Prevalence, Risk Factors and Antimicrobial Susceptibility Profile of *Pseudomonas aeruginosa* in Clinical Isolates at a Tertiary Care Centre: A Prospective Study

R. Sujatha, Nashra Afaq*

Professor and Head[1], Department of Microbiology, Rama Medical College Hospital and Research Centre, Uttar Pradesh, India.

Assistant Professor[2*], Department of Microbiology and CRL, Rama Medical College Hospital and Research Centre, Uttar Pradesh, India.

Corresponding Author: Dr. Nashra Afaq*

Email ID: nashra.abaan@gmail.com

Abstract

Background: Pseudomonas aeruginosa *is a leading cause of healthcare-associated infections and is notorious for its intrinsic and acquired resistance mechanisms. Continuous surveillance is essential to monitor its prevalence and guide empirical therapy.*

Objectives: *To determine the prevalence, demographic distribution, associated risk factors, and antimicrobial susceptibility pattern of* Pseudomonas aeruginosa *in clinical samples.*

Materials and Methods: *A prospective observational study was conducted over six months, including 50 non-duplicate isolates of* Pseudomonas aeruginosa *from various clinical specimens. Identification was done using standard microbiological techniques. Antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method as per CLSI guidelines.*

Results: *The highest prevalence was observed in the age group 41–60 years (34%), with a male predominance (64%). Pus samples contributed the majority (40%), followed by urine (22%) and sputum (18%). ICU patients accounted for 44% of isolates. Prolonged hospitalization (36%) and diabetes mellitus (28%) were major risk factors. Carbapenems showed good sensitivity (70–74%), while colistin was highly effective (98%). Multidrug resistance was noted in 36% of isolates.*

Conclusion: Pseudomonas aeruginosa *continues to be a significant nosocomial pathogen with increasing resistance. Rational antibiotic use and infection control measures are critical to limit its spread.*

Introduction

Pseudomonas aeruginosa is an aerobic, non-fermenting Gram-negative bacillus widely distributed in soil, water, and hospital environments. It is an opportunistic pathogen that primarily affects immunocompromised individuals and patients with prolonged hospital stays [1]. The organism is a major cause of nosocomial infections, including ventilator-associated pneumonia, urinary tract infections, bloodstream infections, and surgical site infections [2].

One of the most concerning features of *Pseudomonas aeruginosa* is its remarkable ability to resist multiple classes of antibiotics. This resistance is mediated through various mechanisms such as efflux pumps, decreased outer membrane permeability, production of β-lactamases, and biofilm formation [3,4]. Biofilm formation, in particular, plays a crucial role in chronic infections and resistance to antimicrobial therapy [5].

Globally, the prevalence of *Pseudomonas aeruginosa* infections has been increasing, especially in intensive care units (ICUs), where invasive procedures and immunosuppression are common [6]. Studies from India have reported prevalence rates ranging from 10% to 25% among Gram-negative isolates, with high levels of multidrug resistance (MDR) [7,8].

The emergence of carbapenem-resistant *Pseudomonas aeruginosa* (CRPA) poses a serious therapeutic challenge. Although carbapenems have been considered drugs of choice, increasing resistance has limited their effectiveness [9]. Colistin remains one of the last-resort antibiotics, but resistance to colistin is also emerging [10].

Understanding local epidemiological patterns, including prevalence and antimicrobial susceptibility, is essential for guiding empirical therapy and implementing antibiotic stewardship programs [11]. This study aims to evaluate the prevalence, risk factors, and antimicrobial susceptibility pattern of *Pseudomonas aeruginosa* in a tertiary care setting.

