Original Article

DOI: 10.7860/JCDR/2026/88281.23864

Clinical Profile and Outcome in Patients Infected with Carbapenem-resistant *Acinetobacter baumannii* Infection in ICU Setting: A Prospective Observational Study

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ABSTRACT

Introduction: Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) causes hospital-acquired infections in Intensive Care Units (ICU), with high resistance and mortality in critically ill patients. It is a major problem in healthcare, especially where infection control and monitoring are limited. Few treatment options exist, so early identification of risk factors is needed for appropriate patient management.

Aim: To evaluate the clinical profile, risk factors, treatment patterns, and outcomes of ICU patients with CRAB infection.

Materials and Methods: This prospective observational study was conducted in the Department of General Medicine at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka, India from January to December 2024. Adult ICU patients (≥18 years) with culture-confirmed CRAB infection were enrolled consecutively. Data were obtained from medical records and laboratory systems from admission until discharge or death. Clinical evaluation included demographics, co-morbidities, antibiotic exposure, ICU factors, laboratory findings, and severity scores (APACHE II, qSOFA, NEWS2). Identification and susceptibility testing used standard microbiological methods. Data analysis was performed using IBM SPSS Statistics version 25.0. Associations were assessed using Chi-square with a p-value <0.05 considered statistically significant.

Results: Fifty adult ICU patients with culture-confirmed CRAB infection were included. Males accounted for 34 (68%) of the study population, while females accounted for 16 (32%). Hypertension was present in 16 (32%) and diabetes mellitus in 13 (26%). Antibiotic exposure occurred in 44 (88%), most for 4-7 days in 28 (56%). ICU stay >14 days was seen in 17 (34%), and invasive procedures in 37 (74%). Pneumonia was the most common infection in 27 (54%). Colistin sensitivity was noted in 25 (50%) and pan-resistance in 20 (40%). Clinical improvement occurred in 25 (50%), while mortality was 20 (40%). NEWS2 showed the highest prognostic value {Area under the Receiver Operating Characteristic Curve (AUC) 0.774, sensitivity 85%, p=0.004}.

Conclusion: CRAB infection in ICU patients is associated with high mortality and limited treatment options, with frequent pan-resistance. NEWS2 outperformed APACHE II and qSOFA in mortality prediction. High antibiotic exposure and prolonged ICU stay highlight the need for strict antimicrobial stewardship and infection control.

Keywords: Colistin resistance, Intensive care unit Urinary tract infections, Ventilator-associated pneumonia

INTRODUCTION

Antimicrobial Resistance (AMR) is a global health problem. The World Health Organisation (WHO) defines AMR as the ability of microorganisms, including bacteria, viruses, fungi, and parasites, to survive drugs that were once effective, leading to persistent infection and continued spread [1]. This reduces treatment effectiveness, prolongs illness, and increases mortality in hospitalised patients. *Acinetobacter baumannii* is an important healthcare-associated pathogen because it can resist many antibiotics, including carbapenems. WHO classifies CRAB as a priority pathogen that needs further research and development of new treatment approaches [2,3]. It is a non-fermenting, aerobic, gram-negative coccobacillus that has evolved from an environmental organism into a cause of hospital-acquired infection. It occurs in critically ill and immunocompromised patients in ICUs with invasive procedures, mechanical ventilation, or prolonged hospitalisation [4].

The CRAB develops through multiple molecular mechanisms. These include production of carbapenem-hydrolysing enzymes such as OXA-type carbapenemases and Metallo-B-Lactamases (MBL), along with efflux pump overexpression, porin alterations, and target site modification. These changes allow survival against β-lactam antibiotics and other antimicrobial classes [5]. The spread of carbapenem-resistant strains in hospitals has increased therapeutic difficulty, with inadequate treatment options and poor clinical outcomes in patients [6]. Patients on prolonged mechanical ventilation, invasive devices, or prior broad-spectrum antibiotics are at higher risk [7,8]. The organism may colonise before infection develops, making differentiation difficult in critically ill patients and leading to inappropriate antibiotic use and selection of resistant strains [9,10].

