Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Microbiology Research

Journal homepage: https://www.ijmronline.org/

Original Research Article

Antimicrobial resistance patterns in *Acinetobacter baumannii*: A study from a tertiary care center in Vadodara, Gujarat

Saurabh Chhotalal Norris[1], **Himani Bhardwaj Pandya**[1], **Binda Prakashbhai Pipaliya**[1]*, **Tanuja Bakul Javadekar**[1]

[1] *Smt. B. K. Shah Medical Institute & Research Centre, Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India*

ARTICLE INFO

Article history:
Received 06-08-2024
Accepted 22-08-2024
Available online 26-09-2024

Keywords:
Multidrug resistance
Antibiotics
Colistin
Tigecycline
Carbapenems
Acinetobacter Spp

ABSTRACT

Background: *Acinetobacter* species are a major cause of nosocomial infections, contributing significantly to morbidity and mortality globally.
Aim: This study aimed to evaluate the antibiotic susceptibility profiles of *Acinetobacter* isolates derived from various clinical specimens at a tertiary care hospital in Vadodara, Gujarat.
Materials and Methods: Specimens were cultured on 5% sheep blood agar and MacConkey agar, followed by identification and antibiotic susceptibility testing using the VITEK 2 automated system (BioMerieux, France).
Results: Among 107 positive samples collected from January 2021, to October, 2021, the highest frequency of isolates was observed in urine samples (48, 44.86%). A significant majority of isolates (89, 83.17%) exhibited resistance to three or more classes of antibiotics. Colistin susceptibility was observed in 101 isolates (94.4%). The susceptibility rates for *Acinetobacter baumannii* were 75.7% for tigecycline and 47.7% for carbapenems.
Conclusion: The combination of colistin and tigecycline remains crucial for treating multidrug-resistant *Acinetobacter baumannii* until new therapeutic options become available. This study underscores the necessity of ongoing antimicrobial resistance surveillance and the strengthening of antibiotic stewardship programs to reduce the prevalence of resistant Acinetobacter strains and other bacteria.

1. Introduction

Acinetobacter are aerobic, gram-negative, non-fermenting, non-fastidious, non-motile, catalase-positive, and oxidase-negative coccobacilli that thrive in moist environments.[1] *Acinetobacter baumannii* is one of the most challenging pathogens among the ESKAPE group, which includes Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Enterobacteriaceae.[2] These pathogens are known for their ability to evade common antibacterial treatments due to their antibiotic resistance mechanisms.[3] Acinetobacter species have emerged as common pathogens causing both community-acquired and hospital-acquired infections.[4] *Acinetobacter baumannii*, in particular, is increasingly associated with hospital-acquired infections, especially in intensive care units (ICUs).[5] These infections, which include wound infections, urinary tract infections, pneumonia, and bacteremia, are linked to trauma, urinary catheters, mechanical ventilators, and central venous access catheters. They result in prolonged hospital stays and increased mortality rates.[6] *Acinetobacter* infections are difficult to treat due to the rapid acquisition and spread of multidrug-resistant strains among hospitalized

* *Corresponding author*.
E-mail address: bindapipaliya@gmail.com (B. P. Pipaliya).

https://doi.org/10.18231/j.ijmr.2024.038

patients and the diverse mechanisms of antimicrobial resistance employed by these bacteria.[7] The ability of *Acinetobacter* to produce biofilms facilitates their survival in hospital environments, and they are frequently found on the skin and in the respiratory and urinary tracts of patients.[8] Globally, the prevalence of multidrug-resistant *Acinetobacter*, particularly *Acinetobacter baumannii*, has been documented in several epidemiological studies[9] with resistance rates of 10-15% to carbapenems, penicillins, and fluoroquinolones.[10,11] Even in countries with high awareness and active national infection surveillance programs, *Acinetobacter* species exhibit relatively high resistance to carbapenems.[12,13] Despite this, carbapenems remain the preferred treatment for *Acinetobacter* infections.[5] The management of hospital-acquired infections remains challenging due to the increasing resistance to antimicrobials.[14]

2. Objectives

1. To determine the prevalence of *Acinetobacter baumannii* infections among the study population.
2. To identify the most common sample types and systems involved in *Acinetobacter baumannii* infections.
3. To assess the types and levels of antimicrobial drug susceptibility of *Acinetobacter baumannii* in patients at a tertiary care hospital.
4. To determine the hospital-acquired infection rate of *Acinetobacter baumannii*.

