acinetobacter isolates, accounting for 41 (41.84%) isolates, followed by sputum and pus (15 each; 15.31%). The Medical ICU contributed the largest proportion of MDR isolates (53; 54.08%). Antimicrobial susceptibility testing demonstrated extensive resistance, with 100% resistance to both imipenem and meropenem. Minocycline demonstrated the highest proportion of susceptible isolates (35; 35.71%) among the tested antimicrobial agents.

Conclusion: The study demonstrated a high proportion of MDR Acinetobacter among ICU-derived clinical isolates, with *A. baumannii* being the predominant species. The high level of resistance to commonly tested antimicrobial agents, particularly the complete resistance observed to imipenem and meropenem, highlights the importance of routine antimicrobial susceptibility testing, continuous local resistance surveillance, antimicrobial stewardship, and rigorous infection prevention and control measures in ICU settings.

Categories: Infectious Disease
Keywords: acinetobacter baumannii, antimicrobial stewardship, antimicrobial susceptibility, carbapenem-resistance, healthcare-associated infections, intensive care unit, multidrug resistance

Introduction

Healthcare-associated infections (HAIs) continue to be a serious concern in hospital settings, especially for critically ill patients in need of intensive care. Patients admitted to intensive care units (ICUs) frequently experience invasive medical device use, extended hospital stays, mechanical ventilation, urinary and arterial catheterization, surgical procedures, and exposure to broad-spectrum antibiotics, all of which may raise the risk of HAIs and antimicrobial resistance [1,2]. Adverse clinical outcomes, longer hospital stays, and higher healthcare expenses may all be caused by these factors [1,2].

Acinetobacter baumannii is a significant opportunistic Gram-negative bacterium linked to infections in healthcare settings, especially in hospitalized and critically ill patients. Urinary tract infections, wound and surgical site infections, bloodstream infections, ventilator-associated pneumonia, and other infections have all been linked to it [3,4]. Its capacity to last for extended periods of time in a hospital context and to develop and accumulate several antimicrobial-resistance pathways contributes to its persistence and spread in healthcare settings [5].

Antimicrobial resistance has become more common, making it more difficult to treat infections caused by multidrug-resistant (MDR) Acinetobacter. Multiple antimicrobial class resistance in MDR isolates can restrict therapeutic options and make choosing the right course of treatment more difficult. For the purpose of directing successful treatment and assisting regional antimicrobial stewardship initiatives, accurate antimicrobial susceptibility testing is crucial [6,7].

Certain *A. baumannii isolates* may still be susceptible to drugs like minocycline, even though the bacteria frequently demonstrate resistance to several antimicrobial treatments. Antimicrobial susceptibility testing should therefore be used in conjunction with the patient's clinical condition to inform therapy choices [8].

Acinetobacter prevalence and patterns of antimicrobial susceptibility differ between hospitals and geographical areas. Antimicrobial-resistant Acinetobacter is significantly prevalent in tertiary-care hospitals and ICUs, according to surveillance studies from India [9]. The significance of institution-specific surveillance is highlighted by the fact that this variance may be influenced by patient characteristics, local antimicrobial-prescribing procedures, infection prevention and control strategies, and healthcare-associated transmission [9].

Local antimicrobial susceptibility data can strengthen antimicrobial stewardship and infection prevention programs by assisting clinicians in selecting appropriate empirical and definitive therapy. Continuous laboratory-based surveillance is therefore essential to detect changes in resistance patterns and guide effective infection prevention and control strategies [9,10].

Therefore, the present study was conducted to determine the proportion of MDR Acinetobacter isolates among Acinetobacter isolates recovered from ICU patients in a tertiary-care hospital, characterize the distribution of Acinetobacter species and clinical specimen sources, and evaluate their antimicrobial susceptibility patterns.

