Section: Pathology

Original Research Article

AN ANALYSIS OF ACINETOBACTER BAUMANNII SUSCEPTIBILITY PROFILES FROM CLINICAL SPECIMENS FROM INTENSIVE CARE UNITS IN A TERTIARY CARE HOSPITAL

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Received *: 28/05/2026*
Received in revised form *: 22/08/2026*
Accepted *:08/09/2026*

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DOI: 10.70034/ijmedph.2026.3.828

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

Int J Med Pub Health
2026; 16 (3); 5383-5389

ABSTRACT

Background: Acinetobacter baumannii is a member of the group of pathogens referred to as HAPs, as it is an important pathogen in ICUs, where critically ill patients are often exposed to invasive devices, to long hospitalizations and to wide-spectrum antibiotics. Multidrug-resistant and carbapenem-resistant A. baumannii have become major issues in the management of infections acquired in the intensive care unit (ICU). The objective is to analyze the antibiotic susceptibility profiles of Acinetobacter baumannii isolates recovered from clinical specimens of intensive care unit patients.

Materials and Methods: This descriptive cross-sectional study was conducted in the Department of Microbiology in collaboration with the Intensive Care Units of Sheikh Khalifa Bin Zayed Al Nahyan Hospital, Rawalakot. In this study, 72 'clinical isolates of Acinetobacter baumannii' collected from patients in an ICU were included. Demographic data, clinical characteristics, specimen type, ICU category, antibiotic susceptibility pattern, resistance phenotype and patient outcome were recorded. Commonly used antibiotics such as cephalosporins, fluoroquinolones, aminoglycosides, carba penems, tigecycline, minocycline and colistin were tested for antimicrobial susceptibility testing. The isolates were classified into non-MDR, MDR, XDR and PDR. Descriptive statistical analyses were carried out and associations between the clinical parameters and resistant phenotype were evaluated. The differences were statistically significant when they had a p value <0.05.

Results: Among 72 isolates, the mean age of patients was 46.8 ± 17.4 years, and males accounted for 44 (61.1%) cases. Tracheal aspirates were the most common specimen source 30 (41.7%), followed by blood 16 (22.2%), wound/pus swabs 12 (16.7%), urine 10 (13.9%), and catheter tips 4 (5.6%). The highest number of isolates was recovered from the medical ICU 28 (38.9%). High resistance was observed against ceftriaxone 68 (94.4%), ceftazidime 66 (91.7%), cefepime 64 (88.9%), ciprofloxacin 64 (88.9%), meropenem 62 (86.1%), and imipenem 60 (83.3%). Colistin showed the highest sensitivity 68 (94.4%), followed by tigecycline 58 (80.6%) and minocycline 50 (69.4%). Most isolates were MDR 54 (75.0%), while 14 (19.4%) were XDR and 2 (2.8%) were PDR. 'Prior antibiotic exposure (p=0.018)' mechanical ventilation (p=0.021), ICU stay >7 days (p=0.009), and mortality (p=0.032) were significantly associated with resistant A. baumannii phenotype.

Conclusion: Acinetobacter baumannii isolates from ICU clinical specimens showed a high level of resistance to cephalosporins, fluoroquinolones, aminoglycosides, and carbapenems. Colistin, tigecycline, and minocycline retained comparatively better in-vitro activity. Prior antibiotic exposure, mechanical ventilation, prolonged ICU stay, and mortality were significantly associated with resistant isolates. Routine resistance surveillance, strict adherence to infection-control protocols, and rational use of antibiotics can help minimize the spread of resistant A. baumannii among critically ill patients.
Keywords: Acinetobacter baumannii; intensive care unit; antimicrobial resistance; multidrug resistance; carbapenem resistance; colistin; tigecycline.

