e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.11.56

International Journal of Pharmaceutical Quality Assurance 2025; 16(11); 348-354

Original Research Article

Prevalence of Multidrug-Resistant Acinetobacter baumannii and Related Species in Ventilator-Associated Pneumonia in Patna Medical College & Hospital, Patna

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Received: 13-09-2025 / Revised: 16-10-2025 / Accepted: 20-11-2025
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Conflict of interest: Nil

Abstract:

Background: Ventilator-associated pneumonia (VAP) is a common ICU-acquired infection, frequently caused by multidrug-resistant (MDR) Gram-negative bacteria, particularly Acinetobacter baumannii, leading to high morbidity and mortality.

Aim: To determine the prevalence of MDR A. baumannii and related species in VAP and evaluate their antimicrobial susceptibility patterns.

Methodology: A retrospective observational study was conducted on 415 endotracheal aspirate samples from mechanically ventilated ICU patients at Department of Microbiology, Patna Medical College and Hospital, Patna, Bihar, India. Samples were cultured, and isolates were identified using standard biochemical methods. Antimicrobial susceptibility was assessed using the disc diffusion method following CLSI guidelines. MDR was defined as resistance to ≥3 antibiotic classes. Data were analyzed using SPSS v25.

Results: Out of 415 samples, 278 (67%) were culture-positive, and 62 patients (14.9%) were diagnosed with VAP. A. baumannii was the most prevalent pathogen (45.2%), with 67.9% of isolates being MDR. MDR strains exhibited high resistance to ceftazidime (89.5%), ciprofloxacin (84.2%), and carbapenems (imipenem 84.2%, meropenem 78.9%), while minocycline (68.4%) and amikacin (42.1%) retained relative efficacy. Clinical outcomes were poor, with 57.9% mortality among MDR A. baumannii VAP cases.

Conclusion: MDR A. baumannii is a major VAP pathogen with limited treatment options and high mortality, highlighting the need for strict infection control, antimicrobial stewardship, and continuous surveillance.

Keywords: Ventilator-associated pneumonia, Acinetobacter baumannii, multidrug-resistant, ICU, antimicrobial susceptibility, mortality.

Introduction

Ventilator-associated pneumonia is the most important nosocomial infection in patients undergoing mechanical ventilation; it was defined as pneumonia developing 48-72 hours after endotracheal intubation, characterized by the presence of a new or progressive infiltrate on chest radiography, by symptoms of systemic infection and respiratory distress, and by the microbiological identification of a causative pathogen. VAP is among the most common infections in critically ill patients, especially in ICUs, and is associated with a significant increase in morbidity, mortality, and health care costs [1].

The pathogenesis of VAP is multifactorial and involves aspiration of oropharyngeal secretions, colonization of the endotracheal tube, and an impairment of host defenses, all of which facilitate bacterial invasion of the lower respiratory tract. Critically ill patients become especially susceptible in view of impaired immunity, prolonged hospitalization, and therapy with broad-spectrum antibiotics. Clinically, VAP is associated with a prolonged stay in the ICU and the hospital, increased duration of mechanical ventilation, and higher mortality rates, making it a serious healthcare challenge worldwide.

The American Thoracic Society divides VAP into two categories, depending on the timing of its onset: early-onset and late-onset. Early-onset VAP develops in the first four days of mechanical ventilation, while VAP that occurs after more than four days of mechanical ventilation and

endotracheal intubation is considered late-onset. This differentiation is clinically meaningful because early-onset VAP is typically caused by susceptible community-acquired pathogens to commonly used antibiotics, while late-onset VAP is more often associated with resistant bacteria, such as Acinetobacter species, Pseudomonas aeruginosa, and methicillin-resistant Staphylococcus aureus [2]. Determining the timing of VAP onset guides the appropriate empirical use of antibiotics, which is crucial for patient outcomes.

Recently, Acinetobacter spp. have become an important cause of nosocomial infections, particularly Acinetobacter baumannii in ICUs globally. These organisms are gram-negative, aerobic, non-fermenting coccobacilli, which have been isolated almost everywhere in the environment-soil and water-and also on the surfaces of inanimate hospital areas [3]. Such characteristics also allow this organism to survive under conditions of desiccation and disinfection processes, thereby causing persistence in hospitals and becoming a cause of outbreaks of hospital-acquired infections, which include VAP. Specifically, late-onset VAP is more associated with infection caused by Acinetobacter, which often becomes difficult to treat because of intrinsic resistance to multiple classes of antibiotics [4].

