e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(7);824-829

Original Research Article

Spectrum of Infections and Antibiotic Susceptibility Pattern of *Pseudomonas aeruginosa* in a Tertiary Care Hospital

Jayanta Debnath[1], Anup Saha[2], Swarupa Chakma[3], Nabaneet Majumder[4], Sourabh Das[5]

[1]Associate Professor, Department of Microbiology, Tripura Medical College &Dr. BR Ambedkar Memorial Teaching Hospital, Agartala, Tripura, India
[2]Assistant Professor, Department of Microbiology, Tripura Medical College &Dr. BR Ambedkar Memorial Teaching Hospital, Agartala, Tripura, India
[3]Assistant Professor, Department of Pathology, Tripura Medical College &Dr. BR Ambedkar Memorial Teaching Hospital, Agartala, Tripura, India
[4]Professor & Head, Department of Pathology, Tripura Medical College &Dr. BR Ambedkar Memorial Teaching Hospital, Agartala, Tripura, India
[5]Senior Resident, Department of Pathology, Tripura Medical College &Dr. BR Ambedkar Memorial Teaching Hospital, Agartala, Tripura, India

Received: 28-04-2023 / Revised: 21-05-2023 / Accepted: 25-06-2023
Corresponding author: Dr. Nabaneet Majumder
Conflict of interest: Nil

Abstract

Background : *Pseudomonas aeruginosa* can cause serious nosocomial and community acquired infections with limited therapeutic options due to their intrinsic resistance to several antibiotics and rapid development of multiple drug resistance mechanisms. This study aims to determine the infections caused by *Pseudomonas aeruginosa* and analyze the antibiotic susceptibility pattern to establish the current therapeutic options.

Materials and Methods: The study was conducted on 166 strains of *Pseudomonas aeruginosa* isolated from various clinical samples. Isolation and confirmation of the organism in culture was performed using standard microbiological techniques. The antibiotic susceptibility testing was performed by Kirby Bauer disc diffusion method.

Results: The predominant infections caused by *Pseudomonas aeruginosa* included Pneumonia (52.4%) followed by Urinary tract infection (28.9%). All isolates were sensitive to Colistin. Other effective antibiotics against *Pseudomonas aeruginosa* were Imipenem (80.7%), Meropenem (78.9%), Piperacillin tazobactum (77.7%) and Netilmicin (72.9%). The isolates were mostly resistant to fluoroquinolones and Antipseudomonal Cephalosporins. Multidrug resistance were observed in 34.3% isolates.

Conclusion: Lower respiratory tract infection and urinary tract infection were the common infections caused by *Pseudomonas aeruginosa*. Piperacillin tazobactum and/or Netilmicin may be considered for empirical treatment of suspected infection. Use of carbapenems and colistin may be restricted to multidrug resistant strains causing serious infections and those resistant to all other classes of antibiotics. Definitive treatment should be based on the culture and sensitivity test results only.

Keywords: *Pseudomonas aeruginosa*, Infections, Antibiotic Sensitivity, Treatment.

Introduction

Pseudomonas aeruginosa are major pathogens causing nosocomial and community acquired infections which include pneumonia, urinary tract infections, septicemia, skin and soft tissue infections, infections secondary to burns and injuries [1,2]. These organisms are widely distributed in nature and hospital environment and are difficult to eradicate.

The infections caused by *Pseudomonas aeruginosa* are often life threatening due to limited treatment options, owing to their intrinsic resistance to several antibiotics and rapid development of multiple drug resistance mechanisms. The antibiotic resistance is mainly due to frequent mutations in chromosomal genes which regulates the resistance factors and further acquisition of exogenous genes from other organisms or environment through plasmids, transposons and bacteriophages [3,4].

High prevalence of the Multidrug resistance strains of *Pseudomonas aeruginosa* has been continuously reported worldwide and is associated with high

morbidity and mortality in these infections. However, the antibiotic susceptibility pattern varies in different geographical areas and periods due to variation in antibiotic pressure, which is dependent upon the differences in antibiotic prescribing habits and treatment policies. This necessitates periodic analysis of antibiotic susceptibility pattern in order to formulate or modify the antibiotic policies which shall guide in deciding the correct therapeutic option.