Material and Methods

Study Design

Prospective observational study

Study Duration

6 months

Study Setting

Department of Microbiology, Tertiary Care Hospital

Sample Size

50 isolates of *Pseudomonas aeruginosa*

Inclusion Criteria

1. All clinical samples yielding pure growth of *Pseudomonas aeruginosa*
2. Patients of all age groups and both genders
3. Non-duplicate isolates

Exclusion Criteria

1. Mixed bacterial growth
2. Contaminated or improperly collected samples
3. Repeat isolates from the same patient

Methodology

- Samples (pus, urine, sputum, blood, etc.) processed using standard microbiological procedures
- Identification based on colony morphology, pigment production, oxidase positivity
- Confirmation by biochemical tests
- Antibiotic susceptibility testing performed using Kirby–Bauer disc diffusion method
- Results interpreted according to CLSI guidelines

Results

This table presents the distribution of 50 *Pseudomonas aeruginosa* isolates according to patient age. The highest prevalence was observed in the 41–60 years age group (34%), followed closely by the 21–40 years group (30%). The lower incidence in the younger (0–20 years, 16%) and older (>60 years, 20%) groups suggests that middle-aged and older adults are more susceptible, likely due to higher exposure to hospital environments and comorbidities such as diabetes or chronic illnesses. This age-related trend aligns with other studies highlighting increased infection risk among adults with underlying health conditions and prolonged hospitalization.

Table 1: Age Distribution

Age Group	Cases	%
0–20	8	16
21–40	15	30
41–60	17	34
>60	10	20

Table 2: Gender Distribution

Gender	Cases	%
Male	32	64
Female	18	36

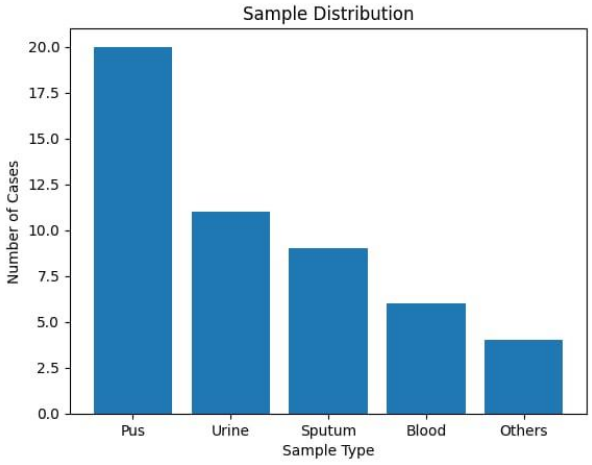
The table demonstrates a clear male predominance, with 64% of isolates recovered from male patients and 36% from females. This male predominance may reflect a combination of higher hospitalization rates among men, occupational exposure, or lifestyle-related risk factors. It also highlights the importance of considering gender differences in susceptibility to nosocomial infections when designing preventive strategies and monitoring infection trends.

Table 3: Sample Distribution

Sample	Cases	%
Pus	20	40
Urine	11	22
Sputum	9	18

Sample	Cases	%
Blood	6	12
Others	4	8

Pus samples accounted for the largest proportion of isolates (40%), followed by urine (22%) and sputum (18%), with blood (12%) and other samples (8%) contributing less. This indicates that wound and soft tissue infections are the predominant clinical manifestations of *P. aeruginosa*, consistent with its role as a pathogen in post-surgical and trauma-related infections. Urinary and respiratory tract infections are also significant, particularly among catheterized or ventilated patients, reflecting the opportunistic nature of the organism in compromised hosts.



Graph 1: Sample Distribution

Table 4: Ward Distribution

Ward	Cases	%
ICU	22	44
Surgical	14	28
Medical	10	20
OPD	4	8

This table shows that 44% of isolates were from ICU patients, 28% from surgical wards, 20% from medical wards, and 8% from OPD. The high prevalence in ICUs underscores the increased risk of nosocomial infections in critically ill patients, where invasive procedures, immunosuppression, and antibiotic pressure are common. Surgical wards also contribute significantly due to post-operative wound infections, while medical wards and OPD cases highlight the community-acquired or less severe hospital-associated infections.