The evaluation of patient outcomes in CRAB infection provides adequate information on the severity and prognosis of the disease. The duration of ICU stay, severity scores like APACHE II, qSOFA, and Glasgow Coma Scale, with laboratory findings of organ dysfunction, are associated with mortality risk [11]. Delay in effective antimicrobial therapy is associated with poorer outcomes thus highlighting the role of early microbiological diagnosis and appropriate treatment [12,13]. Infection control measures, including hand hygiene, environmental cleaning, patient isolation, and careful antibiotic use can help to reduce the transmission and resistance [9].

International surveillance data demonstrate widespread distribution of CRAB in many regions. The resistance rates exceed 77 to 87% in parts of Asia, Latin America, and Europe, with the majority of infections occurring in hospitalised patients receiving intensive care. Ventilator-associated pneumonia and bloodstream infections are the most frequently reported clinical manifestations [6]. In India, tertiary care hospitals report carbapenem resistance rates

of 60-80% among *A. baumannii* isolates. Surveillance data show multidrug-resistant strains as major causes of ventilator-associated pneumonia and hospital-acquired infections. Molecular studies report predominance of OXA-type carbapenemases, mainly OXA-23 and OXA-51, contributing to resistance patterns in clinical isolates [11].

Assessment of prognostic performance of these scores with microbiological resistance profiles and treatment response within a single patient group is uncommon. The present study evaluates dynamic physiological severity scores with resistance profiles and antibiotic regimens. The findings enable early risk stratification and guide antimicrobial use in resource-limited ICU care. This study aimed to evaluate the clinical profile and outcomes of patients with CRAB infection in ICU.

The primary objective of the study was to evaluate the clinical profile, risk factors, and 28-day outcomes (including mortality and clinical improvement) in adult ICU patients with culture-confirmed CRAB infection and the secondary objectives were to determine the antibiotic susceptibility pattern of CRAB isolates, with emphasis on colistin sensitivity and pan-resistance, to assess and compare the prognostic performance of APACHE II, qSOFA, and NEWS2 scores for mortality prediction, to evaluate the association between prior antibiotic exposure, invasive procedures, and the occurrence of CRAB infection and to compare clinical outcomes across different antibiotic regimens, including colistin, tigecycline, and combination therapy.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Medicine at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka, India with patient recruitment in the ICU from January to December 2024. Ethical approval was obtained from the Institutional Ethics Committee of Jawaharlal Nehru Medical College, Belagavi (Ref no.-MDC/JNMCIEC/234). Written informed consent was obtained from patients or legally authorised representatives, and confidentiality of all patient data was maintained.

Sample size calculation: A total of 50 patients were included in the study. Sample size was calculated using the formula $n = (Z^2 \times p \times q) / d^2$, with mortality prevalence of 56% reported by Dey S et al., (2023) [12], 95% confidence level (Z=1.96), and precision of 15%, giving a value of 43. The sample size was increased to 50 to account for incomplete records and loss of data during follow-up, and to improve subgroup analysis. Consecutive sampling was used, and all eligible ICU patients were enrolled during the study period.

Inclusion and Exclusion criteria: Inclusion criteria included adults ≥18 years with culture-confirmed *A. baumannii* from clinical specimens and carbapenem resistance based on Clinical and Laboratory Standards Institute (CLSI) guidelines [13]. Exclusion criteria included age <18 years, polymicrobial infections, incomplete records, and lack of consent.

Study Procedure

Data were obtained from electronic ICU records, physician notes, nursing charts, and laboratory systems. Data extraction used existing medical records within a prospective observational framework, where patients were enrolled consecutively on meeting inclusion criteria during January to December 2024, and outcomes were followed from the time of diagnosis. The collection started at ICU admission and continued until discharge or death. Co-morbidities were identified from documented diagnoses or treatment history and included diabetes mellitus, chronic kidney disease, chronic liver disease, chronic obstructive pulmonary disease, malignancy, hypertension, and immunocompromised states. Clinical risk factors were defined using standard criteria. Previous hospitalisation was defined as admission within the past 90 days. Prolonged ICU stay was defined as more than seven days before culture positivity. Antibiotic exposure was defined as use of systemic broad-spectrum antibiotics within two weeks. Mechanical ventilation referred to invasive ventilation through an endotracheal tube or tracheostomy. Indwelling devices included central venous, urinary, or arterial lines present for more than 48 hours, while haemodialysis referred to renal replacement therapy during admission.

