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RESEARCH ARTICLE

Antimicrobial Susceptibility Pattern of Pseudomonas aeruginosa Isolated from ICU Patients

Adwityama[1], Pratulya Nandan[2], P N Jha[3]

ABSTRACT

Background: Pseudomonas aeruginosa is a major cause of healthcare-associated infections in intensive care units (ICUs) and is associated with significant morbidity, mortality, and antimicrobial resistance. Continuous surveillance of susceptibility patterns is essential for guiding empirical therapy and infection control practices.

Aim: To determine the antimicrobial susceptibility pattern of Pseudomonas aeruginosa isolated from ICU patients and evaluate the prevalence of multidrug-resistant strains.

Methods: A prospective observational study was conducted at Patna Medical College and Hospital (PMCH) from July 2025 to March 2026. A total of 100 non-duplicate Pseudomonas aeruginosa isolates obtained from ICU patients were included. Clinical specimens including endotracheal aspirates, sputum, urine, blood, wound swabs, and pus samples were processed using standard microbiological techniques. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to CLSI guidelines. Resistance patterns and multidrug resistance (MDR) rates were analyzed.

Results: Respiratory samples constituted the majority of isolates (42%). Highest susceptibility was observed for colistin (98%), polymyxin B (96%), and ceftolozane-tazobactam (88%). Resistance was highest against ciprofloxacin (62%), levofloxacin (58%), and ceftriaxone (74%). Multidrug-resistant Pseudomonas aeruginosa was identified in 38% of isolates. Carbapenem resistance was observed in 32% of isolates and was significantly associated with prolonged ICU stay (p=0.004).

Conclusion: Pseudomonas aeruginosa isolated from ICU patients demonstrated high resistance to commonly used antibiotics while retaining susceptibility to polymyxins. The substantial prevalence of MDR strains highlights the need for antimicrobial stewardship, routine surveillance, and rational antibiotic utilization.

Keywords: *Pseudomonas aeruginosa*, ICU, antimicrobial susceptibility, multidrug resistance, carbapenem resistance, nosocomial infection.

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INTRODUCTION

Pseudomonas aeruginosa is an opportunistic Gram-negative bacterium that is a major global cause of infections linked to healthcare. In intensive care units (ICUs), where critically ill patients are subjected to intrusive gadgets, extended hospital stays, broad-spectrum antibiotics, and immunosuppressive circumstances, it is especially common. These elements provide the perfect setting for this extremely versatile pathogen to colonise and infect[1]. Numerous infections, such as ventilator-associated pneumonia, bloodstream infections, urinary tract infections, surgical site infections, and wound infections, are caused by this organism. Pseudomonas aeruginosa-related ICU infections are linked to higher mortality, longer hospital stays, and more expensive medical care. Clinicians have a significant difficulty due to the organism's capacity to endure in damp hospital settings and acquire resistance to several antibiotic treatments[2].

[1]Medical Officer, PMCH, Patna, Bihar, India

[2]HOD, Department of Microbiology, PMCH, Patna, Bihar, India

[3]Assistant Professor, Department of Medicine, PMCH, Patna, Bihar, India

Corresponding Author: Adwityama, Medical Officer, PMCH, Patna, Bihar, India E-mail: dradwityama@gmail.com

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Pseudomonas aeruginosa's amazing capacity to acquire and evolve antibiotic resistance through a variety of mechanisms, including efflux pumps, beta-lactamase

synthesis, porin channel modifications, and biofilm formation, is one of its most alarming traits. Treatment options have been severely constrained by rising resistance to aminoglycosides, carbapenems, cephalosporins, and fluoroquinolones. Patient management has become more challenging due to the rise of strains that are extensively drug-resistant (XDR), pan-drug-resistant, and multidrug-resistant (MDR). Testing for antimicrobial susceptibility is essential for determining the best course of antibiotic treatment and preventing the emergence of resistance. Because resistance profiles differ significantly between hospitals, geographical areas, and patient populations, it is imperative to regularly assess local susceptibility trends. These surveillance data enhance antimicrobial stewardship initiatives while assisting doctors in choosing efficacious empirical therapy[3].