Materials And Methods

This laboratory-based observational study was conducted from August 2024 to March 2025 at the Department of Microbiology, Krishna Institute of Medical Sciences and Krishna Charitable and Medical Research Center, Karad. The study was approved by the Institutional Ethics Committee of Krishna Institute of Medical Sciences, Karad (Protocol No.: KVV/IEC/05/2024). During the study period, clinical specimens received from patients admitted to the ICUs of Krishna Hospital were processed using standard microbiological procedures. Acinetobacter isolates recovered from eligible clinical specimens were assessed for multidrug resistance and included in the present analysis according to the predefined inclusion and exclusion criteria. MDR was defined as acquired nonsusceptibility to at least one antimicrobial agent in three or more antimicrobial categories. Data were collected using a structured proforma containing relevant demographic and clinical information, ICU details, specimen type, bacterial identification, and antimicrobial susceptibility results. The inclusion and exclusion criteria used in the study are summarized in Table *1*.

Inclusion criteria	Exclusion criteria
All clinically significant Acinetobacter isolates recovered from clinical specimens of patients admitted to the ICUs during the study period were eligible for inclusion	Duplicate isolates recovered from the same patient were excluded
MDR Acinetobacter isolates identified among these isolates were included in the present analysis	Acinetobacter isolates obtained from patients admitted to non-ICU wards were excluded

TABLE 1: Inclusion and exclusion criteria

ICU: intensive care unit; MDR: multidrug-resistant

Bacterial identification

Clinical specimens were processed using standard microbiological procedures. Acinetobacter isolates were identified based on colony morphology, Gram staining, and conventional biochemical characteristics. Isolates showing the characteristic phenotypic and biochemical profile of Acinetobacter were further differentiated to species level as *A. baumannii, A. haemolyticus,* or *A. lwoffii* based on their respective phenotypic and biochemical characteristics according to the identification scheme followed in the microbiology laboratory.

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-

Hinton agar and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) M100, 34th edition, 2024 guidelines [11]. No isolates were categorized as intermediate according to the CLSI M100, 34th edition, 2024 interpretive criteria; therefore, the final analysis included only susceptible and resistant categories. The antimicrobial agents tested included amikacin (30 µg), gentamicin (10 µg), ciprofloxacin (5 µg), levofloxacin (5 µg), ceftazidime (30 µg), imipenem (10 µg), meropenem (10 µg), cefoperazone-sulbactam (75/30 µg), trimethoprim-sulfamethoxazole (1.25/23.75 µg), and minocycline (30 µg). *Escherichia coli* ATCC 25922 was used as the quality-control strain for antimicrobial susceptibility testing, and the observed zone diameters were within the acceptable CLSI quality-control ranges.

Results

During the study period, a total of 121 Acinetobacter isolates were recovered from clinical specimens processed from patients admitted to the ICUs. Of these, 98 isolates (80.99%) met the criteria for MDR Acinetobacter and were included in the present analysis. Among the 98 MDR isolates, *A. baumannii* was the predominant species, accounting for 92 isolates (93.88%), followed by *A. haemolyticus* with five isolates (5.10%) and *A. lwoffii* with one isolate (1.02%).

The age-wise distribution of the 121 Acinetobacter isolates showed considerable variation across different age groups. The highest number of isolates was observed among patients aged 31-40 years (31, 25.62%), followed by the 41-50 years age group (29, 23.97%) and the 51-60 years age group (21, 17.36%). Patients aged 61-70 years accounted for 14 isolates (11.57%), while those aged 71-80 years contributed 11 isolates (9.09%). Lower frequencies were observed in the 21-30 years age group (8, 6.61%), patients aged >80 years (3, 2.48%), and those aged 11-20 years (2, 1.65%). Two isolates (1.65%) were recovered from patients aged less than one year (Figure *1*).