The physiological parameters were recorded at ICU admission, at culture positivity, and daily during ICU stay, including pulse rate, respiratory rate, mean arterial pressure, temperature, and oxygen saturation. Disease severity was assessed using APACHE II [14], Qsofa scores [15] and NEWS2 [16] at admission and repeated every 24 hours, while laboratory investigations included complete blood count, renal and liver function tests, arterial blood gas analysis, C-reactive protein, and procalcitonin levels.

Organ dysfunction included respiratory involvement when invasive mechanical ventilation was required or when the PaO_2/FiO_2 ratio was less than 300. Renal dysfunction was defined as serum creatinine ≥2 mg/dL or need for dialysis. Cardiovascular dysfunction was identified when vasopressors were required to maintain mean arterial pressure ≥65 mmHg. Ventilator dependence was defined as continued mechanical ventilation beyond 48 hours after confirmation of infection. Mortality was defined as all-cause in-hospital death during ICU stay [17]. Patients were followed daily from diagnosis until discharge or death. Clinical course, complications, changes in antimicrobial therapy, and organ dysfunction were recorded systematically during hospitalisation.

Microbiological Procedures: Clinical specimens were collected using aseptic technique from multiple sources including blood cultures (primary specimens), respiratory tract specimens (endotracheal aspirates, bronchoalveolar lavage), urine samples, wound swabs, and Cerebrospinal Fluid (CSF) when clinically indicated. Blood cultures were collected in aerobic and anaerobic culture bottles (BACTEC or BacT/ALERT systems). Respiratory specimens were obtained from mechanically ventilated ICU patients. Urine samples were collected via catheterised specimens, and wound swabs from infected surgical or pressure ulcer sites and processed according to standard microbiology procedures. Samples were transported to the microbiology laboratory in sterile, leakproof containers maintained at appropriate temperatures (blood cultures at room temperature; respiratory and wound specimens at 4°C) and processed within 30 minutes of collection to maintain specimen viability and minimise contamination risks. Cultures were performed on blood agar and MacConkey agar and incubated at 37°C for 24-48 hours. The organism was identified using colony morphology, Gram staining, and biochemical tests including oxidase negativity, catalase positivity, non-motility, and indole negativity. Automated confirmation using VITEK 2 Compact (bioMérieux, France) or MALDI-TOF mass spectrometry (Bruker Daltonics, Germany) was performed when initial biochemical identification results were equivocal or when organism identification required confirmation to achieve species-level identification accuracy. VITEK 2 Compact was employed for routine clinical isolates, while MALDI-TOF was used for fastidious organisms or when rapid turnaround time was clinically necessary for timely antimicrobial therapy decisions. Antimicrobial susceptibility testing was done using the Kirby-Bauer disk diffusion method [18] on Mueller-Hinton agar following Clinical and Laboratory Standards Institute (2023) guidelines [13]. Isolates were tested against three carbapenem agents including meropenem (10 µg disk), imipenem (10 µg disk), and ertapenem (10 µg disk) according to CLSI M100 interpretive criteria. Isolates were considered carbapenem-resistant when non-susceptible (resistant or intermediate) to at least one of these carbapenem agents. Carbapenemase production was assessed using a sequential three-method approach to ensure comprehensive detection of carbapenemase-producing strains: 1) Modified Hodge Test was retained as an initial screening method as

it provides cost-effective, readily available preliminary detection in resource-limited settings and serves as a reference for comparison with molecular confirmation; 2) Carba NP test (rapid chromogenic test) [19] was employed as the primary confirmatory method due to its superior sensitivity (>95%) and specificity for active carbapenemase detection, requiring only two hours for results; and 3) EDTA disk synergy test [20] was used for phenotypic differentiation of MBL producers from other carbapenemase types (OXA and KPC). This multi-method approach ensures accurate identification of carbapenemase-producing mechanisms, which is essential for determining appropriate antimicrobial therapy and infection control measures in ICU settings. Quality control strains included *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853, which were processed simultaneously with clinical isolates to ensure validity and accuracy of all testing procedures.

STATISTICAL ANALYSIS

Data analysis was performed using IBM SPSS Statistics version 25.0. The variables were expressed as mean±standard deviation or frequencies and percentages, with associations assessed using the Chi-square test at $p<0.05$.