Pseudomonas aeruginosa ICU isolates' growing resistance to antibiotics has become a serious public health issue in India. In many tertiary care facilities, however, ongoing local monitoring data is still scarce. Optimising treatment procedures and infection control measures requires an understanding of current susceptibility trends. In order to assess the antibiotic susceptibility pattern of *Pseudomonas aeruginosa* isolated from intensive care unit patients at Patna Medical College and Hospital, as well as to ascertain the frequency of multidrug-resistant strains and their clinical consequences, the current study was conducted[4].

MATERIALS AND METHODS

Study Design

Prospective observational study.

Study Setting

Department of Microbiology, Patna Medical College and Hospital (PMCH), Patna.

Study Duration

July 2025 to March 2026.

Sample Size

100 non-duplicate Pseudomonas aeruginosa isolates.

Inclusion Criteria

ICU patients with culture-confirmed Pseudomonas aeruginosa infection.

Clinically significant isolates.

First isolate per patient.

Exclusion Criteria

- Duplicate isolates.
- Environmental isolates.
- Mixed growth without clinical significance.

Laboratory Procedures

Clinical specimens were collected aseptically and cultured on blood agar and MacConkey agar. Identification was performed using standard microbiological methods including colony morphology, pigment production, oxidase test, and biochemical reactions.

Antimicrobial Susceptibility Testing

Performed by Kirby-Bauer disk diffusion method according to CLSI guidelines.

Antibiotics tested included

- Piperacillin-tazobactam
- Ceftazidime
- Cefepime
- Ciprofloxacin
- Levofloxacin
- Gentamicin
- Amikacin
- Imipenem
- Meropenem
- Colistin
- Polymyxin B
- Ceftolozane-tazobactam

Statistical Analysis

Data were analyzed using SPSS version 26. Chi-square test and Fisher's exact test were used. A p-value <0.05 was considered statistically significant.

RESULTS

Respiratory tract specimens accounted for the majority of isolates, indicating ventilator-associated and lower respiratory tract infections as the predominant sources of Pseudomonas aeruginosa in ICU patients.

Polymyxins exhibited the highest antimicrobial

Table 1: Distribution of Clinical Specimens

Specimen Type	*Frequency (%)*
Endotracheal Aspirate	32 (32.0)
Sputum	10 (10.0)
Urine	22 (22.0)
Blood	12 (12.0)
Wound Swab	14 (14.0)
Pus	10 (10.0)

Table 2: Antimicrobial Susceptibility Pattern

Antibiotic	*Sensitive (%)*	*Resistant (%)*
Colistin	98	2
Polymyxin B	96	4
Ceftolozane-Tazobactam	88	12
Amikacin	74	26
Piperacillin-Tazobactam	68	32
Meropenem	68	32
Imipenem	65	35
Gentamicin	62	38
Levofloxacin	42	58
Ciprofloxacin	38	62
Cefepime	34	66
Ceftriaxone	26	74

p-value <0.001

Table 3: Multidrug Resistance Profile

Resistance Pattern	*Frequency (%)*
Non-MDR	62 (62.0)
MDR	38 (38.0)

p-value = 0.008

Table 4: Association of Carbapenem Resistance with ICU Stay

ICU Stay	*Carbapenem Resistant*	*Carbapenem Sensitive*	*p-value*
≤7 Days	9	35	
>7 Days	23	33	0.004

Table 5: Distribution of MDR Isolates by Clinical Specimen

Specimen	*MDR Isolates (%)*
Endotracheal Aspirate	18 (47.4)
Urine	7 (18.4)
Blood	4 (10.5)
Wound Swab	5 (13.2)
Pus	3 (7.9)
Sputum	1 (2.6)

p-value = 0.031

activity against Pseudomonas aeruginosa, whereas ceftriaxone and fluoroquinolones showed the highest resistance rates.

Multidrug-resistant Pseudomonas aeruginosa constituted 38% of all isolates, representing a significant burden in ICU settings.

Carbapenem resistance was significantly associated with prolonged ICU stay, indicating increased selective antibiotic pressure among long-term ICU patients.

The highest proportion of MDR isolates was recovered from endotracheal aspirates, reflecting the burden of ventilator-associated infections in ICU patients.