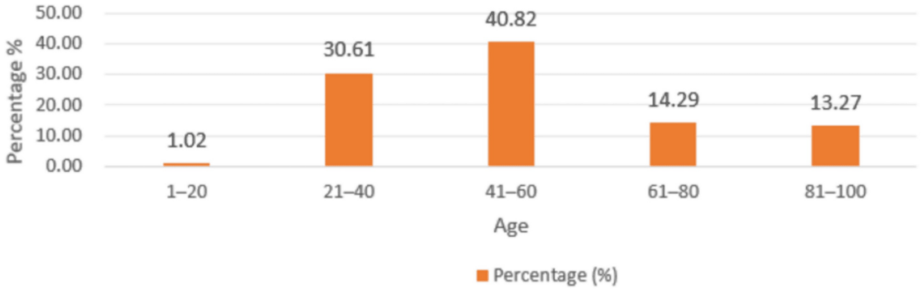


FIGURE 1: Age-wise distribution of Acinetobacter isolates among ICU patients

MDR: multidrug-resistant

Among the 121 Acinetobacter isolates obtained from ICU patients, 98 (80.99%) were identified as MDR isolates. Among these MDR isolates, 61 (62.24%) were recovered from male patients and 37 (37.76%) from female patients (Figure *2*). This distribution describes the sex of the patients from whom the MDR Acinetobacter isolates were recovered and should not be interpreted as indicating a higher risk or greater susceptibility to Acinetobacter infection among male patients, as the sex distribution of the overall ICU patient population was not available.

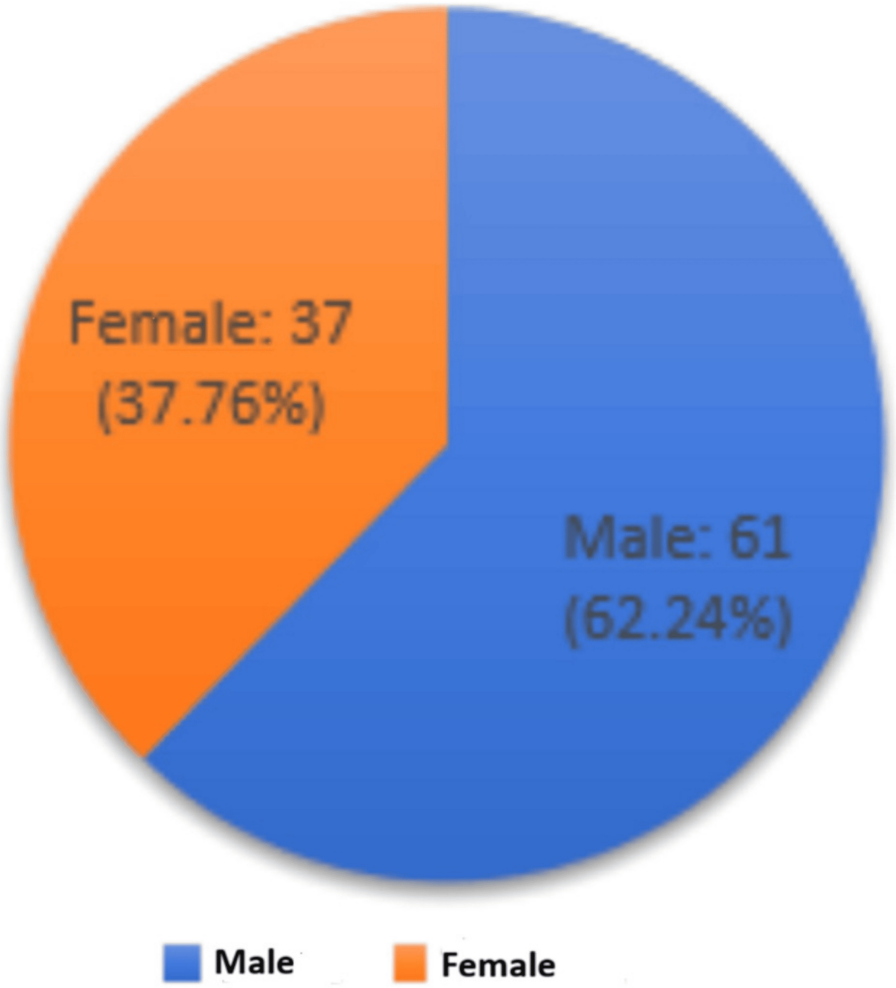


FIGURE 2: Gender-wise distribution of multidrug-resistant Acinetobacter isolates among ICU patients

ICU: intensive care unit

Among the 98 MDR Acinetobacter isolates recovered from ICU patients, *A. baumannii* was the most frequently isolated species, accounting for 92 isolates (93.88%). This was followed by *A. haemolyticus* with five isolates (5.10%), while *A. lwoffii* was the least common species, with only one isolate (1.02%) (Figure 3). These findings demonstrate that *A. baumannii* was the predominant species among MDR Acinetobacter isolates in ICU patients, whereas the other species were isolated less frequently.