INTRODUCTION

Acinetobacter baumannii is a Gram-negative, non-fermenting coccobacillus that has emerged as one of the most important pathogens causing healthcare-associated infections. It is a major problem in ICU where the affected individuals are often immunocompromised, stay hospitalized for long periods, have to take a lot of broad-spectrum antibiotics and require invasive devices like urinary catheter, central venous lines and mechanical ventilators. Such conditions are conducive to the establishment, infection and spread of resistant organisms in a hospital environment. According to the Centers for Disease Control and Prevention (CDC), A. baumannii may lead to fatalities in critically ill hospital patients and is responsible for pneumonia, bloodstream and urinary tract infections, and wound infections.[1-3]

A. baumannii is hard to control in hospital settings because it can survive for extended periods of time on dry surfaces and medical equipment. Can live in ICU settings, soil ventilator circuits, bed rails, and the hands of healthcare workers and can play a role in outbreaks of susceptible patients. 'Among individuals receiving intensive care, A. baumannii is frequently linked with lung infections, bloodstream infections, wound involvement, and infections related to indwelling catheters' It is also more likely in those who are mechanically ventilated and those who stay in the ICU for a longer period of time. Hospital-acquired infections (HAIs) in ICUs are also linked to a rise in antibiotic usage, hospital length of stay, expense of the treatment and death rate.[4-6]

A. baumannii has emerged as a serious concern in the world due to antimicrobial resistance. 'It is resistant to several classes of antibiotics such as cephalosporins, fluoroquinolones, aminoglycosides and carbapenems'. Of particular concern is carbapenem resistance, as carbapenems were thought to be key treatments for severe infections with multidrug-resistant (MDR) Gram-negative bacteria. Carbapenem-resistant A. baumannii has been designated as a critical priority pathogen in the World Health Organization 2024 Bacterial Priority Pathogens List.[7, 8]

The rise of A. baumannii isolates with resistance to multiple, nearly all, or all available antibiotic groups has greatly limited treatment choices and made clinical management more difficult. In many hospitals, only minimal treatment options including colistin, tigecycline and minocycline are effective against resistant isolates. There are also limitations to these drugs, such as toxicity, the existence of tissue barriers in their penetration and the development of resistance. Thus, the local susceptibility data is crucial to support empirical and targeted treatments. ICU-specific antibiograms can guide clinicians in selecting the right antibiotic, limit the unnecessary use of broad-spectrum antibiotic therapy and aid in antimicrobial stewardship programs.[9]

Resistant Gram-negative infections are also complicated in Pakistan and other low- and middle-income countries by overcrowded healthcare facilities, scarce resources for infection control, empirical antibiotic use, and late reporting of culture results. Hence, constant surveillance of ICUs isolates is required to gain insight into local trends of resistance and patient management. Susceptibility patterns of A. baumannii from ICU isolates are also useful for hospital infection control committees to develop specific preventive measures.[10]

The present study was conducted to analyze the antibiotic susceptibility profiles of Acinetobacter baumannii isolates recovered from clinical specimens of ICU patients in a tertiary care hospital. The study also assessed the distribution of isolates according to specimen type and ICU category, determined the frequency of MDR, XDR, and PDR phenotypes, and evaluated clinical factors associated with resistant A. baumannii infection.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in the Department of Microbiology in collaboration with the Intensive Care Units of Sheikh Khalifa Bin Zayed Al Nahyan Hospital, Rawalakot. 'The study was carried out over a period of one year, from January 2025 to December 2025' The purpose of the study was to analyze the antibiotic susceptibility profiles of Acinetobacter baumannii isolates recovered from clinical specimens of ICU-admitted patients.

The study included a total of 72 non-duplicate clinical isolates of Acinetobacter baumannii from patients in the ICUs. Clinical samples were obtained from patients admitted to various intensive care units: medical intensive care unit, surgical intensive care unit, neonatal intensive care unit, pediatric intensive

care unit and isolation intensive care unit. The samples consisted of tracheal aspirates, blood, wound/pus swabs, urinary samples and catheter tips. The first isolate was taken from each patient to prevent multiple testing of the same results. Samples were excluded when they were repeat isolates from the same patient, were not properly labeled, or were contaminated, or when clinical or laboratory data were incomplete.

