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Original Article

The emerging trends in antimicrobial susceptibility pattern of *Pseudomonas species*: A hospital-based cross-sectional study at a tertiary care hospital of South Bihar.

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Abstract

Background
Infections caused by *Pseudomonas spp.* are becoming more common in immunocompromised patients, particularly in hospital settings. The most well-known member of this family is *Pseudomonas aeruginosa*, a serious pathogen. To develop antibiograms, this study examined the distribution and susceptibility patterns of *Pseudomonas species* isolated from various specimens as part of a surveillance program.
Objectives: This study aimed to determine the prevalence and analyze the antibiogram of Pseudomonas species at a tertiary care hospital in South Bihar.

Methods
A hospital-based, retrospective, cross-sectional study was conducted at a tertiary care hospital in South Bihar from February 2024 to January 2025. A total of 68 isolates of *Pseudomonas species* were isolated from 1862 various clinical specimens. For the isolation of the organisms, Blood Agar and MacConkey Agar plates were used. The oxidase test, catalase test, and gram staining were used to characterize phenotypes. The Clinical and Laboratory Standards Institute (CLSI), M100, 2024 recommendations were followed during the antibiotic susceptibility testing of anti-pseudomonal medications.

Results
Among the 68 isolates of *Pseudomonas species* that were isolated, the study found that pus was the most common specimen (46.8%), followed by urine specimens (18.75%). All the isolates were found sensitive to Colistin (100%), whereas Imipenem (76.6%) and Piperacillin-tazobactam (69.5%) were found sensitive in the majority of the isolates, followed by Amikacin (61.3%). Less than half of the isolates were found sensitive to Ciprofloxacin, Levofloxacin, and Gentamycin. Aztreonam had the lowest sensitivity (15%).

Conclusions
The study reveals a rising trend of multidrug resistance among *Pseudomonas species*, with limited susceptibility to commonly used antibiotics.

Recommendation
Regular antimicrobial surveillance and strict antibiotic stewardship programs are recommended to effectively manage and control multidrug-resistant Pseudomonas infections.

Keywords: *Pseudomonas species, Surveillance, Fluoroquinolones, Antimicrobial Stewardship, Antibiogram, Susceptibility*
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Introduction

Pseudomonas species are Gram-negative, non-fermenting rods, and members of the family *Pseudomonadaceae*. They have a broad distribution around the world and are frequently discovered in plants, water, and soil [1]. From a therapeutic standpoint, *Pseudomonas aeruginosa* is the most prominent species, while *Pseudomonas fluorescens* and *Pseudomonas putida* are among the infrequent sources of infection in immune-compromised hosts [2]. Pseudomonas infections can impact a wide range of areas, including the skin, bones, ears, eyes, urinary system, and respiratory tract. They vary depending on the patients' susceptibilities, and there have been reports of rising antibiotic resistance in some populations [3,4].

Due to a constantly growing multidrug resistance that affects fluoroquinolones, aminoglycosides, third and fourth generation cephalosporins, and advanced beta-lactams, *Pseudomonas spp.* has been placed in a critical level of peril [4]. With the rise of multidrug-resistant (MDR) *Pseudomonas aeruginosa,* posing substantial healthcare difficulties, significant morbidity and mortality have been seen globally [5]. The only way to increase patient survival in these infections caused by MDR bacteria is with prompt and appropriate therapy [6]. About 10% of all nosocomial infections in patients with cancer, burns, or cystic fibrosis are caused by *Pseudomonas aeruginosa* spp., which are characterized by rising antibiotic resistance globally and significant death rates [7].

Pseudomonas spp, particularly *Pseudomonas aeruginosa*, are notorious for developing resistance to multiple antibiotics. Tracking resistance trends in local settings is critical for formulating effective treatment guidelines. There is limited published data on the antimicrobial susceptibility patterns of *Pseudomonas sp.* specific to Southern Bihar, and local epidemiological data are essential for guiding empirical therapy, formulating hospital antibiotic policies and planning infection control measures. This study was conducted to evaluate the distribution of *Pseudomonas sp*. associated with infections in patients and their antimicrobial susceptibility patterns, to formulate hospital antibiotic policies, and plan infection control measures.