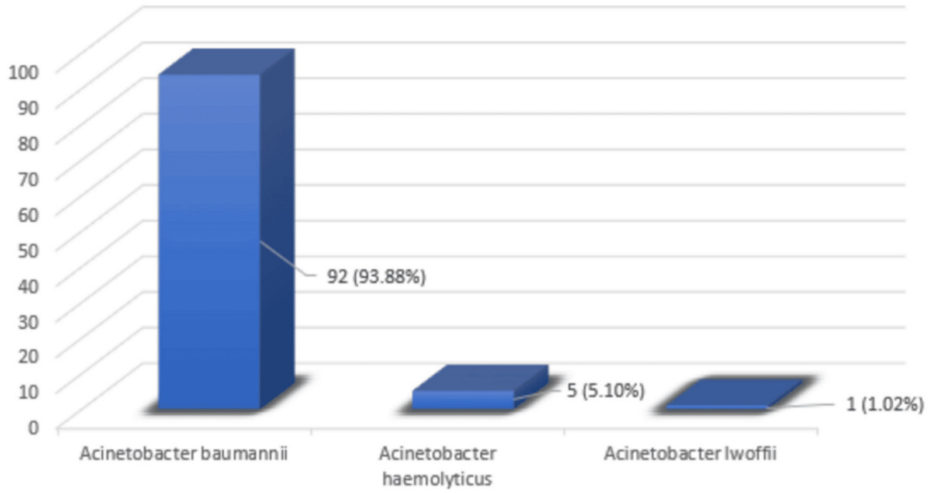


FIGURE 3: Species-wise distribution of MDR Acinetobacter isolates among ICU patients

ICU: intensive care unit; MDR: multidrug-resistant

Among the 98 MDR Acinetobacter isolates recovered from ICU patients, the highest number was obtained from endotracheal tube (ETT) specimens (41), followed by sputum (15) and pus (15). Other specimens included blood (8), urine (7), high vaginal swabs (5), ascitic fluid (3), pleural fluid (2), and cerebrospinal fluid (2). The predominance of isolates from ETT and sputum specimens indicates that the respiratory tract was the major source of Acinetobacter isolation among ICU patients in our study, whereas isolates from other clinical specimens were comparatively less frequent, as presented in Table *2*. However, isolation of Acinetobacter from respiratory specimens, particularly in mechanically ventilated patients, may represent either infection or colonization; therefore, microbiological isolation alone does not establish clinical infection.

Sr. no.	Specimen type	Value, n (%)
1	Endotracheal tube	41 (41.84)
2	Sputum	15 (15.31)
3	Pus	15 (15.31)
4	Blood	8 (8.16)
5	Urine	7 (7.14)
6	High vaginal swab	5 (5.10)
7	Ascitic fluid	3 (3.06)
8	Pleural fluid	2 (2.04)
9	Cerebrospinal fluid	2 (2.04)
Total		98 (100.00)

TABLE 2: Clinical specimen-wise distribution of MDR Acinetobacter isolates among ICU patients

MDR: multidrug-resistant

Among the 98 MDR Acinetobacter isolates recovered from ICU patients, the highest number of isolates was obtained from the medical intensive care unit (MICU), accounting for 53 isolates (54.08%). This was followed by the surgical intensive care unit (SICU), with 17 isolates (17.35%); the emergency intensive care unit (EICU), with 12 isolates (12.24%); and the general ICU, with 10 isolates (10.20%). Lower frequencies were observed in the neuro ICU, with five isolates (5.10%), and the pediatric intensive care unit, with one isolate

(1.02%) (Figure 4). Overall, the MICU accounted for more than half of the MDR Acinetobacter isolates in this study.