The study was conducted to determine the spectrum of infections caused by *Pseudomonas aeruginosa* and analyze the antibiotic susceptibility pattern to establish the current therapeutic options available for treatment of these infections.

Materials and Methods

The study was conducted in a tertiary care teaching hospital of Tripura, a remote north eastern state of India and was duly approved by the Institutional Human Ethics Committee. Convenient sampling was done for a period of two years and a total of 166 isolates of *Pseudomonas aeruginosa* were included in the study. The isolates were from various clinical samples and without any repetitions.

In the laboratory, all collected samples were cultured aerobically on Blood agar and MacConkey agar media plates, incubated at 37°C for 24 hours. Blood samples were cultured in Brain Heart Infusion Broth and subsequently subcultured in Blood agar and MacConkey agar plates. Growth of *Pseudomonas aeruginosa* were identified by non-lactose fermenting colonies, motility testing, Grams reaction and biochemical tests indicating positive oxidase test, alkaline slant in Triple Sugar Iron agar medium, negative Indole production test, positive citrate utilization test and positive nitrate reduction test. Definitive identification of *Pseudomonas aeruginosa* included identifying the production of the blue green pigment pyocyanin and its ability to grow at 42°C [5].

Antibiotic susceptibility testing was performed against Anti-Pseudomonal antibiotics by modified Kirby Bauer Disc diffusion method conforming to the CLSI guidelines [6].

Anti-Pseudomonal antibiotics used for susceptibility testing were from the classes of Ureidopenicillins, Cephalosporins, Carbapenems, Aminoglycosides and Fluoroquinolones. For Quality control *Pseudomonas aeruginosa* ATCC 27853 strain was used. The Multi-Drug Resistant (MDR) strains of *Pseudomonas aeruginosa* were identified by the criteria of resistance to three or more classes of Anti-Pseudomonal antibiotics [7].

Results

The data collected for a period of two years reveals that, out of 5623 samples, culture was positive in 2133 cases and 166 (7.8%) isolates were identified to be *Pseudomonas aeruginosa*. The majority of the patients were males 96 (57.8%) and of elderly age group of more than 60 years 69 (41.6%) as shown in the Table 1.

Table 1: Proportions of Age-Group of patients in relation to sex and isolates of *Pseudomonas aeruginosa*

Age – Group of patients	Number of Isolates N (%)	Males N (%)	Females N (%)
0 – 15 years	13 (7.8%)	06 (46.1%)	07 (53.8%)
16 – 30 years	14 (8.4%)	08 (57.1%)	06 (42.9%)
31 – 45 years	29 (17.5%)	12 (41.4%)	17 (58.6%)
46 – 60 years	41 (24.7%)	23 (56.1%)	18 (43.9%)
>60 years	69 (41.6%)	47 (68.1%)	22 (31.9%)
TOTAL	166	96 (57.8%)	70 (42.2%)

Spectrum of infections caused by *Pseudomonas aeruginosa* included pneumonia, urinary tract infection, abscess, septicemia, otitis media, burn infection and surgical site infection.(Table -2, Fig- 1) Most of the cases were from lower respiratory tract infection and often associated with chronic obstructive pulmonary disease.

Table 2 : Spectrum of infections caused by *Pseudomonas aeruginosa*

Infection	Number of isolates (N=166)	Proportion of isolates (%)
Pneumonia	87	52.4
Urinary tract infection	48	28.9
Abscess	11	6.6
Surgical site infection	7	4.1
Burn infection	6	3.7
Septicemia	6	3.7
Otitis media	1	0.6