RESULTS

The demographic distribution of ICU patients with CRAB infection (n=50) indicates that the majority of cases occurred in older age groups, with 3 (6%) of patients being above 80 years, while no cases were observed in individuals below 20 years of age. In terms of gender distribution, males constituted 68% of the study population, whereas females accounted for 16 (32%), demonstrating a clear male predominance among the infected patients [Table/Fig-1].

Variables	Category	n	%
Age (years)	≤20	0	0.00
	21-40	13	26.00
	41-60	19	38.00
	61-80	15	30.00
	>80	3	6.00
Sex	Female	16	32.00
	Male	34	68.00

[Table/Fig-1]: Demographic characteristics of patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection in ICU (n=50).

The distribution of co-morbidities among ICU patients with CRAB infection showed that hypertension was the most common condition 16 (32%), followed by type 2 diabetes mellitus 13 (26%). A high proportion of patients 44 (88%) had a history of antibiotic use within the preceding 90 days, most commonly for a duration of 4-7 days 28 (56%). Among the antibiotics administered, beta-lactams 27 (54%) and carbapenems 21 (42%) were the most frequently used classes [Table/Fig-2].

The ICU-related risk factors among patients with CRAB infection revealed that the duration of ICU stay prior to organism isolation was most commonly greater than 14 days (34%), followed by 8-14 days (26%), 4-7 days (24%), and 0-3 days (16%). Additionally, a substantial proportion of patients (74%) had undergone invasive procedures, indicating a strong association between such interventions and infection risk [Table/Fig-3].

The clinical presentation of patients with CRAB infection most commonly included altered sensorium (40%) and fever (32%). The predominant underlying diagnosis was intracranial haemorrhage (92%), followed by pneumonia (38%) and septic shock (14%) [Table/Fig-4].

The distribution of infections among patients with CRAB revealed pneumonia as the most common infection (54%), followed by sepsis (22%) and urinary tract infection (20%). The predominant sources of isolates were blood (28%) and endotracheal samples (22%). Notably, colistin susceptibility was observed in 50% of the isolates [Table/Fig-5].

Variables	Category	n (%)
Co-morbidities	Hypertension	16 (32)
	Type 2 diabetes mellitus	13 (26)
	Cerebrovascular accident	4 (8)
	COPD	2 (4)
	Ischaemic heart disease	2 (4)
	Malignancy	2 (4)
	Other co-morbidities*	6 (12)
Prior antibiotic exposure (within 90 days)	Yes	44 (88)
	No	6 (12)
Duration of prior antibiotic therapy (days)	None	6 (12)
	1-3	13 (26)
	4-7	28 (56)
	>7	3 (6)
Prior antibiotic class exposure	Fluoroquinolones	3 (6)
	Beta-lactams	27 (54)
	Carbapenems	21 (42)

[Table/Fig-2]: Co-morbidities and prior antibiotic exposure among patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection in ICU (n=50).
*Other co-morbidities include interstitial lung disease, chronic liver disease, dermatomyositis, hypothyroidism, hyperhomocysteinemia, chronic kidney disease, pregnancy, and status epilepticus (each n=1)

Variables	Category	n (%)
Duration of ICU stay before CRAB isolation (days)	0-3	8 (16)
	4-7	12 (24)
	8-14	13 (26)
	>14	17 (34)
Invasive procedures	Yes	37 (74)
	None	13 (26)

[Table/Fig-3]: ICU-related risk factors among patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection (n=50).
Footnote: ICU: Intensive care unit; CRAB: Carbapenem-resistant *Acinetobacter baumannii*

Variables	Category	n (%)
Clinical presentation at detection	Altered sensorium (including drowsiness)	20 (40)
	Fever	16 (32)
	Breathlessness/dyspnea	7 (14)
	Headache	7 (14)
	History of road traffic accident	6 (12)
	Limb weakness	5 (10)
	Urinary symptoms (burning micturition)	3 (6)
	Cough	3 (6)
	Abdominal pain	2 (4)
	Other symptoms*	6 (12)
Primary diagnosis	Intracranial haemorrhage	46 (92)
	Pneumonia	19 (38)
	Septic shock	7 (14)
	Road traffic accident /severe head injury	5 (10)
	Pyelonephritis	3 (6)
	Other diagnoses†	9 (18)