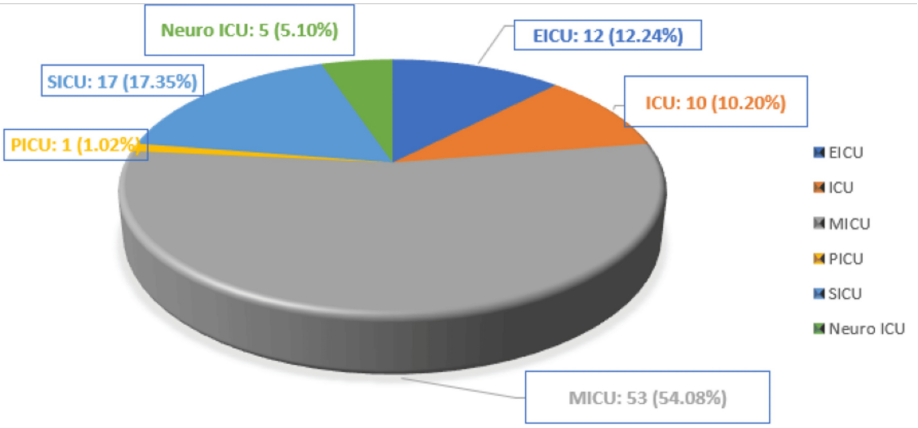


FIGURE 4: ICU-wise distribution of MDR Acinetobacter isolates among ICU patients

MICU: medical intensive care unit; SICU: surgical intensive care unit; EICU: emergency intensive care unit; PICU: pediatric intensive care unit; ICU: intensive care unit; MDR: multidrug-resistant

Figure 5 shows the antimicrobial susceptibility profile of the 98 MDR Acinetobacter isolates. Among the tested antimicrobial agents, minocycline showed the highest susceptibility, with 35 (35.71%) susceptible isolates, followed by trimethoprim-sulfamethoxazole, with 26 (26.53%), and cefoperazone-sulbactam, with 19 (19.39%). Lower susceptibility was observed to amikacin (15; 15.31%), ciprofloxacin (11; 11.22%), gentamicin (10; 10.20%), levofloxacin (8; 8.16%), and ceftazidime (6; 6.12%). Complete resistance was observed to both imipenem and meropenem, with all 98 isolates resistant to these carbapenems. Resistance was also observed to ceftazidime (92; 93.88%), levofloxacin (90; 91.84%), gentamicin (88; 89.80%), ciprofloxacin (87; 88.78%), amikacin (83; 84.69%), cefoperazone-sulbactam (79; 80.61%), trimethoprim-sulfamethoxazole (72; 73.47%), and minocycline (63; 64.29%).

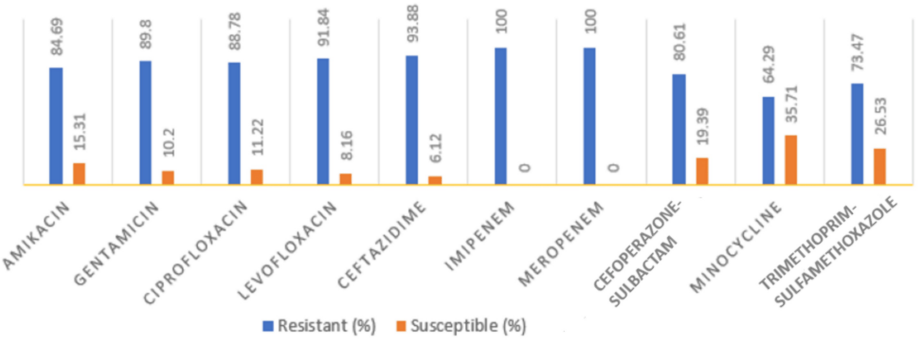


FIGURE 5: Antibiotic susceptibility profile of multidrug-resistant Acinetobacter species isolates

R: resistant; S: susceptible

Discussion

In the present study, 121 Acinetobacter isolates were recovered from ICU patients, of which 98 (80.99%) were classified as MDR. A high burden of MDR Acinetobacter has also been reported from tertiary-care and intensive care settings in India, highlighting the continuing importance of antimicrobial resistance among Acinetobacter isolates in hospitalized patients. Banerjee et al. reported a high prevalence of MDR Acinetobacter spp. in an ICU of a tertiary-care hospital in India [12]. Kumari et al. similarly documented substantial antimicrobial resistance among Acinetobacter isolates in a level-I trauma center in India [13]. These findings support the importance of continued local surveillance of antimicrobial resistance in ICU settings [12,13].