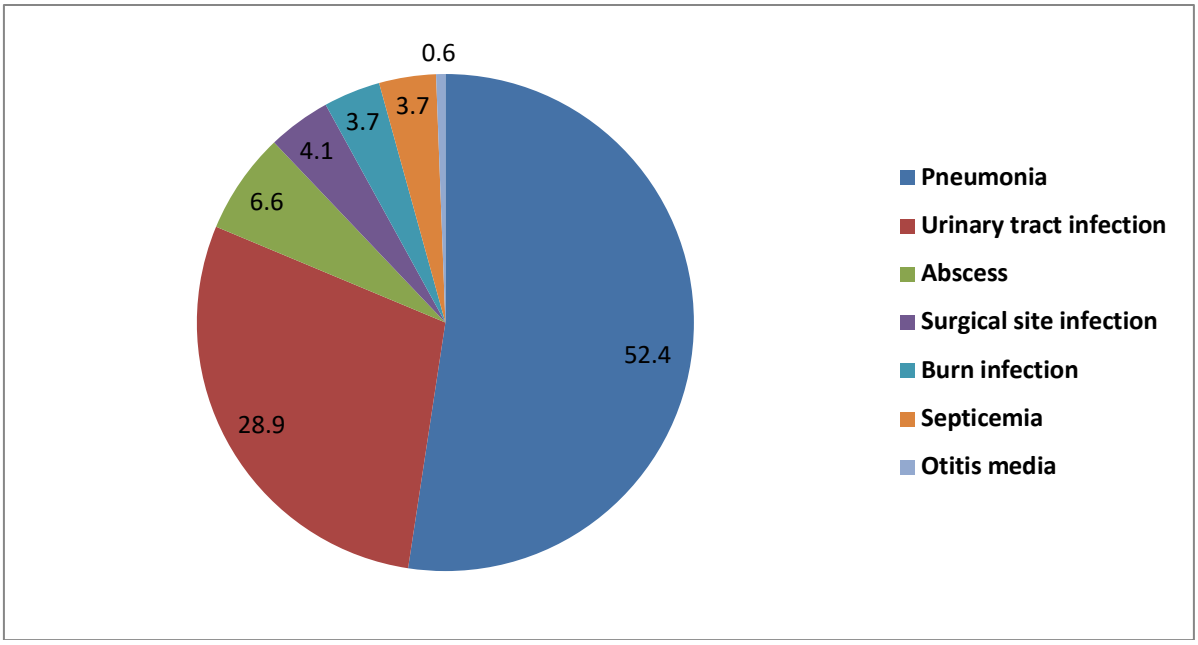

Figure 1: Proportion of isolates causing different spectrum of infections.

The isolates of *Pseudomonas aeruginosa* were most commonly identified from lower respiratory tract secretions 87(52.4%) in specimen like sputum, Broncho-alveolar lavage and Endotracheal aspirates, followed by urine 48(28.9%) as mentioned in the Table 3.

Table 3: Proportion of Isolates from various clinical samples

Clinical Sample	Number of isolates (N=166)	Proportion of isolates (%)
Pulmonary samples	87	52.4
Urine	48	28.9
Pus	16	9.6
Wound swab	09	5.4
Blood	06	3.7

Among the Beta-Lactams tested, the most effective agent was Imipenem 134(80.7%) followed by Meropenem 131(78.9%). The susceptibility results of combination of Beta-Lactams and Beta-Lactamase inhibitors tested were Piperacillin-tazobactum 129(77.7%) and Cefoperazone-sulbactum 103(67.5%). Among the Aminoglycosides, Netilmicin showed considerable sensitivity of 121(72.9%), followed by Gentamicin 109(65.7%) and Amikacin 104 (62.6%). Only 77(46.3%) isolates were sensitive to Ciprofloxacin and 84(50.6%) to Levofloxacin. All isolates were sensitive to Colistin. The observation is depicted in Table 4 (Fig. 2). A total of 57(34.3%) isolates were multi-drug resistant, i.e. resistant to three or more antibiotic classes.

Table 4: In vitro antibiotic susceptibility pattern of *Pseudomonas aeruginosa* isolates

Antibiotic (Disk concentration in µg)	Proportion of susceptibleisolates [N(%)]	Proportion of resistant isolates [N(%)]
Colistin (10)	166 (100)	0 (0)
Imipenem (10)	134 (80.7)	32 (19.3)
Meropenem (10)	131 (78.9)	35 (21.1)
Piperacillin Tazobactum (100/10)	129 (77.7)	37 (22.3)
Piperacillin (100)	84 (50.6)	82 (49.4)
Cefoperazonesulbactum (75/30)	112 (67.5)	54 (32.5)
Cefepime (30)	97 (58.4)	69 (41.6)
Ceftazidime (30)	91 (54.8)	75 (45.2)
Netilmicin (30)	121 (72.9)	45 (27.1)
Gentamicin (10)	109 (65.7)	57 (34.3)
Amikacin (30)	104 (62.7)	62 (37.3)
Levofloxacin (5)	84 (50.6)	82 (49.4)
Ciprofloxacin (5)	77 (46.4)	89 (53.6)