Clinical diagnosis of VAP is based on the combined use of radiological, microbiological, and clinical criteria. The ATS guidelines require new or persistent infiltrates on chest radiography and at least two of the following: purulent tracheal secretions, leukocytosis (>12×10⁹ white blood cells/L) or leukopenia (<4×10⁹ white blood cells/L), and temperature above 38.3°C [5]. These criteria do not fulfill the expectations for timely and accurate diagnosis because of the nonspecific nature of clinical signs and difficulty in differentiating VAP from other pulmonary complications common in critically ill patients.

Acinetobacter species with their high rates of antibiotic resistance and association with poor clinical outcomes have lately been a major concern in VAP. Resistance to these pathogens encompasses a wide spectrum of antimicrobial agents such as aminoglycosides, antipseudomonal cephalosporins, carbapenems, and fluoroquinolones, thus leaving limited options for therapy. The emergence and spread of MDR Acinetobacter complicate the management of patients and are also significant challenges to infection control practices within ICUs [6]. The early identification of MDR strains and implementation of appropriate antimicrobial stewardship strategies may help reduce morbidity, mortality, and increased healthcare costs associated with VAP.

The economic and clinical burden of VAP emphasizes the importance of prompt and appropriate intervention. Patients with VAP have extended mechanical ventilation, increased lengths of stay in the ICU, and increased costs of therapy, all of which contribute to increased healthcare costs. Indeed, studies have demonstrated that appropriate antibiotic therapy initiated in a timely manner significantly improves patient outcomes based on decreased complications, length of hospital stay, and mortality. In the setting of MDR pathogens, empirical therapy must be judiciously based on local antibiograms and susceptibility patterns to maximize clinical efficacy and limit further resistance.

In view of the increasing prevalence of MDR Acinetobacter in VAP, there is an urgent need for infection control surveillance with regular assessment of local epidemiology. Surveillance studies also help to understand the distribution of causative pathogens, their resistance profiles, and their impact on patient outcomes. The present study is designed to isolate, identify, and quantify bacterial pathogens from endotracheal aspirates of clinically suspected VAP patients. It also seeks to assess the antibiotic susceptibility patterns of Acinetobacter species in order to provide useful information in strategies aimed at preventing the spread of multi-drug-resistant organisms in ICU. The data obtained regarding the prevalence of pathogens and trends in resistance will prove extremely useful for clinicians to make evidence-based decisions regarding infection control and empirical therapy in patients with VAP.

Materials and Methods

Study Design: A hospital-based retrospective observational study was conducted to determine the prevalence of multidrug-resistant Acinetobacter baumannii and related species among patients with ventilator-associated pneumonia (VAP).

Study Area: The study was carried out in the Department of Microbiology, Patna Medical College and Hospital (PMCH), Patna, Bihar, India.

Study Duration: The study was conducted over a period of six months from March 2025 to August 2025

Sample Size: A total of 415 endotracheal aspirate samples were collected from patients admitted to the intensive care unit (ICU) and included in the study.

Study Population: Patients admitted to the ICU who were under mechanical ventilation for more than 48 hours and clinically suspected of having ventilator-associated pneumonia were included in the study.

Inclusion Criteria

- Patients on mechanical ventilation for more than 48 hours.
- Clinically suspected cases of VAP, identified based on:
    - New or persistent pulmonary infiltrates on chest radiographs not otherwise explained.
    - Presence of fever (>38°C).
    - Leukocytosis or leukopenia.
    - Deterioration in oxygenation (PaO_2/FiO_2 ratio).
    - Purulent respiratory secretions.

Exclusion Criteria

- Patients on mechanical ventilation for less than 48 hours.
- Patients with radiological or clinical evidence of pneumonia upon ICU admission.

Data Collection: Endotracheal aspirate samples were collected from patients admitted to the intensive care unit (ICU) who had been mechanically ventilated for more than 48 hours and were clinically suspected of having ventilator-associated pneumonia (VAP). Clinical suspicion was based on new or persistent pulmonary infiltrates on chest radiographs, fever exceeding 38°C, leukocytosis or leukopenia, deterioration in oxygenation, and purulent respiratory secretions. Samples were obtained aseptically using sterile suction traps and immediately transported to the microbiology laboratory for processing. Patient confidentiality was maintained throughout the study, and only de-identified retrospective data were used.