The required patient details and clinical findings were recorded on a predesigned data collection form. Data collected included age, sex, type of intensive care unit, length of stay in an intensive care unit, mechanical ventilation, central venous catheterization, urinary catheterization, previous antibiotic exposure, comorbid conditions, type of clinical specimen, antibiotic resistance and patient outcome. Prior antibiotic exposure was identified as use of any systemic antibiotic before isolation of A. baumannii in the same hospital admission. An ICU stay of more than 7 days was considered to be prolonged stay.

Standard microbiological processing was done for all clinical specimens. Blood samples were inoculated into blood culture bottles and incubated as per laboratory protocol. Appropriate media such as blood agar and MacConkey agar were used to culture the tracheal aspirates, wound/pus swabs, urine and catheter tip specimens. Specimens was incubated at 35 + 2 °C for 18 – 24 hrs under aerobic condition. Suspected colonies of Acinetobacter baumannii were determined by the colony morphology, the gram staining, oxidase test and non-lactose fermenting (NLF) appearance on MacConkey agar, and by biochemical reactions using API 20NE. When in doubt, identification was confirmed in additional by an automated bacterial identification system Vitek 2 compact.

MBT was done by disc diffusion method on Muller Hinton Agar against the antimicrobial agents. A bacterial suspension was adjusted to a 0.5 McFarland turbidity standard before it was inoculated. The inoculated agar plates were placed with antibiotic discs and the plates were incubated at 35-37C for 16-18 hours. 'The diameter of inhibition zones was recorded in mm and deemed sensitive, intermediate, or resistant based on Clinical Laboratory Standard Institute (CLSI) guidelines. Intermediate isolates were grouped with the resistant isolates for analysis to give a more conservative interpretation based on clinical data.

The antibiotics tested were ceftriaxone, ceftazidime, cefepime, ciprofloxacin, levofloxacin, meropenem, imipenem, piperacillin-tazobactam, gentamicin, amikacin, trimethoprim-sulfamethoxazole, minocycline, tigecycline, and colistin. Imipenem and meropenem were used to determine carbapenem resistance among the isolates. Following antimicrobial susceptibility testing, each isolate was categorized according to its response to the tested antibiotic groups. Isolates showing resistance to several important antimicrobial classes were placed in the MDR category. Those with susceptibility retained to only a very small number of antibiotic groups were categorized as XDR, while isolates resistant to all antibiotics included in the testing panel were classified as PDR.

Standard microbiological procedures, correct media preparation, sterility checks and control strains (as appropriate) were used to ensure quality control during the laboratory procedure. Careful review of culture and susceptibility results was done prior to final data entry. Data was entered into and analyzed using a SPSS version 25.0. Association of resistant A. baumannii phenotype with clinical variables was tested using chi square test or Fisher's exact test. Fisher's exact test was employed in cases of low number of expected cells. The p-value < 0.05 was considered statistically significant.

RESULTS

During the study period, 72 clinical Acinetobacter baumannii were obtained. Patients aged 41 to 60 years had the maximum number of isolates, 30 (41.7%). The incidence of disease was greater among males than females (44 patients; 61.1% male and 28 patients; 38.9% female). Forty-eight (66.7%) patients were found to have been intubated mechanically and 50 (69.4%) were pre-treated with antibiotics. Forty-five (62.5%) patients had stayed in the ICU for more than 7 days.