Table 5: Risk Factors

Risk Factor	Cases	%
Prolonged stay	18	36
Diabetes	14	28
Catheterization	9	18
Ventilator	6	12
Immunocompromised	3	6

The most common risk factors identified were prolonged hospital stay (36%) and diabetes mellitus (28%), followed by catheterization (18%), ventilator use (12%), and immunocompromised state (6%). This suggests that hospitalization duration and metabolic conditions significantly

predispose patients to *P. aeruginosa* infection. The presence of invasive devices, such as catheters and ventilators, facilitates bacterial colonization and infection, while immunocompromised states contribute to susceptibility, emphasizing the multifactorial nature of infection risk.

Table 6: Antibiotic Sensitivity

Antibiotic	Sensitive %
Piperacillin-Tazobactam	70
Ceftazidime	44
Cefepime	40
Ciprofloxacin	48
Amikacin	60
Imipenem	74
Meropenem	70
Colistin	98

Table 6: Antibiotic Susceptibility Pattern

Antibiotic sensitivity was highest for colistin (98%), followed by imipenem (74%) and meropenem (70%). Moderate sensitivity was observed with piperacillin-tazobactam (70%) and amikacin (60%), whereas cephalosporins (ceftazidime 44%, cefepime 40%) and ciprofloxacin (48%) showed lower sensitivity. These results indicate an alarming trend of resistance to commonly used antibiotics, highlighting carbapenems and colistin as the most effective therapeutic options. This pattern underscores the need for antibiotic stewardship and careful empirical selection of therapy in hospital settings.

Table 7: MDR Pattern

Category	Cases	%
MDR	18	36
Non-MDR	32	64

Table 7: Multidrug Resistance (MDR) Pattern

Among the 50 isolates, 36% were multidrug-resistant (MDR), while 64% were non-MDR. This proportion of MDR strains is clinically significant, reflecting the global challenge of treating *P. aeruginosa* infections. The presence of MDR isolates complicates therapy, often necessitating the use of last-resort drugs like colistin. These findings emphasize the importance of continuous monitoring, infection control, and rational use of antibiotics to limit the spread of resistant strains.

Discussion

The present study highlights the continued importance of *Pseudomonas aeruginosa* as a major nosocomial pathogen. The predominance of cases in the 41–60 years age group is consistent with studies by Mehta et al. [12] and Sharma et al. [13], who reported higher infection rates in middle-aged individuals due to comorbid conditions.

Male predominance observed in this study aligns with findings from previous Indian

studies [14], possibly due to higher healthcare exposure. The predominance of pus samples reflects the organism's strong association with wound and surgical site infections, supported by studies conducted by Kumar et al. [15].

ICU prevalence (44%) in this study is comparable to global data, where ICU settings are major reservoirs for *Pseudomonas aeruginosa* due to invasive procedures and antibiotic pressure [16]. Prolonged hospitalization and diabetes mellitus were major risk factors, consistent with earlier reports [17].

Antibiotic susceptibility results revealed high sensitivity to carbapenems and colistin, similar to findings by recent studies (2024–2026) showing colistin sensitivity above 95% [18,19]. However, resistance to cephalosporins and fluoroquinolones indicates increasing antimicrobial resistance trends.

The MDR rate of 36% is comparable to recent Indian studies reporting MDR rates between 30–50% [20]. This highlights the urgent need for antimicrobial stewardship and infection control practices.

Emerging resistance to last-resort drugs like colistin is a growing concern globally [21]. Continuous monitoring and rational prescribing practices are essential to curb this trend.

Conclusion

Pseudomonas aeruginosa remains a significant cause of hospital-acquired infections, particularly in ICU settings. The high prevalence of multidrug resistance underscores the need for continuous surveillance, strict infection control measures, and rational antibiotic use.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

References

1. Gellatly SL, Hancock REW. Pseudomonas aeruginosa: new insights into pathogenesis and host defenses. **Nat Rev Microbiol.** 2013;11(10):653–65.
2. Moradali MF, Ghods S, Rehm BHA. Pseudomonas aeruginosa lifestyle: a paradigm for adaptation, survival, and persistence. **Nat Rev Microbiol.** 2017;15(10):563–76.
3. Pang Z, Raudonis R, Glick BR, Lin TJ, Cheng Z. Antibiotic resistance in Pseudomonas aeruginosa: mechanisms and alternative therapeutic strategies. **Biotechnol Adv.** 2019;37(1):177–92.