3. Materials and Methods

This study was conducted in the tertiary care Hospital, Vadodara, Gujarat, from January 2021, to October, 2021. Samples were collected aseptically and transferred to the laboratory. Isolation of *Acinetobacter* species was performed on nutrient agar, 5% sheep blood agar, and MacConkey agar. Urine samples were inoculated onto UTI Chrome agar. Identification of clinical isolates was performed using Gram staining, colony morphology, and biochemical reactions. *Acinetobacter* species were identified as non-lactose fermenting, non-motile, oxidase-negative, gram-negative coccobacilli colonies. Species differentiation was done based on biochemical reaction tests.[15]

Identification was confirmed using the VITEK 2 automated system (BioMerieux, France), which employs Advanced Colorimetry principles. Identification was performed with a pure overnight subculture, as recommended by the manufacturer, and results were provided according to the instrument's regularly updated database.

Antibiotic susceptibility testing was conducted using the VITEK 2 system (BioMerieux, France) by the microbroth dilution method. Bacterial suspensions of each sample were compared with 0.5 McFarland turbidity standards. The antibiotics tested included piperacillin/tazobactam, ceftazidime, cefoperazone/sulbactam, cefepime, carbapenems, amikacin, gentamicin, ciprofloxacin, minocycline, tigecycline, colistin, and trimethoprim/sulfamethoxazole. Minimum inhibitory concentrations (MICs) were calculated and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) 2023 guidelines.[16] Isolates of *Acinetobacter* resistant to three or more classes of antibiotics were considered multidrug-resistant (MDR).[17]

4. Result

The distribution of *Acinetobacter baumannii* across various clinical samples is detailed in Table 1. The highest percentage was observed in urine and catheter samples, constituting 44.86% (48 out of 107) of the positive cases. Pathogenicity was confirmed based on a significant colony count of 100,000 cfu/ml. This was followed by pus/wound swabs with a prevalence of 33.64% (36 out of 107), blood samples at 10.28% (11 out of 107), and respiratory tract samples (including sputum, BAL fluid, and endotracheal tube secretions) at 8.41% (9 out of 107). The lowest prevalence was recorded in miscellaneous samples, at 2.80% (3 out of 107).

Table 1: Distribution of *Acinetobacter baumannii* in various clinical samples

Samples	Positive (n=107)	Percentage
Urine and catheter	48	44.86%
Pus/wound swab	36	33.64%
Blood	11	10.28%
Respiratory tract (Sputum, BAL fluid, Endotracheal tube secretion)	09	8.4%
Miscellaneous	3	2.8%

Table 2 outlines the distribution of *Acinetobacter baumannii* across hospital departments. The majority of the cases were reported from the wards, with a percentage of 57.94% (62 out of 107). Intensive Care Units (ICUs) reported 31.78% (34 out of 107) of the cases, while the Outpatient Department (OPD) had the lowest prevalence at 10.28% (11 out of 107).

The distribution of multidrug-resistant (MDR) and non-MDR *Acinetobacter baumannii* isolates is presented in Table 3. A significant proportion of the isolates were identified as MDR, accounting for 89.71% (96 out of 107) of the total. Non-MDR isolates comprised 10.28% (11 out of 107) of the total isolates.

Table 4 provides a detailed account of antibiotic susceptibility and resistance among the clinical isolates of *Acinetobacter baumannii*. The resistance rates were

Table 2: Distribution of *Acinetobacter baumannii* across hospital departments

Department	Positive (n=107)	Percentage
OPD (Outpatient Department)	11	10.28%
Ward	62	57.94%
ICU (Intensive Care Unit)	34	31.78%

Table 3: Distribution rates of MDR and non-MDR *Acinetobacter baumannii* isolates

Strain Type	Number of Isolates (n=107)	Percentage (%)
MDR Strain	96	89.71
Non-MDR Strain	11	10.28

notably high for Piperacillin/Tazobactam (85.1%), Ceftazidime (77.6%), and Cefepime (82.3%). Other antibiotics with significant resistance rates included Cefoperazone/Sulbactam (69.2%), Gentamicin (78.5%), and Ciprofloxacin (74.8%). On the other hand, the highest sensitivity was observed for Colistin (94.4%) and Tigecycline (75.7%), indicating these antibiotics as potential therapeutic options. Amikacin also showed moderate sensitivity with 40.2%, whereas Minocycline exhibited sensitivity in 38.3% of the isolates.