Material and methods

Study design and setting

A retrospective cross-sectional study was conducted at the Department of Microbiology, Narayan Medical College and Hospital, Jamuhar (Rohtas), Bihar, for one year from February 2024 to January 2025. All specimens were processed by the laboratory's Standard Operating Procedures (SOPs).

Sample size

A total of 1862 clinical samples collected from ICU patients were included in the study.

Sample processing

All clinical samples were cultured on Blood agar and MacConkey agar plates and incubated aerobically at 37°C for 24 hours. Non-lactose fermenting colonies observed on MacConkey agar were subjected to Gram staining and oxidase testing. Colonies identified as oxidase-positive Gram-negative rods were further processed using biochemical tests, including Triple Sugar Iron (TSI) agar, Citrate Utilization test, and Urease test. Bacterial motility was evaluated using the Hanging Drop preparation method.

Antibiotic susceptibility testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method, as per the Clinical Laboratory Standards Institute (CLSI) guidelines (M100, 34th edition, 2024) [8]. The diameters of the inhibition zones were measured and interpreted as Sensitive, Intermediate, or Resistant, following the CLSI interpretive criteria.

Data analysis

All collected data were entered into Microsoft Excel for initial documentation and were subsequently analyzed using the Statistical Package for the Social Sciences (SPSS).

Results

68 isolates of *Pseudomonas sp*. were isolated from clinical specimens received from ICU patients of the hospital. Out of 68 isolates, 63 (92 %) were isolated from IPDs.

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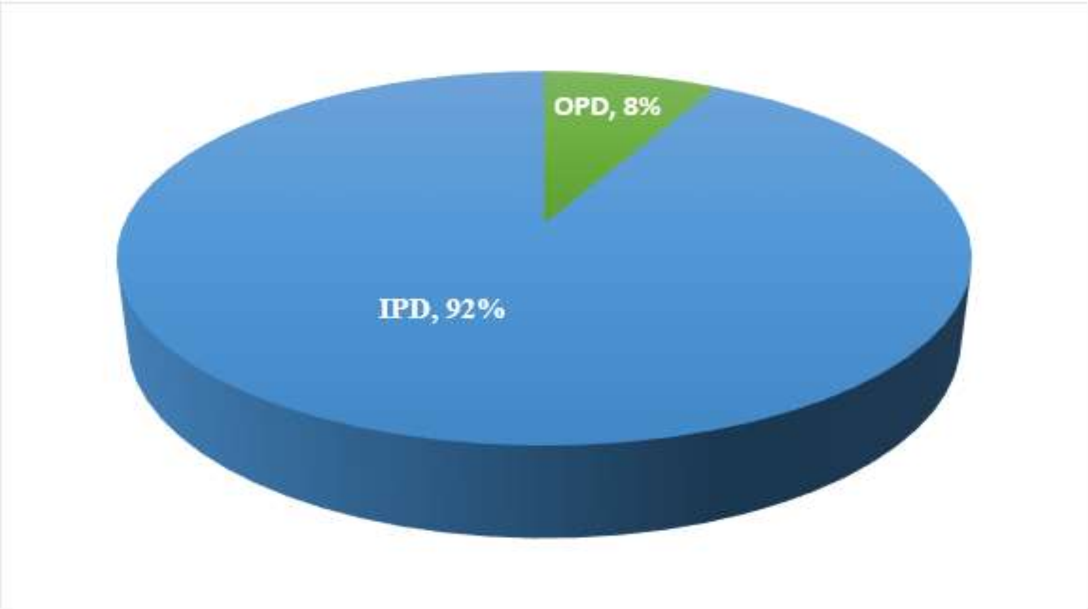
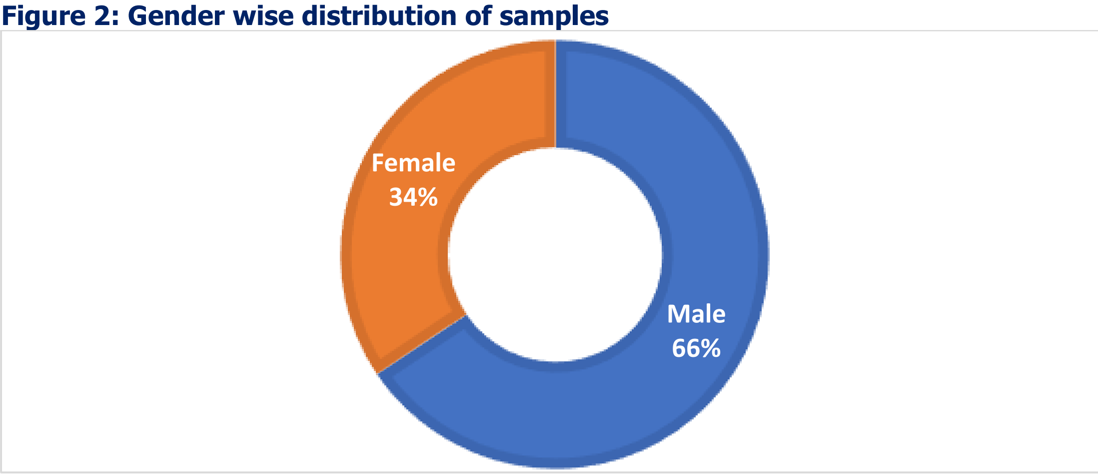
Figure 1: Source-wise distribution of specimens of Pseudomonas aeruginosa



