# Path-Organism Burden and Antibiogram Outline of *Pseudomonas aeruginosa* Isolates in a Tertiary Care Hospital of Jamshedpur, Jharkhand, India

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**ABSTRACT**

**BACKGROUND**

*Pseudomonas aeruginosa* is an opportunistic pathogen involved in a variety of nosocomial infections like pneumonia, bacteraemia, wound infection and urinary tract infection. It is also involved in infections of rigorous burns and infections in immunocompromised persons. This study was undertaken to determine the prevalence and antibiotic susceptibility patterns of pathogenic *P. aeruginosa* isolated from a variety of clinical specimens in a tertiary care hospital of Jamshedpur, Jharkhand, India.

**METHODS**

*Pseudomonas aeruginosa* was identified using standard methods from various clinical samples collected over a period of seven months. This was a descriptive cross-sectional study which was approved by the ethical committee. The study was conducted from January 2019 to January 2020 in the Department of Microbiology at MGM Medical College, Jamshedpur, Jharkhand, India. This hospital has ICUs, one emergency ward, surgical & medical wards and Out-Patient Departments.

**RESULTS**

Our study showed the prevalence of *P. aeruginosa* during the study period from January 2019 to January 2020 in the Department of Microbiology at MGM Medical College, Jamshedpur, Jharkhand, India. A total of 1389 clinical samples were aerobically cultured, out of which 758 (54.6 %) yielded significant growth and the rest 630 (45.4 %) samples were either sterile or showed non-significant growth. From 758 positive growth samples, 161 (21.20 %) *P. aeruginosa* were isolated.

**CONCLUSIONS**

The high prevalence of *P. aeruginosa* as an opportunistic nosocomial pathogen and high frequency of antimicrobial resistance among the clinical isolates demand regular monitoring of antibiogram of *P. aeruginosa* isolates with proper implementation of antimicrobial policy. Antibiotics should be used appropriately with care. Antimicrobial therapy should not be started unless there is clear evidence of infection and infection to be handled with proper infection control measures.

**KEYWORDS**

*Pseudomonas aeruginosa*, Pus Samples, Antimicrobial Resistance

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## BACKGROUND

*Pseudomonas aeruginosa* is an aerobic, gram-negative rod which is motile and is the most significant cause of opportunistic nosocomial infections. It is liable for 10 % of all hospital-acquired infections.[1] *Pseudomonas aeruginosa* is an opportunistic pathogen involved in a variety of nosocomial infections like pneumonia, bacteraemia, wound infections and urinary tract infection.[2,3] It has been involved in miscellaneous infections such as urinary-tract infection, pneumonia, skin and soft-tissue infections, in severe burns and in infections suffered by immunocompromised persons. Duration of hospital stay of patient's being admitted to the wards or in the intensive care unit (ICU), mechanical ventilation of the wards, increase in malignant disease and history of chronic obstructive pulmonary disease have all been recognised as self-determining risk factors for multidrug-resistant (MDR) *P. aeruginosa* infections.[4-6] There are a number of causative factors for its high incidence and susceptibility of causing infections. Apart from its individual range of virulence factors; misuse of antibiotics and immunocompromised state of patients are the other causes for its increased involvement in health care associated infections and persistence of *P. aeruginosa* as a drug resistant microorganism.[7] Moreover, high risk patients in intensive care units, out- patient departments, burn units and surgery wards are commonly infected with multidrug resistant *P. aeruginosa* isolates is mainly the reason for high morbidity and mortality.[8,9]

Infections caused by *P. aeruginosa* are often severe, life-threatening and are difficult to treat because of limited susceptibility to antimicrobial agents and high frequency of emergence of antibiotic resistance *P. aeruginosa* during therapy.[10] The antibiotic resistance mechanisms consist of the achievement of extended-spectrum β-lactamases, aminoglycoside-modifying enzymes, carbapenemases and 16S ribosomal ribonucleic acid methylases. Mutational changes causing the up-regulation of multidrug efflux pumps, derepression of AmpC, modification of antimicrobial targets and changes in the outer membrane permeability barrier are also described as mechanisms of antibiotic resistance. Furthermore, the ability of *P. aeruginosa* to exist inside and outside humans as slow-growing organism adds to its resistance mechanisms. Thus, emergence of MDR *P. aeruginosa* is of clinical concern and the pandrug-resistant (PDR) isolates, treatable only with colistin, are on the rise.[11]