Table 4: Antibiotic susceptibility and resistance in clinical isolates of *Acinetobacter baumanni*

Antibiotic	Sensitive	Percentage (%)	Resistant	Percentage (%)
Carbapenems	51	47.7	56	52.3
Piperacillin / Tazobactam	16	14.9	91	85.1
Ceftazidime	24	22.4	83	77.6
Cefoperazone / Sulbactam	33	30.8	74	69.2
Cefepime	19	17.7	88	82.3
Amikacin	43	40.2	64	59.8
Gentamicin	23	21.5	84	78.5
Ciprofloxacin	21	25.2	86	74.8
Minocycline	41	38.3	66	61.7
Tigecycline	81	75.7	26	24.3
Colistin	101	94.4	06	5.6
Trimethoprim/ Sulfamethoxazole	33	30.8	74	69.2

These findings highlight the critical issue of high percentage and extensive multidrug resistance of *Acinetobacter baumannii* in hospital settings, particularly in wards and ICUs. The significant resistance to commonly used antibiotics necessitates stringent infection control measures and the exploration of alternative therapeutic strategies to effectively manage and treat infections caused by this pathogen.

5. Discussion

Acinetobacter baumannii is a significant pathogen in nosocomial infections, known for its ability to acquire multidrug resistance (MDR) and its role in hospital outbreaks. Our study provides an overview of the antimicrobial susceptibility patterns of *A. baumannii* isolates from various clinical samples at a tertiary care hospital in Piparia, Vadodara.

5.1. Distribution and Resistance Patterns

In our study, 44.86% were isolated from urine samples, followed by wound swabs (33.64%), blood (10.28%), and respiratory samples (8.4%). This is consistent with other studies where urinary tract infections and wound infections are common sites for *A. baumannii* isolation in healthcare settings.[18]

Our findings indicate that 87.8% of the isolates were multidrug-resistant (MDR), with significant resistance observed against commonly used antibiotics. Similar high MDR rates have been reported globally documented a high prevalence of MDR *A. baumannii* in their study, highlighting the global challenge of resistance.[19]

Likewise, a study by Peleg and Hooper (2019) also reported high levels of resistance to multiple antibiotics, reinforcing the need for effective infection control strategies.[8]

5.2. Antibiotic susceptibility

The susceptibility of *A. baumannii* isolates to tigecycline was 75.7%, while susceptibility to colistin was higher at 94.4%. This finding is consistent with other regional studies.[20] However, resistance to carbapenems was observed in 47.7% of the isolates, which aligns with findings from various global studies.[21,22]

5.3. Implications for treatment and control

The high MDR rates observed in our study reinforce the necessity for ongoing surveillance and robust infection control measures. The effectiveness of colistin and tigecycline as treatment options is supported by our data, but their use should be carefully monitored to prevent further resistance development. Our findings suggest the need for continuous antimicrobial resistance surveillance and the strengthening of antibiotic stewardship programs, as recommended by the recent expert proposal by Magiorakos et al. (2021).[17]

6. Conclusion

The high resistance of *A. baumannii* to commonly used antibiotics necessitates a comprehensive approach to infection control and antimicrobial stewardship. Our study provides valuable insights into the resistance patterns