[Table/Fig-4]: Clinical presentation and primary diagnoses among patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection in ICU (n=50).
Other symptoms include ascites, seizures, vomiting, slurring of speech, blackish discoloration of fingers, and history of carbamate poisoning (each n=1). †Other diagnoses include hypovolemic shock, metabolic encephalopathy, carbamate poisoning, alcoholic liver disease, antepartum eclampsia, bronchiectasis, carcinoma oesophagus, post-LSCS state, foot ulcer post-debridement, left shaft fracture, wet gangrene of upper limb, post-temporal lobe abscess, and subacute bacterial peritonitis (each n=1); Patients may have had more than one primary diagnosis

Variables	Category	n (%)
Type of infection	Pneumonia	27 (54)
	Sepsis	11 (22)
	Urinary tract infection (UTI)	10 (20)
	Meningitis	1 (2)
	Peritonitis	1 (2)
	Acute suppurative otitis media	1 (2)
Site of sample collection	Blood culture	14 (28)
	Endotracheal culture	11 (22)
	Urine	10 (20)
	Sputum	9 (18)
	Central line	4 (8)
	Other sites*	4 (8)
Antibiotic susceptibility profile	Colistin	25 (50)
	Pan-resistant isolates	20 (40)
	Tobramycin	4 (8)
	Levofloxacin	3 (6)
	Tetracycline	3 (6)
	Gentamicin	2 (4)
	Trimethoprim-sulfamethoxazole	2 (4)
	Amikacin	2 (4)

[Table/Fig-5]: Infection characteristics, specimen source, and antibiotic susceptibility profile of Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) isolates in ICU (n=50).
Other specimen sources include tracheostomy, pleural fluid, peritoneal collection, cerebrospinal fluid, and ear discharge (each n=1)

The severity score distribution showed that most patients had lower APACHE II scores, with 44% in the 0-9 range and 40% in the 10-19 range. A qSOFA score of 2-3 was observed in 34% of cases, while NEWS2 scores ≥7 were present in 46% of patients, indicating a considerable proportion of patients with high clinical severity [Table/Fig-6].

Score	Category	n (%)
APACHE II	0-9	22 (44)
	10-19	20 (40)
	20-29	7 (14)
	≥30	1 (2)
qSOFA	0-1	33 (66)
	2-3	17 (34)
NEWS2	0-4	18 (36)
	5-6	9 (18)
	≥7	23 (46)

[Table/Fig-6]: Distribution of severity scores among patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection in ICU (n=50).
APACHE II: Acute physiology and chronic health evaluation II; qSOFA: quick Sequential organ failure assessment; NEWS2: National early warning score 2; ICU: Intensive care unit.

The laboratory findings showed that haemoglobin levels were predominantly in the range of 10-11.9 g/dL (44%), with a mean value of 10.30 g/dL. Platelet counts were ≥150 ×10³/µL in 78% of patients. The white blood cell count was elevated, with a mean of 14.46 ×10³/µL, indicating leukocytosis. Serum creatinine levels were ≤1.29 mg/dL in 72% of cases. Electrolyte analysis revealed that sodium and potassium levels were mostly within normal limits [Table/Fig-7].

The antibiotic therapy and outcome analysis revealed that tigecycline (26%) and colistin (24%) were the most commonly used agents. Clinical improvement was observed in 53.8% of patients treated with tigecycline and 50% with colistin. Combination therapy demonstrated an improvement rate of 46.2%, along with a mortality rate of 53.8%. Regimens involving ceftazidime-avibactam were associated with a mortality rate 55.6%, while amikacin and other salvage therapies were linked to higher mortality outcomes [Table/Fig-8].

Parameters	Category/Range	n (%)	Mean±SD
Haemoglobin (g/dL)	<7	3 (6)	10.30±2.16
	7-9.9	15 (30)	
	10-11.9	22 (44)	
	≥12	10 (20)	
Platelet count (×10³/µL)	<50	2 (4)	806.66±392.65
	50-99	3 (6)	
	100-149	6 (12)	
	≥150	39 (78)	
White blood cell count (×10³/µL)	<4.0	0 (0)	14.46±7.22
	4.0-11.0	16 (32)	
	11.1-15.0	15 (30)	
	15.1-30.0	17 (34)	
	>30.0	2 (4)	
Serum creatinine (mg/dL)	≤1.29	36 (72)	1.12±0.68
	1.3-1.99	8 (16)	
	2.0-2.99	4 (8)	
	≥3.0	2 (4)	
Serum sodium (mEq/L)	<130	3 (6)	139.78±9.24
	130-134	8 (16)	
	135-145	33 (66)	
	146-150	1 (2)	
	151-160	3 (6)	
	>160	2 (4)	
Serum potassium (mEq/L)	<3.0	1 (2)	4.02±0.62
	3.0-3.49	9 (18)	
	3.5-5.0	38 (76)	
	5.1-5.59	1 (2)	
	5.6-6.0	1 (2)	
	>6.0	0 (0)	