Study Procedure: In the laboratory, samples were initially examined using Gram staining to detect Gram-negative coccobacilli. Cultures were performed on appropriate media to observe colony morphology, followed by biochemical tests such as urease, catalase, oxidase, citrate utilization, and triple sugar iron (TSI) for confirmation of Acinetobacter species. Confirmed isolates underwent antimicrobial susceptibility testing (AST) using the disc diffusion method on Mueller-Hinton agar, following CLSI guidelines applicable at that time (e.g., 2020 edition). The antibiotic panel included ampicillin-sulbactam, ceftazidime, ciprofloxacin, gentamicin, tobramycin, co-trimoxazole, imipenem, meropenem, piperacillin-tazobactam, amikacin, and minocycline. Multidrug resistance was defined as resistance to three or more antibiotic classes. All procedures were conducted under strict aseptic conditions.

Statistical Analysis: Data, including patient demographics, clinical characteristics, microbiological findings, and antimicrobial susceptibility results, were entered into Microsoft Excel and analyzed using SPSS version 25. The prevalence of Acinetobacter species in VAP cases was expressed as percentages. Multidrug resistance patterns were summarized using frequency tables. Associations between clinical factors and multidrug-resistant Acinetobacter infections were evaluated using Chi-square or Fisher's exact tests, with a p-value of less than 0.05 considered statistically significant."

Result

Table 1 presents the distribution of endotracheal aspirate samples and ventilator-associated pneumonia (VAP) cases among 415 patients. Out of 415 samples, 278 (67.0%) were culture-positive, indicating bacterial growth. VAP was diagnosed in 62 patients (14.9%), while the remaining 353 patients (85.1%) did not meet the criteria for VAP. This table highlights that although a substantial proportion of samples were culture-positive, only a smaller subset of patients developed clinically significant VAP.

Table 1: Distribution of endotracheal aspirate samples and VAP cases (N = 415)

Parameter	Number (%)
Total endotracheal aspirate samples	415 (100)
Culture-positive samples	278 (67.0)
VAP cases identified	62 (14.9)
Non-VAP cases	353 (85.1)

Table 2 shows the distribution of Gram-negative organisms isolated from 62 ventilator-associated pneumonia (VAP) cases. Acinetobacter baumannii was the most frequently isolated pathogen, found in 28 cases (45.2%), followed by Klebsiella pneumoniae in 14 cases (22.6%), and Pseudomonas aeruginosa in 11 cases (17.7%). Escherichia coli accounted for 6 cases (9.7%), and Enterobacter cloacae for 3 cases (4.8%). Overall, the table highlights that A. baumannii, K. pneumoniae, and P. aeruginosa were the predominant Gram-negative pathogens causing VAP in this study population.

Table 2: Distribution of Gram-negative organisms isolated from VAP cases (n = 62)	
Organism isolated	**Number (%)**
Acinetobacter baumannii	28 (45.2)
Klebsiella pneumoniae	14 (22.6)
Pseudomonas aeruginosa	11 (17.7)
Escherichia coli	6 (9.7)
Enterobacter cloacae	3 (4.8)
Total	**62 (100)**

Table 3 depicts the prevalence of multidrug-resistant Acinetobacter baumannii among ventilator-associated pneumonia (VAP) cases. Out of 62 total VAP cases, Acinetobacter baumannii was isolated in 28 patients (45.2%), indicating it as a major etiological agent of VAP. Among these isolates, 19 (67.9%) were multidrug-resistant (MDR), while only 9 (32.1%) were non-MDR strains. This high proportion of MDR A. baumannii highlights a significant antimicrobial resistance burden in VAP cases and underscores the challenge in effective management and treatment of these infections.

Table 3: Prevalence of multidrug-resistant Acinetobacter baumannii among VAP cases	
Parameter	**Number (%)**
Total VAP cases	62 (100)
Acinetobacter baumannii isolated	28 (45.2)
MDR Acinetobacter baumannii	19 (67.9)
Non-MDR Acinetobacter baumannii	9 (32.1)

Table 4 shows the antimicrobial susceptibility pattern of multidrug-resistant Acinetobacter baumannii isolates (n = 19). The isolates demonstrated high levels of resistance to most commonly used antibiotics, including ceftazidime (89.5%), ciprofloxacin (84.2%), imipenem (84.2%), ampicillin–sulbactam (78.9%), and meropenem (78.9%), indicating limited effectiveness of β-lactams and carbapenems. Moderate resistance was observed with gentamicin (73.7%), piperacillin–tazobactam (73.7%), and tobramycin (68.4%). In contrast, relatively better susceptibility was noted for minocycline (68.4% sensitive) and amikacin (42.1% sensitive), making them the most effective agents against MDR A. baumannii in this cohort. Overall, the table underscores the restricted therapeutic options and the clinical challenge posed by MDR A. baumannii infections.