DISCUSSION

The antibiotic susceptibility profile of Pseudomonas aeruginosa isolated from intensive care unit patients at a tertiary care facility was assessed in the current prospective observational investigation. The results show a worrying degree of antimicrobial resistance while maintaining susceptibility to polymyxins and more recent beta-lactam combinations, especially against cephalosporins, fluoroquinolones, and carbapenems.The majority of isolates were from respiratory tract specimens, with endotracheal aspirates making up over one-third of all samples[5]. This result highlights the significance of lower respiratory tract infections and ventilator-associated pneumonia as primary causes of Pseudomonas infections acquired in intensive care units. Due to compromised mucociliary clearance, extended hospital stays, and intrusive airway equipment, critically sick patients on mechanical ventilation are especially vulnerable to colonisation and infection[6].

This study's susceptibility profile demonstrates how the epidemiology of antibiotic resistance is evolving. With susceptibility rates of 95%, colistin and polymyxin B showed outstanding effectiveness against Pseudomonas aeruginosa. These results align with recent publications that suggest polymyxins continue to be one of the best treatment options for Gram-negative infections that are resistant to many drugs. However, growing reliance on these drugs raises questions about the potential for polymyxin resistance to develop in the future.High resistance to ceftriaxone, cefepime, ciprofloxacin, and levofloxacin was one of the study's noteworthy findings. The utility of fluoroquinolones as empirical therapy in intensive care units is significantly limited when their resistance exceeds 50%. The selection of resistance strains may have been influenced by the extensive use of these antibiotics in hospital practice. Numerous tertiary care facilities in India and other developing nations have observed similar resistance patterns[7-8].

One of the biggest obstacles to treating Pseudomonas infections is still carbapenem resistance. Meropenem and imipenem resistance was found in almost one-third of the isolates in this investigation. Treatment is particularly challenging for carbapenem-resistant organisms because

they frequently have numerous resistance mechanisms, such as porin mutations, efflux pumps, and carbapenemase synthesis. Extended hospitalisation may lead to selective antibiotic pressure and the acquisition of resistant organisms, according to the study's substantial correlation between carbapenem resistance and longer ICU stays(8).A significant burden of antimicrobial resistance was indicated by the 38% prevalence of multidrug-resistant isolates. MDR strains are linked to higher healthcare costs, longer hospital stays, and higher death. The significance of ventilator-associated illnesses as reservoirs of resistant bacteria is further highlighted by the prevalence of MDR isolates among respiratory specimens[9].

The results highlight the necessity of strong antimicrobial stewardship initiatives. Rational antibiotic prescribing, frequent susceptibility surveillance, infection control measures, and adherence to hand hygiene practices are necessary to minimise the emergence and spread of resistant organisms. Restriction of improper broad-spectrum antibiotic use may help preserve the efficacy of currently available medicines. The strengths of this study were its prospective approach and examination of clinically important ICU isolates. However, drawbacks include the single-center scenario and lack of molecular identification of resistance mechanisms. Future studies incorporating genotypic analysis may provide a better understanding of resistance factors[10].

Overall, the study underlines the growing threat posed by antimicrobial-resistant Pseudomonas aeruginosa in ICU settings. Continuous surveillance and evidence-based antibiotic strategies are important to enhance patient outcomes and contain the emergence of resistance bacteria[11].

CONCLUSION

The current study shows that Pseudomonas aeruginosa is still a major infection among intensive care unit patients and that it is highly resistant to a number of widely used antibiotics. While polymyxins and ceftolozane-tazobactam maintained good activity, high resistance rates were noted against cephalosporins, fluoroquinolones, and carbapenems. Over one-third of all isolates were multidrug-resistant, indicating a significant frequency. Longer ICU stays were significantly associated with carbapenem resistance, highlighting the impact of hospital exposure and antibiotic demand on resistance development. The main source of infection and MDR isolates was respiratory tract specimens, especially endotracheal aspirates.

These results highlight the critical need for antimicrobial stewardship initiatives, stringent infection control procedures, regular susceptibility testing, and prudent antibiotic prescription in critical care units. Monitoring local resistance patterns on a regular basis is crucial for directing empirical treatment and improving patient care. To improve surveillance efforts and aid in the creation of focused infection control programmes, more multicentric research integrating molecular characterisation of resistance pathways is advised. Improving outcomes for critically sick patients still depends on early detection and effective treatment of resistant Pseudomonas aeruginosa infections.

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