In the present study, the highest number of Acinetobacter isolates was recovered from patients aged 31-40 years (31; 25.62%), followed by those aged 41-50 years (29; 23.97%) and 51-60 years (21; 17.36%). Kumari et al. reported that adult patients constituted the majority of Acinetobacter isolates in their surveillance study [13]. The higher frequency of isolates among adult patients in the present study may reflect the greater representation of critically ill adults requiring intensive care and invasive medical interventions. However, the present study did not specifically evaluate age as an independent risk factor for MDR Acinetobacter infection.

Gender-wise analysis in the present study showed a male predominance, with 61 (62.24%) MDR Acinetobacter isolates recovered from male patients compared with 37 (37.76%) from female patients. A similar male predominance was reported by Kumari et al., who observed that 83.7% of *Acinetobacter* isolates were recovered from male patients [13]. The observed male predominance in the present study should, however, be interpreted cautiously because the study was descriptive and did not assess sex-specific risk factors or adjust for differences in ICU admission patterns.

Among the 98 MDR Acinetobacter isolates in the present study, *A. baumannii* was the predominant species, accounting for 92 (93.88%) isolates, followed by *A. haemolyticus* (5; 5.10%) and *A. lwoffii* (1; 1.02%). Similar species predominance has been reported in Indian studies. Kumari et al. reported *A. baumannii* as the predominant species, accounting for 98.5% of Acinetobacter isolates [13]. More recently, Rangineni et al. also identified *A. baumannii* as the most prevalent species among clinical Acinetobacter isolates in a tertiary-care hospital in India [14]. The predominance of *A. baumannii* in the present study is therefore consistent with findings from other tertiary-care settings [13,14].

In the present study, ETT specimens constituted the most common source of MDR Acinetobacter isolates, accounting for 41 (41.84%) isolates, followed by sputum and pus, with 15 (15.31%) isolates each. Similar findings have been reported by Kumari et al., who identified tracheal aspirates as an important clinical specimen yielding Acinetobacter isolates [13].

Puttegowda et al. also specifically investigated *A. baumannii* recovered from endotracheal aspirates in a tertiary-care ICU in South India, supporting the importance of respiratory specimens as a source of Acinetobacter isolation in ICU settings [15]. The predominance of respiratory specimens in the present study may reflect the frequent use of mechanical ventilation and airway instrumentation among critically ill patients; however, we did not specifically evaluate these factors.

The ICU-wise distribution showed that the MICU contributed the highest proportion of MDR Acinetobacter isolates, accounting for 53 (54.08%), followed by the SICU with 17 (17.35%), EICU with 12 (12.24%), general ICU with 10 (10.20%), Neuro ICU with 5 (5.10%), and Pediatric ICU with 1 (1.02%) isolate.

Previous studies have demonstrated a substantial burden of MDR Acinetobacter in intensive care settings. Banerjee et al. reported a high prevalence of MDR Acinetobacter in an ICU of a tertiary-care hospital [12]. The multicenter IMPRES study also documented a considerable burden of antimicrobial-resistant Gram-negative bacterial infections among ICU patients across India [16]. The higher number of isolates observed in the MICU in the present study may reflect differences in patient characteristics, duration of ICU stays, invasive procedures, and antimicrobial exposure; however, these factors were not independently assessed.

The antimicrobial susceptibility profile demonstrated high levels of resistance among the 98 MDR Acinetobacter isolates to most of the tested antimicrobial agents. Resistance was highest to imipenem and meropenem (100% each), followed by ceftazidime (93.88%), levofloxacin (91.84%), gentamicin (89.80%), ciprofloxacin (88.78%), amikacin (84.69%), cefoperazone-sulbactam (80.61%), trimethoprim-sulfamethoxazole (73.47%), and minocycline (64.29%).

High levels of antimicrobial resistance among Gram-negative bacterial isolates have also been reported from Indian tertiary-care and intensive care settings [16]. Kumari et al. documented high resistance to several commonly used antimicrobial agents among Acinetobacter isolates from a level-I trauma center in India [13]. The IMPRES study similarly reported substantial resistance among Gram-negative bacterial isolates recovered from Indian ICUs. These findings demonstrate the considerable antimicrobial-resistance burden in critical-care settings [16].