As shown in Figure 2, this study shows that 65.6% of the *Pseudomonas species* were obtained from male patients as compared to 34.4% from females.

Figure 2: Gender wise distribution of samples



The distribution of *Pseudomonas sp*. in various specimens is shown in Figure 3. Wound swabs were the most common specimen (48%), from which *Pseudomonas* sp. were isolated, followed by Pus specimens (19 %).

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Figure 3: Distribution of samples

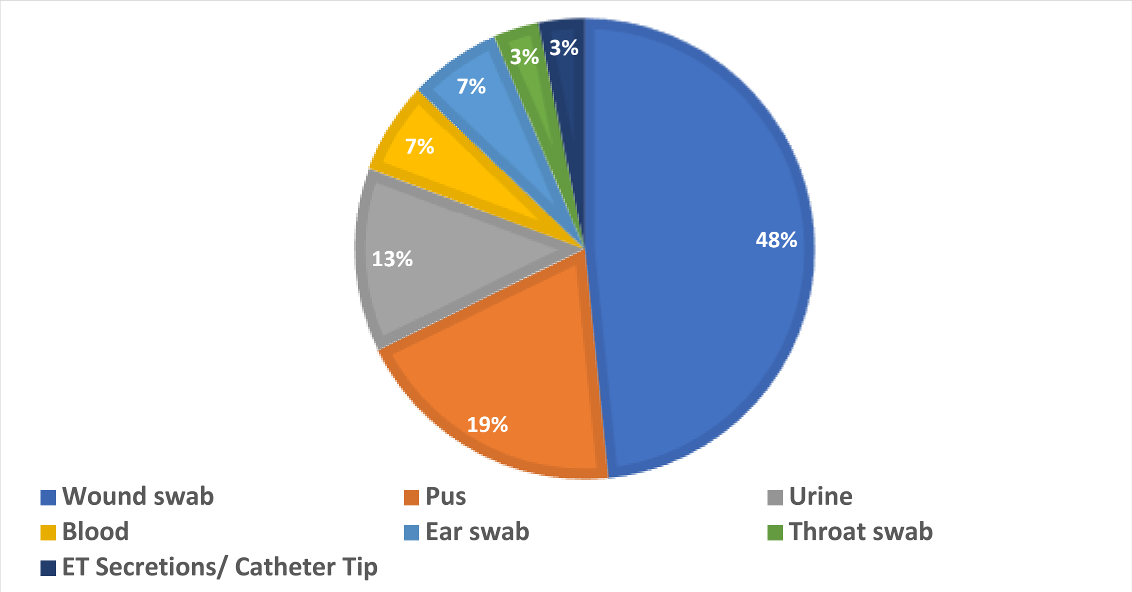
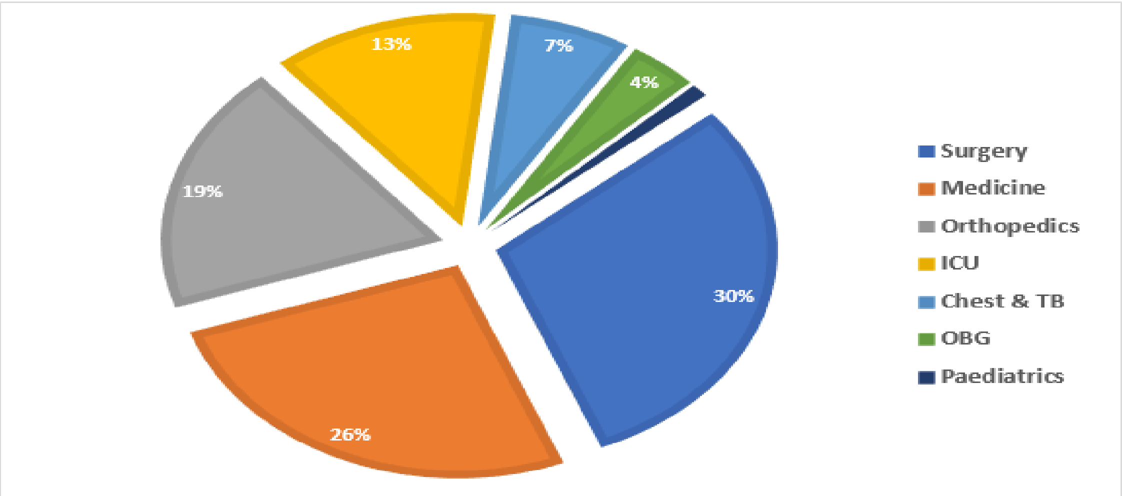


Figure 4: Department-wise distribution of samples



As per age-wise distribution, the most affected age group was 41-60 years, followed by the age group of 1-20 years (Fig. 5)