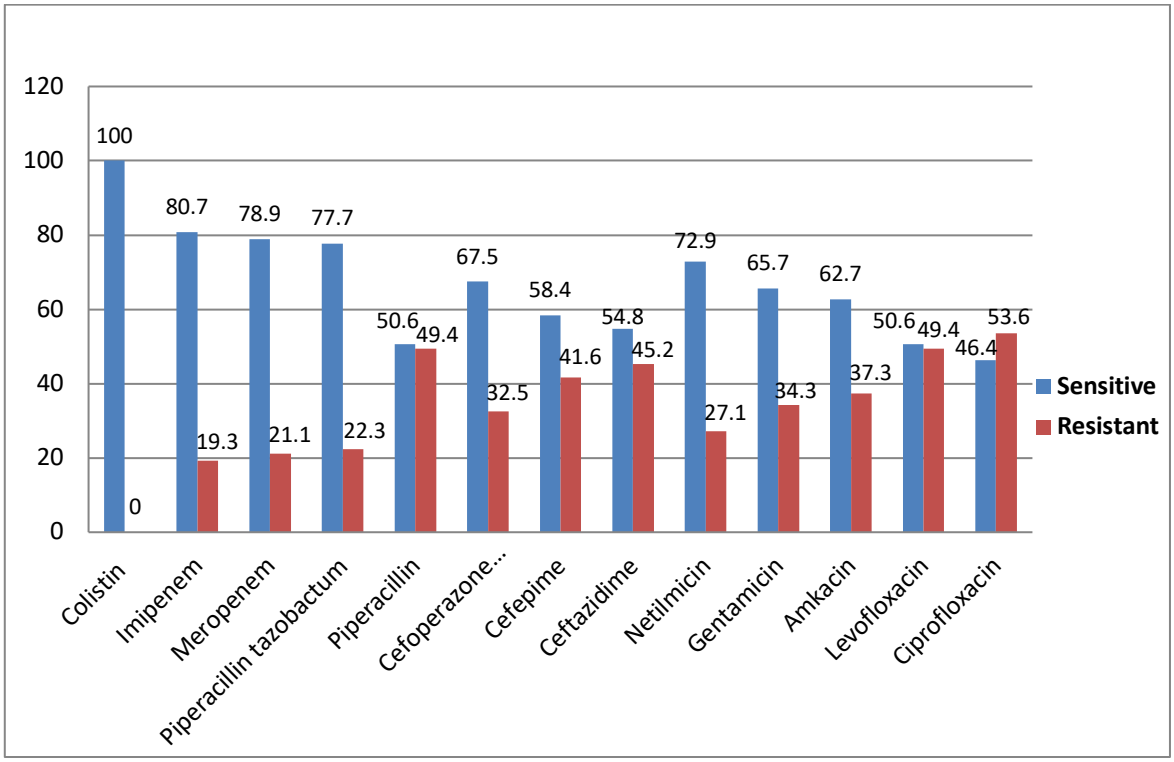

Figure 2: Proportion of Isolates Susceptible and Resistant to Antibiotics

Discussion

Over a period of two years in this study, 166 (7.8%) clinical isolates were identified as *Pseudomonas aeruginosa*. Most of the isolates were from male patients (57.8%) and in elderly age of more than 60 years (41.6%). The prevalence rate of infections caused by *Pseudomonas aeruginosa* varies among different healthcare centres, which may be mainly due to degree of adherence to infection control policies and practices. Various studies reported prevalence rate of isolation of *Pseudomonas aeruginosa* in clinical settings from as low as 4.8% [8] and 5.5% [9] to as high as 20.3%[10] and 32.1%[11]. The predominance of infections caused by *Pseudomonas aeruginosa* in males has also been stated in other studies[9,10]. Dash et al revealed significant association of infections caused by *Pseudomonas aeruginosa* in hospitalized elderly patients of more than 55 years age [1]. Yadav et al also found that most of these cases belonged to the age group of 41 – 60 years (41%) followed by above 60 years (32%) [12]. The high prevalence of such infections in elderly subjects might be due to presence of more comorbidities and immunocompromised status.