Table 1: Demographic and clinical characteristics of ICU patients with Acinetobacter baumannii isolates

Variable	Frequency (n)	Percentage (%)
Age group		
≤20 years	6	8.3
'21–40 years'	18	25.0
'41–60 years'	30	41.7
'>60 years'	18	25.0
Gender		
Male	44	61.1
Female	28	38.9
Mechanical ventilation	48	66.7
Central venous catheter	42	58.3
Urinary catheter	46	63.9
Prior antibiotic exposure	50	69.4
ICU stay >7 days	45	62.5
Diabetes mellitus	22	30.6

Chronic kidney disease	10	13.9
Chronic respiratory disease	12	16.7

Isolates by specimen type revealed that most were from tracheal aspirates (30, 41.7%). This was followed by blood cultures 16 (22.2%), wound/pus swabs 12 (16.7%), urine 10 (13.9%), and catheter tips 4 (5.6%). Hence, the highest percentage of A. baumannii were from the respiratory tract specimens.

Table 2: Distribution of Acinetobacter baumannii isolates according to clinical specimens

Specimen type	Frequency (n)	Percentage (%)
Tracheal aspirate	30	41.7
Blood	16	22.2
Wound/Pus swab	12	16.7
Urine	10	13.9
Catheter tip	4	5.6
Total	72	100.0

Results from the distribution of ICU-wise distribution revealed that the highest number of isolates was obtained from the medical ICU which has 28 cases (38.9%). The surgical ICU was followed by the medical ICU with 20 (27.8%) isolates. The neonatal ICU 10 (13.9 %), pediatric ICU 8 (11.1 %) and COVID/isolation ICU 6 (8.3 %) had fewer isolates.

Table 3: ICU-wise distribution of Acinetobacter baumannii isolates

ICU type	Frequency (n)	Percentage (%)
Medical ICU	28	38.9
Surgical ICU	20	27.8
Neonatal ICU	10	13.9
Pediatric ICU	8	11.1
COVID/Isolation ICU	6	8.3
Total	72	100.0

The antibiotic resistance pattern was found to be highly resistant to commonly used antibiotic drugs. Ceftriaxone 68 (94.4%), ceftazidime 66 (91.7%), cefepime 64 (88.9%) and ciprofloxacin 64 (88.9%) demonstrated the highest resistance. There was also high resistance to carbapenems, with 62 (86.1%) isolates being resistant to meropenem and 60 (83.3%) resistant to imipenem. Comparatively best sensitivity was noted for colistin which showed 68 (94.4%) sensitive isolates, followed by tigecycline 58 (80.6%) and minocycline 50 (69.4%).

Table 4: Antibiotic susceptibility profile of Acinetobacter baumannii isolates

Antibiotic	Sensitive n (%)	Resistant n (%)
Ceftriaxone	4 (5.6)	68 (94.4)
Ceftazidime	6 (8.3)	66 (91.7)
Cefepime	8 (11.1)	64 (88.9)
Ciprofloxacin	8 (11.1)	64 (88.9)
Levofloxacin	10 (13.9)	62 (86.1)
Meropenem	10 (13.9)	62 (86.1)
Imipenem	12 (16.7)	60 (83.3)
Piperacillin-tazobactam	14 (19.4)	58 (80.6)
Gentamicin	18 (25.0)	54 (75.0)
Amikacin	22 (30.6)	50 (69.4)
Trimethoprim-sulfamethoxazole	16 (22.2)	56 (77.8)
Minocycline	50 (69.4)	22 (30.6)
Tigecycline	58 (80.6)	14 (19.4)
Colistin	68 (94.4)	4 (5.6)

The overall resistance pattern revealed 54 (75.0%) multidrug-resistant, 14 (19.4%) extensively drug-resistant and 2 (2.8%) pan-drug-resistant isolates. 2 (2.8%) isolates were determined to be non-MDR. The prevalence of carbapenem resistance was high with 62 (86.1%) isolates

Table 5: Resistance pattern among Acinetobacter baumannii isolates

Resistance pattern	Frequency (n)	Percentage (%)
Non-MDR	2	2.8
MDR	54	75.0
XDR	14	19.4
PDR	2	2.8
Total	72	100.0

Isolates were classified into resistance phenotype as MDR, XDR, and PDR isolates and non-MDR phenotype for association analysis. Fisher's exact test was used due to the low number of non-MDR isolates. The resistant A. baumannii isolates were found to be statistically associated with prior antibiotic use, mechanical ventilation and length of stay in the intensive care unit of more than 7 days' duration. 'Patients who had previously used antibiotics (p=0.018), mechanical ventilation (p=0.021) and had a longer stay in the ICU (p=0.009) were more likely to have resistant isolates' The presence of resistant isolates was also significantly associated with mortality (p=0.032). There were no statistically significant associations of resistant phenotype with the use of central venous catheter, urinary catheter, diabetes mellitus, chronic kidney disease, chronic respiratory disease (p>0.05).