[Table/Fig-7]: Haematological and biochemical laboratory parameters among patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection in ICU (n=50).
Footnote: ICU: Intensive care unit; SD: Standard deviation

Antibiotic regimen	n (%)	Improved n (%)	Expired n (%)	AMA n (%)	Unchanged n (%)
Colistin	12 (24)	6 (50.0)	6 (50.0)	0	0
Tigecycline	13 (26)	7 (53.8)	6 (46.2)	0	0
Colistin + Tigecycline	13 (26)	6 (46.2)	7 (53.8)	0	0
Ceftazidime + Avibactam	9 (18)	3 (33.3)	5 (55.6)	1 (11.1)	1 (11.1)
Ceftazidime + Avibactam + Aztreonam	5 (10)	2 (40.0)	3 (60.0)	0	0
Ceftazidime + Avibactam + Vancomycin	2 (4)	1 (50.0)	0	1 (50.0)	0
Aztreonam	1 (2)	1 (50.0)	0	0	0
Amikacin	3 (6)	1 (33.3)	2 (66.7)	0	0
Cefoperazone + Sulbactam	1 (2)	1 (100)	0	0	0
Multiple drug salvage regimens*	2 (4)	0	2 (100)	0	0
No active antibiotic (–)	18 (36)	10 (55.6)	7 (38.9)	1 (5.6)	0

[Table/Fig-8]: Antibiotic therapy administered and clinical outcomes among ICU patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection (n=50).
AMA: Against medical advice; ICU: Intensive care unit; Multiple drug salvage regimens refer to individualised combinations used in refractory infections; Patients may have received more than one regimen sequentially

The clinical outcomes demonstrated an improvement rate of 50% and a mortality rate of 40% among the study population. In terms of prognostic performance, the NEWS2 score showed the highest predictive value with an AUC of 0.774 and a sensitivity of 85%, followed by qSOFA and APACHE II scores [Table/Fig-9].

Variables	Category	n (%)	AUC	Sensitivity (%)	Specificity (%)	χ^2	p-value
Clinical outcome	Improved	25 (50)	–	–	–	–	–
	Expired	20 (40)	–	–	–	–	–
	AMA	4 (8)	–	–	–	–	–
	Unchanged	1 (2)	–	–	–	–	–
APACHE II score	Prognostic performance	–	0.698	75.0	50.0	16.766	0.053
qSOFA score	Prognostic performance	–	0.656	55.0	80.0	8.512	0.037
NEWS2 score	Prognostic performance	–	0.774	85.0	63.3	19.300	0.004
Follow-up vs outcome	Association	–	–	–	–	35.755	<0.001

[Table/Fig-9]: Clinical outcome and prognostic performance of severity scores among ICU patients with Carbapenem-Resistant *Acinetobacter baumannii* (CRAB) infection (n=50)
Chi-square test was used; ICU: Intensive care unit; AMA: Against medical advice; AUC: Area under the receiver operating characteristic curve; APACHE II: Acute physiology and chronic health evaluation II; qSOFA: quick Sequential organ failure assessment; NEWS2: National early warning score 2

DISCUSSION

The CRAB is a serious problem in ICUs due to high resistance and increased mortality. The present study evaluated the clinical profile, risk factors, microbiological characteristics, treatment patterns, and outcomes in ICU patients with CRAB infection, highlighting its occurrence predominantly in critically ill individuals with multiple co-morbidities, prior antibiotic exposure, and prolonged ICU stay. The age distribution showed predominance of patients aged 41-60 years (38%) and 61-80 years (30%). This has been documented in previous reports and is in concordance with the present study [21]. A multicentre study reported a mean age of 66.6 years in patients with CRAB bloodstream infections [22].