In this study, Pneumonia (52.4%) followed by Urinary tract infection (28.9%) and other pyogenic infections were the spectrum of infections caused by *Pseudomonas aeruginosa*. Accordingly, *Pseudomonas aeruginosa* were mostly isolated from pulmonary samples like sputum, tracheal aspirates, bronchoalveolar lavage, followed by urine. This observation is different from most of the other studies stating that *Pseudomonas aeruginosa*has been predominantly isolated from pus and urine [1,4,12]. Kumari et al in their five years retrospective study stated that majority of the isolates of *Pseudomonas aeruginosa* (35.7%) were from pulmonary samples like sputum, tracheal aspirates, bronchoalveolar lavage and pleural fluid [2]. A study from northern India also reported similar observation as ours, stating that 53.89% isolates of *Pseudomonas aeruginosa* were from respiratory samples [13]. In such cases, most of the isolates were from hospitalized patients, indicating nosocomial infection.

On analysis of the antibiogram, we observed that all of the isolates of *Pseudomonas aeruginosa* were sensitive to Colistin. It was seen that 19.3% and 21.1% isolates were resistant to Imipenem and Meropenem respectively, followed by Piperacillin tazobactum (22.3%) and Netilmicin (27.1%). Higher level of resistance were observed with Fluoroquinolones like Ciprofloxacin (53.6%) and Levofloxacin (49.4%) and Ureidopenicillin like Piperacillin (49.4%). Significant resistance were also seen with antipseudomonal Cephalosporins like Ceftazidime (45.2%) and Cefepime (41.6%). It was evident that combination of a Beta lactamase inhibitor like tazobactum with acid resistant penicillin like Piperacillin resulted in significantly increased spectrum of activity. This observation has also been reported in a study from Gujarat [10]. The isolates also exhibited less resistance (32.5%) to Cefoperazone sulbactum. The isolates also showed considerable resistance to other aminoglycosides like Gentamicin (34.3%) and Amikacin (37.3%).

Javiya et al from Gujarat reported that 19.6% resistance were offered by their isolates against Carbapenems like Imipenem and Meropenem and higher degree of resistance (69.6%) to fluoroquinolones as Ciprofloxacin and Levofloxacin. Unlike our observation, among aminoglycosides, they found Amikacin to be more sensitive (48.21%) than Netilmicin and Gentamicin. Similar to our observation, they also recommended Piperacillin tazobactum for treatment which had 64.29% susceptibility [10]. Kumari et al in their five year retrospective study at New Delhi, stated that the highest level of resistance of the isolates were against Levofloxacin (69%) and Ciprofloxacin (67%). They observed higher resistance to carbapenems which included Imipenem (53%) and Meropenem (63%), whereas the aminoglycosides where less resistant as Amikacin (58%) and Tobramycin (51%) [2]. Dash et al in their study at Odisha, reported that Imipenem, Meropenem and Piperacillin tazobactum were the most effective drugs against *Pseudomonas aeruginosa* showing low resistance rates of 6.4%, 8% and 11.3% respectively. They found that the isolates were highly resistant to Cephalosporins like Ceftazidime(77.7%) and Cefepime (64.8%), compared to fluoroquinolones [1].

It is evident that, even though the demographic characteristics and spectrum of infections remains quite similar in various geographical areas in the country, the antibiogram results significantly varies. This may be due to difference in antibiotic prescribing habits, injudicious use of antibiotics and dissimilar infection control practices. In a measure to counteract the development of multidrug and extended drug resistant strains due to various Beta lactamases, adherence to an uniform antibiotic policy and infection control measures at national level is utmost needed. Such policies are standardized and modified from time to time by analysis of the accumulated local antibiogram data. Such data generated from the published studies need to be based on standardized economical phenotypic methods or more preferably genotypic methods, which is a limitation of our study.