Table 6: Association of clinical factors with resistant Acinetobacter baumannii phenotype

Variable	Resistant phenotype n (%)	Non-MDR n (%)	p-value
Prior antibiotic exposure	50 (71.4)	0 (0.0)	0.018
Mechanical ventilation	48 (68.6)	0 (0.0)	0.021
ICU stay >7 days	45 (64.3)	0 (0.0)	0.009
Central venous catheter	42 (60.0)	0 (0.0)	0.064
Urinary catheter	45 (64.3)	1 (50.0)	0.081
Diabetes mellitus	21 (30.0)	1 (50.0)	0.216
Chronic kidney disease	10 (14.3)	0 (0.0)	0.418
Chronic respiratory disease	12 (17.1)	0 (0.0)	0.362
Mortality	21 (30.0)	0 (0.0)	0.032

Clinical outcome analysis revealed that 38 (52.8%) patients improved or were transferred to the ward and 21 (29.2%) patients died on the ICU. All 9 (12.5%) patients were lost to follow-up and 4 (5.6%) were referred to another facility. Patients with resistant A. baumannii isolates were more likely to die.

Table 7: Clinical outcome of ICU patients with Acinetobacter baumannii isolates

Outcome	Frequency (n)	Percentage (%)
Improved/shifted to ward	38	52.8
Death	21	29.2
Left against medical advice	9	12.5
Referred	4	5.6
Total	72	100.0

In general, the results indicated that Acinetobacter baumannii strains isolated from clinical samples from the ICU had high resistance to the cephalosporins, fluoroquinolones, aminoglycosides and carbapenems. In-vitro activity of the isolates was best against colistin and tigecycline. Important factors associated with resistant A. baumannii infections in the ICU patients were the presence of prior antibiotic use, mechanical ventilation, and the length of stay in the ICU.

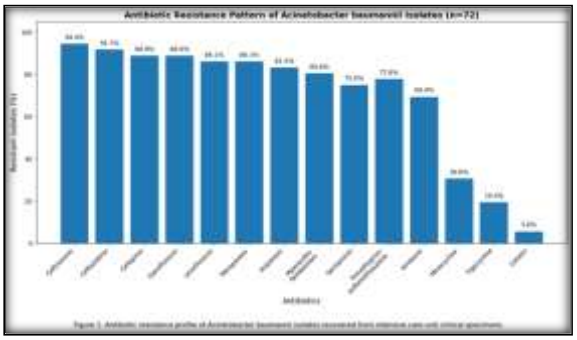

Figure 1: Antibiotic resistance profile of Acinetobacter baumannii isolates recovered from intensive care unit clinical specimens.

DISCUSSION

The present study evaluated the susceptibility profile of 72 clinical isolates of Acinetobacter baumannii recovered from intensive care unit patients in a tertiary care hospital. The findings showed that A. baumannii was more frequently isolated from male patients and from patients aged 41–60 years. Many had important ICU-related risk factors, including mechanical ventilation, urinary catheterization, central venous catheterization, prior antibiotic exposure, and ICU stay of more than seven days. These findings indicate that A. baumannii infection in ICU settings is strongly linked with critical illness, invasive devices, and prolonged hospital exposure. The predominance of isolates from tracheal aspirates in the present study further suggests that respiratory tract colonization and ventilator-associated infection may be major contributors to ICU-acquired A. baumannii infection.[11,12]