Pseudomonas species are the most common non-fermenter isolated from clinical specimens. Biochemically, they are oxidase, catalase positive and oxidisers of carbohydrates.[9] It colonises in natural and artificial surfaces, and are therefore found on medical equipments including invasive catheters causing cross infections in hospitals and clinics. This bacterium is notorious for its low antibiotic susceptibility which is not only due to its intrinsic resistance but also *P. aeruginosa* can acquire resistance by mutation either in chromosomally encoded genes or by the horizontal gene transfer of antibiotic resistance determinants.[12,13] Low permeability of the bacterial cellular envelopes and achievement of multidrug efflux pumps contribute significantly to drug resistance. This efflux pump is associated with elevated minimum inhibitory concentration (MICs) with penicillins, cephalosporins, quinolones, tetracyclines, chloramphenicol, metallo-b-lactamases and later carbapenems.[14-18]

Moreover, literature review showed that the resistance of *P. aeruginosa* to β-lactams, quinolones, aminoglycosides and carbapenems, especially imipenem has steadily increased.[14,17,18,19] The present study was undertaken to find out the frequency of drug resistance and antibiotic susceptibility patterns of pathogenic *P. aeruginosa* inaccessible from a variety of clinical specimens in a tertiary care hospital of Jamshedpur, Jharkhand India.

## METHODS

This was a descriptive cross-sectional study was carried out from January 2019 to January 2020 in the Department of Microbiology at a MGM Medical College Jamshedpur Jharkhand India. This hospital has ICUs, one emergency ward, medical & surgical wards and out-patient departments. Different clinical samples such as pus / swab, urine, sputum, blood, cerebrospinal fluid, pleural fluid, peritoneal fluid, tissue biopsies and bronchial lavage were collected from patients and transferred to the laboratory without delay for further processing. Patient's age, sex, cause for admission to the hospital, duration of stay and special invasive procedure conducted were evaluated. on the basis of the case record histories. Blood agar, MacConkey's agar and nutrient agar were used as growth media for the culturing of samples. The plates were then incubated at 37° C for 24 hours to get the growth and were then processed further for identification using standard procedures. *P. aeruginosa* was identified by Gram's staining, motility test and biochemical tests like oxidase test, oxidative-fermentative (O / F) test and growth at $42^0$ C.[20]

Every specimen was processed for bacterial culture for the isolation and identification. Blood agar, chocolate agar, and MacConkey's agar were used. Inoculation was done by four-flame streak method. Identification criteria included colonial morphology, Gram's stain, oxidase test, and pigment production. Analytical Profile Index (API 20 NE system) was put up for species differentiation. A suspension of *Pseudomonas aeruginosa* equal to 0.5 McFarland turbidity standard was prepared by inoculating in nutrient broth. Lawning was done by sterile culture swab stick on Mueller-Hinton agar plates, using the standard guidelines.

### Antimicrobial Susceptibility Test

Antimicrobial agents and their concentrations were as follows: among aminoglycosides (amikacin 30 µg), beta - lactam + beta - lactamase inhibitor combination (piperacillin + tazobactam, 100 µg and cefoperazone + sulbactam, 75 - 10 µg), cephalosporin 3rd generation (cefoperazone, 30 µg), fluroquinolone 2nd generation (ciprofloxacin, 5 µg), carbapenem (imipenem, 10 µg), monobactam (aztreonam 10 µg). Mueller-Hinton plates were inoculated with well

isolated and differentiated strains of *Pseudomonas aeruginosa*, followed by aerobic incubation at 37° C for 24 hours.

The antibiotic susceptibility outline of all the *Pseudomonas aeruginosa* isolates were assessed by modified Kirby–Bauer disc diffusion method on Mueller–Hinton agar against the following antibiotics: amikacin (30 µg), gentamicin (10 µg), ciprofloxacin (5 µg), levofloxacin (5 µg), piperacillin-tazobactam (110 µg), ceftazidime (30 µg), aztreonam (30 µg), imipenem (10 µg), meropenem (10 µg), polymyxin B (300 U) and colistin (10 µg). After incubation for 24 hours at 37° C, the zone diameters measured around each disc were interpreted on the basis of guidelines published by the Clinical and Laboratory Standards Institute (CLSI).[21]

### Statistical Analysis

Statistical analysis was done by descriptive statistics using simple ratio and percentages. Microsoft office 2007 was used to generate tables.