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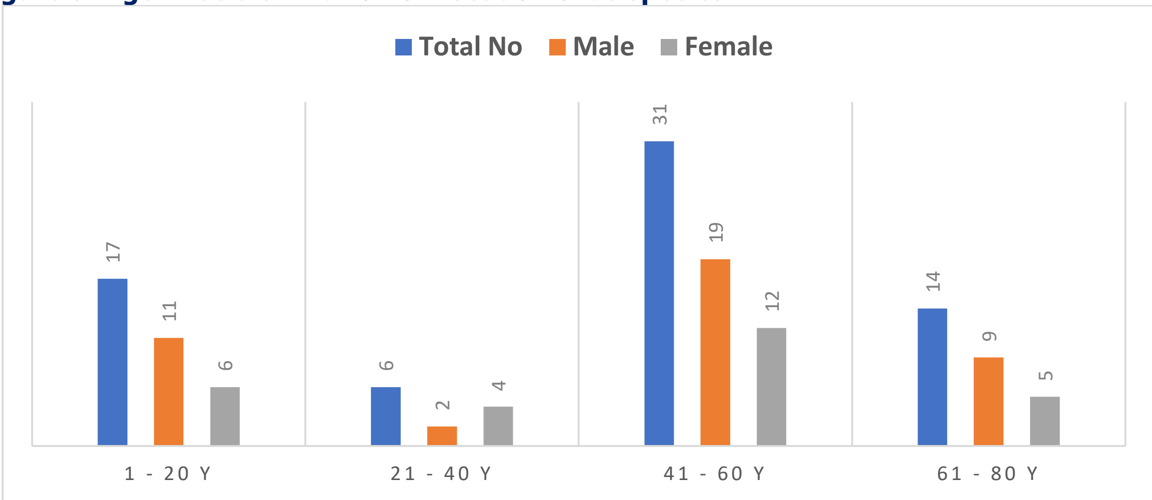
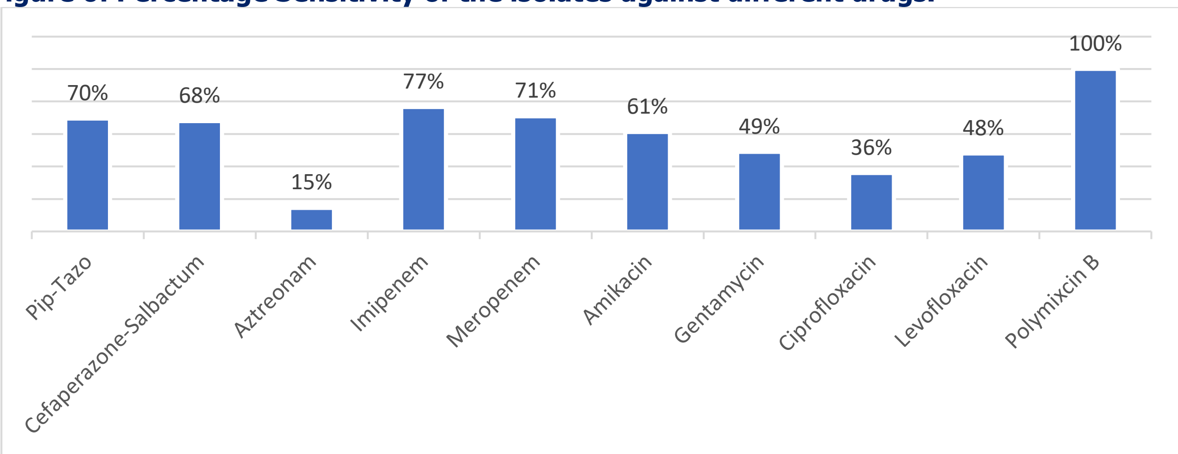
Figure 5: Age-wise distribution of Pseudomonas species



Polymyxin B was found to be 100% sensitive, similar to a study done by Kalaivani R et al. [9]. Imipenem (76.6%) and Piperacillin-tazobactam (69.5%) were found sensitive in most of the isolates, followed by Amikacin (61.3%).

Figure 6: Percentage Sensitivity of the isolates against different drugs.



This study also analyzed the sensitivity patterns of two commonly used antibiotics for urine isolates of *Pseudomonas species*. Among those, Fosfomycin was sensitive in 78.3% isolates, whereas Nitrofurantoin turned out to be sensitive in 50 % isolates.

Discussion

In this study, a total of 68 isolates of *Pseudomonas* species were identified, with wound swabs being the most frequent specimen type, followed by pus, urine, blood, ear/throat swabs, endotracheal secretions, and catheter tips. This distribution is consistent with reports from Nigeria and Nepal, where wound swabs were also reported as the predominant specimen, although the order of specimen types varied slightly [12–15]. The high isolation rate from wound and pus specimens may be attributed to *Pseudomonas* species' opportunistic nature, as it often infects sites where the skin barrier is compromised [9]. Moreover, a high prevalence of underlying conditions, poor hygiene, malnutrition, and frequent hospitalizations likely contributes to increased infection rates.