Specimen distribution revealed that tracheal aspirates were the most common specimen source for the presence of isolates, followed by blood, wound/pus swabs, urine, and catheter tips. This pattern is clinically relevant as A. baumannii has a known ability to persist on hospital surfaces, ventilator circuits, catheters and medical equipment. It can remain viable in the ICU environment, raising the risk of cross-transmission in high-risk patients. Another encouraging result is the high percentage of respiratory isolates in this study (as is also the case in mechanically ventilated patients). In the present study, mechanical ventilation was significantly associated with the resistant A. baumannii phenotype

(p=0.021) and should reinforce the importance of performing the ventilator care bundles, hand hygiene, equipment disinfection, and removing unnecessary invasive devices as early as possible.[13,14]

Antimicrobial testing of the recovered isolates revealed considerable resistance to several commonly prescribed drugs. The greatest resistance was observed against ceftriaxone, ceftazidime, cefepime, ciprofloxacin, and carbapenem agents, indicating limited effectiveness of these antibiotics against ICU-associated A. baumannii isolates. The detection of carbapenem resistance in 86.1% of isolates is worrisome, as carbapenems are thought to be important drugs for severe Gram-negative infections. This high resistance may be a result of repeated exposure to antibiotics, broad-spectrum antibiotic use and may be due to the possible spread of resistant strains in ICUs. In this study, history of antibiotic exposure was significantly linked to resistant phenotype (p=0.018) suggesting that previous antibiotic exposure may play a role in the selection and dissemination of resistant A. baumannii isolates. These results underscore the need to implement antimicrobial stewardship programs, culture-directed antibiotic use, and periodic reevaluation of empiric antibiotic prescribing guidelines.[15,16]

Colistin and tigecycline showed comparatively good in-vitro activity despite high resistance to other antibiotics that are commonly used. Tigecycline, minocycline and then colistin were the most sensitive. They indicate that these agents might still be relevant agents in the treatment of resistant A. baumannii infections. But using last line drugs should be done with caution as it may cause more resistance if the drug is not used appropriately, kidney damage (nephrotoxicity), and restricted treatment options. Thus, antibiotic susceptibility results, site of infection, and patients' clinical conditions should be considered when choosing the antibiotics for treatment, which should be based on local antibiogram data. To maintain the efficacy of the remaining active agents, infection control measures and rational antibiotic use are also crucial.[17-19]

All the isolates were multidrug-resistant and some were extensively drug-resistant and pan-drug-resistant as revealed by the overall resistance pattern. This is significant as MDR and XDR A. baumannii infections are linked to restricted therapeutic choices, longer stay in the ICU, higher treatment expenses and unfavorable clinical outcomes. Resistant phenotype was significantly linked to an ICU stay more than seven days (p=0.009) and mortality was also significantly higher among patients with resistant isolates (p=0.032) in the present study. The findings indicate that in addition to being a microbiological issue, resistant A. baumannii infection is a significant clinical issue that impacts patient prognosis. Improving antibiotic stewardship, infection control, isolation precautions, regular surveillance, and early detection of resistant strains, are recommended to limit the burden of resistant A. baumannii in ICU environments.[20]

CONCLUSION

This study concluded that Acinetobacter baumannii isolates recovered from ICU clinical specimens ‘showed a high level of antimicrobial resistance, particularly against cephalosporins, fluoroquinolones, aminoglycosides, and carbapenems’ Tracheal aspirates were the most common specimen source, indicating a major respiratory burden among ICU patients. Most isolates were multidrug-resistant, and a considerable proportion showed extensively drug-resistant patterns. Colistin and tigecycline demonstrated the highest in-vitro activity and remained the most effective options among the tested antibiotics. Prior antibiotic exposure, mechanical ventilation, prolonged ICU stay, and mortality were significantly associated with resistant A. baumannii infection. The findings emphasize the need for routine antibiogram monitoring, strict infection control practices, culture-based antibiotic therapy, and effective antimicrobial stewardship programs in intensive care units.

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