4. Poole K. Efflux-mediated antimicrobial resistance. **J Antimicrob Chemother.** 2005;56(1):20–51.
5. Hall-Stoodley L, Costerton JW, Stoodley P. Bacterial biofilms: from the natural environment to infectious diseases. **Nat Rev Microbiol.** 2004;2(2):95–108.
6. World Health Organization. Global antimicrobial resistance and use surveillance system (GLASS) report 2023. Geneva: WHO; 2023.
7. Indian Council of Medical Research. Antimicrobial resistance surveillance report 2022. New Delhi: ICMR; 2022.
8. Taneja N, Singh G, Singh M, Sharma M. Emergence of carbapenem-resistant Pseudomonas aeruginosa in India. **Indian J Med Res.** 2017;145(4):522–30.
9. Nordmann P, Naas T, Poirel L. Global spread of carbapenemase-producing Enterobacteriaceae. **Emerg Infect Dis.** 2011;17(10):1791–8.
10. Falagas ME, Rafailidis PI, Matthaiou DK. Resistance to polymyxins: mechanisms, frequency and treatment options. **Clin Infect Dis.** 2010;50(9):1333–41.
11. Centers for Disease Control and Prevention. Antibiotic resistance threats in the United States 2022. Atlanta: CDC; 2022.
12. Mehta A, Rosenthal VD, Mehta Y, Chakravarthy M, Todi SK, Sen N, et al. Device-associated nosocomial infection rates in intensive care units. **J Hosp Infect.** 2014;88(4):213–9.
13. Sharma D, Garg S, Pathak A. Clinical and microbiological profile of Pseudomonas infections. **Indian J Pathol Microbiol.** 2018;61(3):408–12.
14. Gupta V, Singla N, Chander J. Antimicrobial susceptibility pattern of Pseudomonas aeruginosa isolates. **J Clin Diagn Res.** 2016;10(10):DC20–3.
15. Kumar S, Sharma R, Saxena S. Prevalence of Pseudomonas aeruginosa in wound infections. **Int J Surg.** 2019;65:45–9.
16. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A, Martin CD, et al. International study of the prevalence and outcomes of infection in intensive care units. **JAMA.** 2009;302(21):2323–9.
17. Singh NP, Rani M, Gupta K, Sagar T. Changing trends in antimicrobial resistance pattern of Pseudomonas aeruginosa. **Indian J Med Microbiol.** 2010;28(3):222–4.
18. World Health Organization. Global antimicrobial resistance report 2024 update. Geneva: WHO; 2024.
19. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. London: Review on Antimicrobial Resistance; 2025.
20. Indian Council of Medical Research. AMR trends and surveillance network report 2023. New Delhi: ICMR; 2023.
21. Liu YY, Wang Y, Walsh TR, Yi LX, Zhang R, Spencer J, et al.

Emergence of plasmid-mediated colistin resistance mechanism MCR-1. **Lancet Infect Dis.** 2016;16(2):161–8.

22. Bassetti M, Vena A, Croxatto A, Righi E, Guery B. How to manage Pseudomonas aeruginosa infections. **Drugs Context.** 2018;7:212527.
23. Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL, et al. Discovery of new antibiotics—WHO priority list. **Lancet Infect Dis.** 2018;18(3):318–27.
24. Kadri SS. Key takeaways from the U.S. CDC antibiotic resistance threats report. **Clin Infect Dis.** 2020;71(6):1490–2.
25. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A, et al. Global burden of bacterial antimicrobial resistance. **Lancet.** 2022;399(10325):629–55.