The high antimicrobial resistance observed in the present study is consistent with recent Indian studies reporting substantial resistance among clinical Acinetobacter isolates. Rangineni et al. reported a high burden of multidrug resistance and substantial antimicrobial resistance among clinical *Acinetobacter* isolates in a tertiary-care hospital [14]. Puttegowda et al. also reported considerable antimicrobial resistance among *A. baumannii* isolates recovered from endotracheal aspirates in a tertiary-care ICU in South India [15]. The findings from these studies are consistent with the continuing burden of antimicrobial resistance among Acinetobacter isolates in Indian healthcare settings.

The high level of antimicrobial resistance observed in the present study emphasizes the importance of performing antimicrobial susceptibility testing before selecting definitive antimicrobial therapy. Continuous

local antimicrobial-resistance surveillance can assist clinicians in developing institution-specific treatment strategies and antimicrobial stewardship programs. The persistence of MDR Acinetobacter in ICU environments also highlights the importance of appropriate infection prevention and control practices, particularly among patients requiring invasive devices and prolonged intensive care. Institution-specific surveillance is important because antimicrobial susceptibility patterns may vary between hospitals and patient populations.

The present study demonstrates a substantial burden of MDR Acinetobacter among ICU-derived clinical isolates, with *A. baumannii* being the predominant species and respiratory specimens representing the major source of isolation. Similar findings from Indian tertiary-care and ICU studies support the importance of continued laboratory-based surveillance of Acinetobacter resistance patterns. The observed resistance profile highlights the need for routine antimicrobial susceptibility testing, rational antimicrobial use, antimicrobial stewardship, and strict infection prevention and control measures in ICU settings. These measures may help reduce the selection and transmission of MDR Acinetobacter and support more appropriate management of affected patients.

Limitations

This study has some limitations. It was carried out in a single tertiary care hospital and included only patients admitted to the ICU, so the findings may not represent other hospitals or patient populations. Molecular tests to identify the genes responsible for carbapenem resistance were not performed. In addition, patient follow-up, treatment outcomes, and long-term clinical outcomes were not included in this study. Despite these limitations, the study provides useful information on the prevalence of MDR Acinetobacter, its antimicrobial susceptibility pattern, and carbapenem resistance among ICU patients. These findings may help improve antibiotic selection, infection control practices, and antimicrobial stewardship in hospitals.

Conclusions

This study demonstrated a high proportion of MDR Acinetobacter isolates among the clinical Acinetobacter isolates recovered from ICU patients, with *A. baumannii* identified as the predominant species. MDR Acinetobacter isolates were most frequently recovered from patients aged 31-60 years and showed a male predominance. Respiratory specimens, particularly ETT samples, were the predominant source of Acinetobacter isolation, and the highest number of isolates was recovered from the MICU.

The antimicrobial susceptibility pattern revealed high resistance to commonly used antibiotics, with complete resistance to imipenem and meropenem, indicating a high burden of carbapenem resistance. Minocycline showed the highest susceptibility rate among the tested antimicrobial agents, followed by trimethoprim-sulfamethoxazole and cefoperazone-sulbactam. Overall, these findings emphasize the importance of routine antimicrobial susceptibility testing, continuous surveillance, strict infection prevention and control practices, and effective antimicrobial stewardship programs to reduce the spread of MDR Acinetobacter and support appropriate patient management in the ICU.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Devika G. Bhati, Harsha V. Patil, Satish Patil

Acquisition, analysis, or interpretation of data: Devika G. Bhati, Harsha V. Patil

Drafting of the manuscript: Devika G. Bhati, Harsha V. Patil, Satish Patil

Critical review of the manuscript for important intellectual content: Devika G. Bhati, Harsha V. Patil, Satish Patil

Supervision: Harsha V. Patil, Satish Patil

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee of Krishna Vishwa Vidyapeeth (Deemed to Be University) issued approval KVV/IEC/05/2024. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years

with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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