## RESULTS

During the study period from January 2019 to January 2020 in the Department of Microbiology at a MGM Medical College Jamshedpur Jharkhand India., a total of 1389 experimental samples were aerobically cultured, out of which 758 (54.6 %) yielded significant growth and the rest 630 (45.4 %) samples were either sterile or showed non-significant growth. From 758 positive growth samples, 161 (21.20 %) *P. aeruginosa* were secluded. From 161 isolates noticed, 24 % of the isolates were from the patients who attended OPD, while ICU (19 %) and medicine department (18 %) contributed significantly. But, comparatively a smaller number of isolates were seen from paediatrics (8 %) and gynaecology (5 %) departments. (Figure 1, Table 1)

| Department | No of Isolates (N) | Percentage (%) |
|---|---|---|
| OPD | 39 | 24 |
| Medicine | 29 | 18 |
| ICU | 31 | 19 |
| ENT | 19 | 12 |
| Surgery | 22 | 14 |
| Paediatrics | 13 | 8 |
| OBG | 08 | 5 |

***Table 1. Section Wise Allotment of P. aeruginosa Isolates (N = 161)***

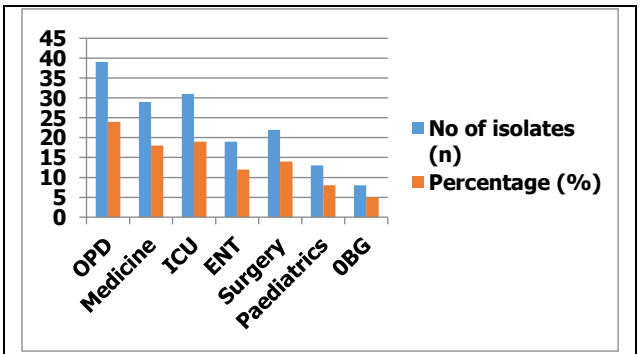


***Figure 1. Department Wise Distribution of P. aeruginosa Isolates (N = 161)***

This study also revealed that *P. aeruginosa* isolates were mostly retrieved from middle aged adult patients in the age group of 36 – 55 years followed by patients of 15 - 25 years. (Table 2)

| Age Groups (in Years) | No. of Isolates (n) | Percentage (%) |
|---|---|---|
| < 15 | 13 | 8 |
| 15 - 25 | 21 | 13 |
| 26 - 35 | 19 | 12 |
| 36 - 45 | 37 | 23 |
| 46 - 55 | 35 | 21 |
| 56 - 65 | 17 | 11 |
| 66 - 75 | 19 | 12 |

***Table 2. Age Wise (in Years) Distribution of P. aeruginosa Isolates (N = 161)***

Our study showed that most of the *P. aeruginosa* clinical isolates were obtained from pus (43 %) followed by urine (18 %), sputum (21 %), blood (8 %), bronchoalveolar lavage (BAL) (5 %) and tracheal aspirate (4 %). (Table 3)

| Specimen | No of Isolation (N) | Percentage (%) |
|---|---|---|
| PUS | 69 | 43 |
| Urine | 31 | 19 |
| Sputum | 34 | 21 |
| Blood | 13 | 8 |
| BAL | 08 | 5 |
| Tracheal aspirate | 06 | 4 |

***Table 3. Specimen Wise Distribution of P. aeruginosa Isolates (161)***

The bacterial strains resistant to three or more categories of antibiotics are defined as multidrug resistant (MDR) strains, MDR strains of *P. aeruginosa* isolated in this study were 21.20 %. Antimicrobial susceptibility of these 161 *P. aeruginosa* isolates to 11 antimicrobial agents was shown in Table 3. We observed that the highest susceptibility was shown to polymyxins group i.e. polymyxin B (97.2 %) and colistin (91.3 %) followed by piperacillin-tazobactam (74.2 %) and amikacin (71.1 %) and lowest to ceftazidime (22.6 %) and gentamicin (52 %). (Table 4)

| Antimicrobial Agents | Number of Isolates (%) | |
|---|---|---|
| | Resistant (R) | Susceptible (S) |
| Amikacin | 47 (28.9) | 114 (71.1) |
| Gentamicin | 77 (48) | 84 (52) |
| Levofloxacin | 68 (42) | 93 (58) |
| Ciprofloxacin | 71 (44) | 90 (56) |
| Piperacillin-tazobactam | 42 (25.8) | 119 (74.2) |
| Ceftazidime | 125 (77.4) | 36 (22.6) |
| Aztreonam | 71 (43.8) | 90 (56.2) |
| Meropenem | 75 (46.8) | 86 (53.2) |
| Imipenem | 62 (38.5) | 99 (61.5) |
| Colistin | 14(8.7) | 147 (91.3) |
| Polymyxin B | 5 (2.8) | 156 (97.2) |

***Table 4. Antimicrobial Susceptibility Patterns of P. aeruginosa Clinical Isolates (N = 161)***

## DISCUSSION

*Pseudomonas aeruginosa* is generally a widespread non-fermenting bacterium isolated from clinical specimens and presents a severe remedial challenge for dealing of both community-acquired and nosocomial infections. Detection and assortment of relevant antibiotic to initiate therapy is essential to optimising the clinical outcome.[22] The main intention of the present study was to investigate and to find out the prevalence of drug resistance and antibiotic susceptibility patterns of pathogenic *P. aeruginosa* secluded

from various clinical specimens in a tertiary care hospital of Jamshedpur, Jharkhand India.