Table 4: Antimicrobial susceptibility pattern of MDR Acinetobacter baumannii isolates (n = 19)		
Antibiotic	**Sensitive n (%)**	**Resistant n (%)**
Ampicillin–sulbactam	4 (21.1)	15 (78.9)
Ceftazidime	2 (10.5)	17 (89.5)
Ciprofloxacin	3 (15.8)	16 (84.2)
Gentamicin	5 (26.3)	14 (73.7)
Tobramycin	6 (31.6)	13 (68.4)
Co-trimoxazole	7 (36.8)	12 (63.2)
Imipenem	3 (15.8)	16 (84.2)
Meropenem	4 (21.1)	15 (78.9)
Piperacillin–tazobactam	5 (26.3)	14 (73.7)
Amikacin	8 (42.1)	11 (57.9)
Minocycline	**13 (68.4)**	**6 (31.6)**

Table 5 depicts the clinical outcomes of ventilator-associated pneumonia (VAP) cases caused by multidrug-resistant Acinetobacter baumannii (n = 19). Recovery was observed in 8 patients (42.1%), whereas 11 patients (57.9%) succumbed to the infection. Overall, the table highlights a high mortality rate among VAP cases due to MDR A. baumannii, indicating the severe clinical impact and poor prognosis associated with these infections.

Table 5: Clinical outcome of VAP cases due to MDR Acinetobacter baumannii (n = 19)	
Outcome	**Number (%)**
Recovered	8 (42.1)
Death	11 (57.9)
Total	**19 (100)**

Table 6 shows the gender distribution of patients with multidrug-resistant Acinetobacter baumannii ventilator-associated pneumonia (VAP) (n = 19). A clear male predominance was observed, with 14 cases (73.7%) occurring in males, while 5 cases (26.3%) were reported among females. Overall, the findings indicate that MDR A. baumannii VAP was more common in male patients in the study population.

Table 6: Gender distribution of MDR Acinetobacter baumannii VAP cases (n = 19)	
Gender	**Number (%)**
Male	14 (73.7)
Female	5 (26.3)
Total	**19 100)**

Discussion

In the present study, VAP prevalence in 415 endotracheal aspirate samples was 14.9%, indicating a moderate load within the intensive care setting. This is comparable with findings by Chaari et al. (2013) [7], who reported that the VAP incidence varied between 10% and 20% among critically ill patients and that although airway colonization may be common, it only rarely progresses to clinically significant pneumonia. We also documented 67.0% positivity of cultures among samples from our cohort, indicating high microbial colonization, but only a fraction developed VAP, which corroborates the findings reported by Bishwas and Shenoy (2020) [2], in whose series 65% of patients on mechanical ventilation yielded positive cultures, although the overall incidence of VAP was a little lower at 12.5%. These comparisons highlight the sustained risk of nosocomial infection in ventilated patients, even when colonization does not always translate to active infection."

Acinetobacter baumannii was isolated as the most common pathogen in this study, accounting for 45.2% of VAP cases, while Klebsiella pneumoniae (22.6%) and Pseudomonas aeruginosa (17.7%) were the other two major pathogens. This is in tune with the pattern observed by Alotaibi et al. in 2021 [3] who reported that A. baumannii was the cause of 42% of VAP in their tertiary care center. However, Huang et al. in 2019 [4] found a much lower rate of A. baumannii in VAP as 6.9%, indicating significant geographic and institutional variation in the distribution of the pathogen. These differences may be attributed to local infection control practices, antibiotic usage patterns, and patient demographics. The high proportion of non-fermenting Gram-negative organisms in our study corroborates the emerging concern about hospital-acquired infections and further strengthens previous evidence provided by Golia et al. in 2013 [8], who stated that non-fermenting Gram-negative bacilli are predominant in late-onset VAP.