and emphasizes the importance of regular monitoring and effective management strategies.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Peleg AY, Seifert H, Paterson DL. Acinetobacter baumannii: Emergence of a successful pathogen. *Clin Microbiol Rev*. 2008;21(3):538–82.
2. Rice LB. Progress and challenges in implementing the research on ESKAPE pathogens. *Infect Control Hosp Epidemiol*. 2010;31(1):7–10.
3. Pendleton JN, Gorman SP, Gilmore BF. Clinical relevance of the ESKAPE pathogens. *Expert Rev Anti Infect Ther*. 2013;11(3):297–308.
4. Antunes LC, Visca P, Towner KJ. Acinetobacter baumannii: evolution of a global pathogen. *Pathog Dis*. 2014;71(3):292–301.
5. Howard A, O'Donoghue M, Feeney A, Sleator RD. Acinetobacter baumannii: an emerging opportunistic pathogen. *Virulence*. 2012;3(3):243–50.
6. Dijkshoorn L, Nemec A, Seifert H. An increasing threat in hospitals: Acinetobacter baumannii. *Nat Rev Microbiol*. 2007;5(12):939–51.
7. Lee CR, Lee JH, Park M, Park KS, Bae IK, Kim YB, et al. Biology of Acinetobacter baumannii: Pathogenesis, Antibiotic Resistance Mechanisms, and Prospective Treatment Option. *Front Cell Infect Microbiol*. 2017;7:55.
8. Peleg AY, Hooper DC. Hospital-acquired infections due to gram-negative bacteria. *N Engl J Med*. 2010;362(19):1804–13.
9. Castanheira M, Mendes RE, Gales AC. Global Epidemiology and Mechanisms of Resistance of Acinetobacter baumannii-calcoaceticus Complex. *Clin Infect Dis*. 2023;76(2):166–78.
10. Manchanda V, Sanchaita S, Singh N. Multidrug resistant acinetobacter. *J Glob Infect Dis*. 2010;2(3):291–304.
11. Munoz-Price LS, Weinstein RA. Acinetobacter infection. *N Engl J Med*. 2008;358(12):1271–81.
12. Hsu LY, Apisarnthanarak A, Khan E, Suwantarat N, Ghafur A, Tambyah PA. Carbapenem-Resistant Acinetobacter baumannii and Enterobacteriaceae in South and Southeast Asia. *Clin Microbiol Rev*. 2017;30(1):1–22.
13. Higgins PG, Pérez-Llarena FJ, Zander E, Fernández A, Bou G, Seifert H. OXA-235, a novel class D β-lactamase involved in resistance to carbapenems in Acinetobacter baumannii. *Antimicrob Agents Chemother*. 2013;57(5):2121–6.
14. Boucher HW, Talbot GH, Bradley JS, Edwards JE, Gilbert D, Rice LB, et al. Bad bugs, no drugs: no ESKAPE! An update from the Infectious Diseases Society of America. *Clin Infect Dis*. 2009;48(1):1–12.
15. Bergogne-Bérézin E, Towner KJ. Acinetobacter spp. as nosocomial pathogens: microbiological, clinical, and epidemiological features. *Clin Microbiol Rev*. 1996;9(2):148–65.
16. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing. CLSI supplement M100. 33rd ed. Wayne, PA: CLSI; 2023.
17. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. *Clin Microbiol Infect*. 2012;18(3):268–81.
18. Maragakis LL, Perl TM. Acinetobacter baumannii: epidemiology, antimicrobial resistance, and treatment options. *Clin Infect Dis*. 2008;46(8):1254–63.
19. Ashuthosh KC, Hegde A, Rao P, Manipura R. Multidrug-Resistant Acinetobacter baumannii - The Modern Menace: A Retrospective Study in a Tertiary Hospital in Mangalore. *Infect Drug Resist*. 2020;13:2181–7.
20. Sannathimmappa MB, Nambiar V, Aravindakshan R. Antibiotic Resistance Pattern of Acinetobacter baumannii Strains: A Retrospective Study from Oman. *Saudi J Med Med Sci*. 2021;9(3):254–60.
21. Ghareeb AM, Raafat MM, Bazan NS, Samir R. Carbapenem-resistant Acinetobacter baumannii infections among diabetic and non-diabetic patients and possible effective combination treatments. *Futur J Pharm Sci*. 2024;10:90. doi:10.1186/s43094-024-00661-x.
22. Ramirez MS, Bonomo RA, Tolmasky ME. Carbapenemases: Transforming Acinetobacter baumannii into a Yet More Dangerous Menace. *Biomolecules*. 2020;10(5):720.

Author biography

Saurabh Chhotalal Norris, Associate Professor https://orcid.org/0000-0002-9813-4132

Himani Bhardwaj Pandya, Associate Professor https://orcid.org/0000-0001-9444-9279

Binda Prakashbhai Pipaliya, Associate Professor https://orcid.org/0009-0000-2681-6698

Tanuja Bakul Javadekar, Professor

Cite this article: Norris SC, Pandya HB, Pipaliya BP, Javadekar TB. Antimicrobial resistance patterns in *Acinetobacter baumannii*: A study from a tertiary care center in Vadodara, Gujarat. *Indian J Microbiol Res* 2024;11(3):211-214.