Multidrug resistant *P. aeruginosa* has numerous times been connected with treatment failure. This is seen more commonly in nosocomial infections. In the present study, a total of 161 *P. aeruginosa* strains were isolated from various significant growth clinical specimens. Isolation rate was 20.21 % of all 758 significant growth clinical isolates. Almost similar, 19.45 % of isolation rate was observed by Rajak KC.[23] Pus was predominant specimen, accounting for 44.76 % of all specimens. Senthamarai S. et al. in their study isolated 47.11 % *P. aeruginosa* from pus specimens which is fairly comparable with our study.[24]

In this study, we observed that 22 % of the isolates were from outdoor patients which closely matched with the findings of Poddar CK et al. (26.22 %).[25] Moreover, ICU (20 %) and medicine department (20 %) contributed significantly in our study which matched with the study of Sharma et al. (22.8 % and 12.3 % respectively).[26]

Furthermore, our learning showed that most of the *P. aeruginosa* scientific isolates were obtained from pus (43 %) followed by urine (19 %), sputum (21 %), blood (8 %), BAL (5 %) and tracheal aspirate (4 %). Pathi et al., found almost comparable figures for pus (29 %), urine (23 %), sputum (18.8 %) and blood (11 %).

In this present study, we observed that these 161 *Pseudomonas aeruginosa* isolates demonstrated highest susceptibility to polymyxins category i.e. (97.2 %) and colistin (91.3 %) which is at par with the observation of Saderi et al. (polymyxin B and colistin 95.5 % and 90.9 % respectively).[27] Colistin was considered as the last resort to treat these isolates but still there are reports of colistin resistant *P. aeruginosa*.[27-31]

Among the aminoglycosides, amikacin was found to be superior than the gentamicin and susceptibility to amikacin (71.1 %) and gentamicin (52 %) was much better than the findings of Saderi et al. (amikacin and gentamicin 55 % and 27.3 % respectively)[27] and Tadvi et al. (amikacin and gentamicin 56 % and 55 % respectively).[32] Fluoroquinolones (levofloxacin), monobactams (aztreonam) and carbapenems (meropenem) were fairly active against these isolates (58 %, 56.2 %, 52.2 % respectively) which also mimics results obtained by Iranian researchers.[27] However, the Gujarat group noticed much higher percentage of susceptibility for fluoroquinolones (levofloxacin: 92.66 %) and carbapenems (meropenem: 93.33 %).[32]

In our study, we noticed that piperacillin-tazobactam, in the penicillins / ß-lactamase inhibitors category, was relatively better in killing these isolates (74.2 %) as compared to other groups and this observation was also comparable to that of Saderi et al. (63.6 %)[27] and Tadvi et al., (80.66 %).[32] But susceptibility to ceftazidime in the cephalosporin category was bad in our study (22.6 %) than Iranian group (63.6 %)[27] and Gujarat group (80.66 %).[32]

The rate of drug resistant *Pseudomonas aeruginosa* is growing throughout the world and poses a therapeutic trouble. Treatment option of MDR-*Pseudomonas aeruginosa* are inadequate. Therefore, there is an urgent need to highlight the judicious use of antibiotics and firm adherence to "reserve drugs" to lessen the misuse of available antibiotics. Additionally, consistent laboratory detection and antimicrobial susceptibility surveillance of *Pseudomonas aeruginosa* is necessary for local monitoring of resistance trends. Hospitals as the main sourced, carry the highest responsibility for proper supervising of our existing antimicrobial resources. In fact, an effective national and state level antibiotic policy and summary strategy should be prepared to preserve the effectiveness of antibiotics and for enhanced patient managing.

## CONCLUSIONS

Our study revealed that the prevalence of *P. aeruginosa* is large and most of these were obtained from middle-aged adult male patients particularly from outdoor and ICU. Isolation of this organism was maximum from wound infections. Polymyxins were the drugs of choice. Spread of this organism within an organisation is dangerous. Active screening methods with good infection control practices play an important role in the control of health-care associated infections. Moreover, monitoring of antibiotic sensitivity pattern of *P. aeruginosa* and strict antibiotic policy implementation with antimicrobial supervision programme are mandatory to control the situation.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
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