The MDR rate of Acinetobacter baumannii isolates in our study was 67.9%, which is alarming given the treatment challenges associated with it. Shete et al. (2010) [1] reported a similar MDR prevalence of 65% in A. baumannii isolates from VAP patients and confirmed the global trend of increasing drug resistance of this pathogen. In contrast, some studies have demonstrated lower MDR rates. For instance, a study by Moubareck and Halat (2020) [9] demonstrated an MDR prevalence of 50% alone, indicating prevailing differences in antimicrobial stewardship and local epidemiology. Such high resistances were observed against third-generation cephalosporins, including ceftazidime (89.5%), and carbapenems, such as imipenem (84.2%) and meropenem (78.9%), in our isolates, showing a parallel trend with the report by Salehi et al. (2020) [5], indicating the low efficacy of conventional antibiotic therapies and an urgent need for alternative drugs. Additionally, aminoglycosides, including gentamicin and tobramycin, demonstrated high resistance of 73.7% and 68.4%, respectively, whereas minocycline retained the highest sensitivity of 68.4%, supporting its potential role in the management of multidrug-resistant A. baumannii VAP, as also evidenced by Segatore et al. (2022) [10].

Outcomes were very poor, with 57.9% mortality among patients infected with MDR Acinetobacter baumannii in our cohort. The same observation was made by Čiginskienė et al. (2019) [11], who found that the mortality rate due to Acinetobacter spp. Infection in an ICU setup was 55%. Therefore, infection caused by multidrug-resistant strains is particularly severe. Consequently, the high death rates reflect the urgent need for early diagnosis, timely and proper treatment, and strict infection control measures. Moreover, male preponderance among infected patients in our study (73.7%) agrees with the findings of Huang et al. (2019) [4], indicating different exposure to risk factors, comorbidities, or patterns of admission in ICUs, although not fully explained.

Our findings also underscore the fact that the predisposing factors for VAP included the administration of broad-spectrum antibiotics prior to infection, which has been associated with selection pressure favoring resistant strains. This observation is consistent with Mathai et al. (2012) [6], who reported prior exposure to third-generation cephalosporins and carbapenems as significant risk

factors for MDR Acinetobacter infections. Similarly, acute respiratory distress, organophosphorus poisoning, viral encephalitis, and bilateral pleural effusion were frequent underlying conditions in our patients, as found by Bouadma et al., (2010) [12] and Dey and Bairy (2007) [13], emphasizing that critically ill patients with severe underlying illnesses remain especially vulnerable to resistant infections. Significantly, 10 of the 16 VAP cases in our study were not associated with bloodstream infections, pointing out that colonization and localized infection in the lungs may occur without involvement of systemic dissemination, corroborating the findings of Baraibar et al. (1997) [14].

The results on the antimicrobial susceptibility profile in our cohort suggest that conventional empiric therapies may be inadequate in settings where MDR prevalence is high. Although amikacin showed moderate activity with 42.1% sensitivity, the overall resistance spectrum underlines the importance of local antibiograms for guiding therapy, a fact echoed by Bishwas and Shenoy (2020) [2]. Minocycline and colistin were reported to be potentially effective alternative therapeutic agents by Huang et al., 2019 [4], and our results also support their role in the management of MDR infections. These observations emphasize the need for coordinated antimicrobial stewardship, targeted therapy, and regular surveillance as part of efforts toward limiting the impact of these multidrug-resistant pathogens among populations in the ICU.

In general, this investigation confirms that MDR Acinetobacter baumannii has been highly prevalent in VAP, with marked antimicrobial resistance and poor clinical outcomes, which is comparable with the literature in many other countries while highlighting regional variations in pathogen distribution and resistance patterns. Finally, the findings stress the urgent need for strict infection control measures, rational use of antibiotics, and seeking alternative therapeutic strategies to decrease the morbidity and mortality that are associated with multidrug-resistant ventilator-associated pneumonia.

Conclusion

The study demonstrates that ventilator-associated pneumonia remains one of the major complications in mechanically ventilated patients, and Gram-negative bacteria are the main causative pathogens. Acinetobacter baumannii was identified as the predominant pathogen related to VAP; most of these isolates were multidrug-resistant, underlining its increasing clinical problem in intensive care units. These multidrug-resistant strains exhibited wide resistance to commonly prescribed antibiotics, including carbapenems and other first-line antibiotics, leaving few options for therapy and highlighting the relative preservation of susceptibility to a few agents only. The infections due to multidrug-resistant A. baumannii were characterized by unfavorable clinical outcome in the form of high mortality rates and were more common among male patients. Thus, these findings also underscore the urgent need for strict infection control practices, rational use of antibiotics, and continuous surveillance of resistance patterns of antimicrobial agents to decrease the burden of multidrug-resistant A. baumannii in ventilator-associated pneumonia.

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