The clinical presentation included altered sensorium (40%) and fever (32%). Pneumonia was the main infection (54%), followed by sepsis and urinary tract infection. Respiratory and bloodstream infections were frequent, with pneumonia and device-related infections commonly reported in CRAB cases [6,23].

The antibiotic susceptibility profile indicated restricted therapeutic options, with colistin sensitivity in 50% of isolates and 40% showing pan-resistance. Similar resistance trends have been reported in earlier studies, with rising concern regarding increasing pan-resistant strains [24,25]. This high rate of pan-resistance is concerning and exceeds rates reported in some regional studies, indicating an intense selection pressure within our ICU environment [14]. Laboratory findings showed anaemia and leukocytosis in a large proportion, with mean leukocyte count of $14.46\times10^3/\mu L$, indicating an active inflammatory state.

Male predominance (68%) was observed, with males forming a larger proportion of affected patients [26]. Antibiotic exposure within 90 days was high (88%), with most patients receiving treatment for 4-7 days. Beta-lactams (54%) and carbapenems (42%) were commonly used. Antibiotic exposure increases selection of resistant organisms and contributes to CRAB infection. Studies also identify antibiotic use as a major risk factor in ICU patients [27,28], with 46.8% receiving antibiotics before bloodstream infection [26]. Studies with longer durations of broad-spectrum antibiotic use differ from this cohort, where patients received mainly short courses, indicating that limited exposure in the ICU setting can select resistant Acinetobacter strains in critically ill patients. ICU stays longer than 14 days were seen in 34%, and invasive procedures in 74%. Prolonged ICU stay and invasive devices increase colonisation and infection risk [24,29]. Mechanical ventilation and catheter use support biofilm formation and persistence [30-32], with frequent exposure reported in resistant infections [32].

Elevated inflammatory markers and reduced platelet counts have been associated with higher mortality in ICU infections, indicating severe systemic involvement [29]. Severity assessment showed that many patients had moderate APACHE II scores, while 46% had NEWS2 ≥7, indicating physiological instability. Higher severity scores have been associated with adverse outcomes [30]. The analysis included direct comparison of APACHE II, qSOFA, and NEWS2. NEWS2 showed the highest predictive value for mortality (AUC 0.774), with better performance than APACHE II and qSOFA. NEWS2 is simple to calculate and does not require laboratory data, which allows rapid bedside risk stratification. The treatment included colistin and tigecycline as monotherapy or in combination, with limited use of ceftazidime-avibactam and high mortality observed in treatment groups. The colistin and tigecycline monotherapy showed similar outcomes, while combination therapy showed no advantage, and high mortality has been reported in previous studies [27,31]. A multicenter study reported 56.5% mortality in bloodstream infections, higher than the 40% observed here, with colistin-based therapy associated with lower mortality [32]. CRAB infection shows high morbidity and mortality with limited treatment options, and identification of high-risk patients with appropriate therapy can improve survival. The use of NEWS2 at bedside can help in the timely care and guide initial antimicrobial choice in ICU patients. Future work should include larger multicentre studies and evaluation of antimicrobial protocols based on resistance profiles and severity scores to guide clinical management.

Limitation(s)

The study has several limitations, and the findings should be interpreted with caution. These include the single-centre design, relatively small sample size, absence of a control group, variability in treatment regimens and the lack of molecular characterisation of resistance mechanisms.

CONCLUSION(S)

The study demonstrates that CRAB infection in ICU patients is strongly associated with prior antibiotic exposure, invasive procedures, and prolonged ICU stay, contributing to high mortality. Severity scores help identify patients at higher risk of poor outcome. NEWS2 showed better mortality prediction than APACHE II and qSOFA. Judicious antibiotic use and strict infection control practices are essential to limit the emergence and transmission of resistant strains. Colistin-based combination therapy did not show a survival advantage. Further large-scale multicentre studies and evaluation of newer antimicrobial agents are required to improve treatment strategies and patient outcomes.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Feb 18, 2026
- Manual Googling: Apr 06, 2026
- iThenticate Software: Apr 08, 2026 (2%)

ETYMOLOGY: Author Origin

EMENDATIONS: 5

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Feb 16, 2026**
Date of Peer Review: **Apr 08, 2026**
Date of Acceptance: **Apr 10, 2026**
Date of Publishing: **Jul 01, 2026**