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Most isolates in this study were from inpatients (91.67%), with only a small proportion from outpatients (8.33%). This trend aligns with findings by earlier studies [9,15], who noted higher isolation rates among hospitalized patients, emphasizing the link between longer hospital stays and increased infection risk. Gender-wise, males were more frequently affected than females, a pattern also observed in studies from Pakistan [10] and Cyprus [11]. The majority of infections were noted in the 41–60 years age group, followed by the 1–20 years age group. However, the affected age groups vary across studies, possibly due to differences in immunity levels, comorbidities, and hospitalization durations [12–14].

Antimicrobial susceptibility testing revealed high rates of multidrug resistance among *Pseudomonas* isolates, posing significant treatment challenges. In this study, Imipenem (65.5%) and Piperacillin-tazobactam (62.5%) showed the highest sensitivity among the tested antibiotics, in line with several previous studies [9,15]. However, the declining sensitivity to Imipenem compared to the 100% susceptibility reported by Ullah et al. [11] in ESBL-producing isolates is concerning. Fluoroquinolones (Ciprofloxacin and Levofloxacin) and Gentamicin exhibited poor sensitivity, with less than 50% susceptibility, reflecting widespread resistance patterns seen in other studies [12,19].

Among aminoglycosides, Amikacin showed relatively better efficacy (59.3%), outperforming Gentamicin and Tobramycin, a finding consistent with previous reports [16–18]. However, resistance to commonly prescribed agents such as Ciprofloxacin and Gentamicin is likely influenced by their frequent use, leading to selective pressure and resistance development. Aztreonam showed the lowest sensitivity (15%), suggesting limited clinical utility against *Pseudomonas* in this setting.

Resistance to anti-pseudomonal cephalosporins was also notable, with up to 40% sensitivity observed, aligning with previous studies reporting resistance rates up to 100% for third-generation cephalosporins [20–22]. The widespread use of beta-lactam antibiotics, along with mechanisms like enzymatic inactivation and biofilm formation, likely contributes to the rising resistance to cephalosporins.

Overall, the findings of this study underscore the growing threat of multidrug-resistant *Pseudomonas* species and highlight the need for regular antimicrobial surveillance and rational antibiotic use to limit further resistance development.

Generalizability

The findings of this study apply primarily to tertiary care hospital settings with similar patient populations and antimicrobial practices.

Conclusion

This study highlights the emergence of *Pseudomonas* species as significant multidrug-resistant (MDR) pathogens. The increasing resistance among these organisms poses a serious challenge to clinical management, particularly in hospitalized and immunocompromised patients. The study findings demonstrate high levels of resistance to commonly used antibiotics, with limited efficacy observed for many therapeutic options. The most active agents were Imipenem and Piperacillin-tazobactam, though reduced susceptibility to these drugs raises concern. The misuse and overuse of antibiotics remain major contributors to the rapid development of resistance. Therefore, targeted antibiotic therapy based on susceptibility testing is essential to improve treatment outcomes and prevent further resistance.

Recommendation

Strict antibiotic stewardship and restriction of carbapenem use to severe cases are essential to control rising resistance. Mandatory prescription based on culture and sensitivity testing should be enforced. Regular surveillance and public awareness programs are recommended to curb antimicrobial misuse.

Funding information

There was no funding involved.

Conflict of interest

The Authors state no conflict of interest.

Study limitations

The study was limited by its retrospective design, single-center setting, and small sample size.

List of abbreviations

MDR – Multidrug-resistant
ICU – Intensive Care Unit
OPD – Outpatient Department
IPD – Inpatient Department
SOP – Standard Operating Procedure
CLSI – Clinical and Laboratory Standards Institute
ESBL – Extended-Spectrum Beta-Lactamase
SPSS – Statistical Package for the Social Sciences

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Author contributions

All authors contributed to the study design, data collection, analysis, and manuscript preparation.

Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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