IDSA guidelines recommend a bench mark of 10-20% resistance at which first line empirical therapy should be modified [14]. In our centre, except Colistin and Imipenem, none of the antibiotics conformed to the recommended standard to be considered in empirical treatment. So, treatment here need to be based on antibiotic susceptibility test report. However, Piperacillin tazobactum and/or Netilmicin may be considered to initiate treatment of the infections caused by *Pseudomonas aeruginosa*. In order to reduce the antibiotic pressure, use of carbapenems may be restricted to multidrug resistant strains exhibiting production of Beta lactamases, in correlation with the antibiotic susceptibility report. The use of Colistin is warranted only for serious infections caused by those strains which are resistant to all other classes of antibiotics.

Conclusion

Lower respiratory tract infection and urinary tract infection were the common infections caused by *Pseudomonas aeruginosa*. Piperacillin tazobactum and/or Netilmicin may be considered for empirical treatment of suspected infection. Definitive treatment should be based on the culture and sensitivity test results only. Periodical analysis of the antibiogram need to be done to formulate and modify the antibiotic policy.

References

1. Dash M, Sanghamitra P, Narasimhan MV, Pattnaik S. Antimicrobial resistance pattern of *Pseudomonas aeruginosa* isolated from various clinical samples in a tertiary care hospital, South Odisha, India. Saudi J HealthSci. 2023; 3(1): 15-19.
2. Kumari M, Khurana S, Bhardwaj N, Malhotra R, Mathur P. Pathogen burden & associated antibiogram of *Pseudomonas spp.* in a tertiary care hospital of India. Indian J Med Res.2019; 149: 295-298.
3. Strateva T, Yordanov D. *Pseudomonas aeruginosa* – A phenomenon of bacterial resistance. J Med Microbiol. 2009; 58(9): 1133-1148.
4. Mohanasundaram KM. The antimicrobial resistance pattern in the clinical isolates of *Pseudomonas aeruginosa* in a tertiary care hospital: 2008-2010(3 year study). J ClinDiagn Res. 2011; 5(3): 491-494.
5. Collee JG, Miles RS, Watt B., Tests for identification of Bacteria. In: Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie and McCartney Practical Medical Microbiology. 14th ed. Singapore: Churchill Livingstone. 2006;136-149.
6. CLSI, 2019. Performance standards for antimicrobial susceptibility testing: Twenty-nine informational supplement. CLSI document M100 – S29. Clinical and Laboratory Standards Institute, Wayne; PA: USA.
7. Magiorakos AP., 2011. Multidrug-Resistant (MDR), Extensively Drug Resistant (XDR) and Pandrug Resistant (PDR) bacteria in healthcare settings. Expert proposal for a standardized international terminology. Available online at www.escmid.org.
8. Sambyal SS, Kaur A, Soodan PS, Mahajan B. Changing antibiotic sensitivity pattern in Gram negative nonfermenting isolates: A study in a tertiary care hospital. IOSR J Dent Med Sci. 2015; 14(5): 129-133.

9. Bindu D, Saikumar C. Antibiotic profile of *Pseudomonas aeruginosa* in a tertiary care hospital in Chennai, India. J Pure ApplMicrobiol.2022; 16(1): 430-434.
10. Javiya VA, Ghatak SB, Patel KR, Patel JA. Antibiotic susceptibility patterns of *Pseudomonas aeruginosa* at a tertiary care hospital in Gujarat, India. Indian J Pharmacol. 2008; 40(5): 230-234.
11. Rajat RM, Ninama GL, Mistry K, Parmar R, Patel K, Vegad MM. Antibiotic resistance pattern in *Pseudomonas aeruginosa* species isolated at a tertiary care hospital, Ahmedabad. Natl J Med Res.2012; 2: 156-159.
12. Yadav VC, Kiran VR, Jaiswal MK, Singh K. A study of antibiotic sensitivity pattern of *Pseudomonas aeruginosa* isolated from a tertiary care hospital in South Chattisgarh. Int J Med Sci Public Health. 2017; 6(3): 600-605.
13. Prakash V, Mishra PP, Premi HK, Walia A, Dhawan S, Kumar A. Increasing incidence of multidrug resistant *Pseudomonas aeruginosa* in patients of a tertiary care hospital. Int J Res Med Sci.2014; 2: 1302-1306.
14. Warren JW, Abrutyn E, Hebel JR, Schaeffer AJ, Stamm WE: Guidelines for antimicrobial treatment of uncomplicated acute bacterial cystitis and acute pyelonephritis in women. Clin Infect Dis. 1999; 29: 745–759.