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Research Article

Prevalence and Characterization of Multidrug-Resistant *Pseudomonas Aeruginosa* Isolates From Pus Samples in a Tertiary Care Hospital in Delhi/ NCR

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A B S T R A C T

Skin and soft tissue infections (SSTIs) are commonly associated with pus formation and are often caused by opportunistic pathogens such as Pseudomonas aeruginosa. This study aimed to determine the prevalence and antibiotic resistance pattern of P. aeruginosa isolated from pus samples in a tertiary care hospital. Out of the samples analyzed, 40% yielded P. aeruginosa, with higher isolation rates among female patients (57%). The organism showed maximum resistance to Cefepime (45%) and Ciprofloxacin (42%). These findings highlight the growing antimicrobial resistance in P. aeruginosa and emphasize the importance of proper infection control practices, sterilization, hand hygiene, and rational antibiotic use.

Keywords: Pseudomonas aeruginosa, Skin and Soft Tissue Infections, SSTIs, Pus Samples; Antimicrobial Resistance, Antibiotic Susceptibility, Cefepime Resistance, Ciprofloxacin Resistance, Opportunistic Pathogens, Infection Control, Tertiary Care Hospital

Introduction

Skin and soft tissues infections (SSTIs) often arise when microbial pathogens invade following injuries such as trauma, burns, or surgeries, typically leading to pus formation, a white to yellow fluid comprised of dead WBCs, cellular debris, and necrotic tissues [1–3] and beside this the various clinical condition leads to pus accumulation, acting as a major source of infection as it provide moist environment for pathogens growth, spread an infection. Pus samples represent a pyogenic infection which is characterized by local inflammation usually caused by any pyogenic bacteria; it leads to accumulation of dead leucocytes and infectious agent. [4] A break or abrasion in the skin can provide an entryway for these surface bacteria into the body, this stick and moist environment of abrasion allow bacteria to grow

exponentially into the cut. The body's defence starts acting by recruiting immune cells into the site attacking bacteria. Eventually, accumulation of these cells produces the thick whitish liquid that we call pus.[5]

Pseudomonas aeruginosa is a Gram –negative, rod shaped bacterium known for its mobility and characteristic blue-green pigment.[6, 7].Classified under the *Pseudomonadaceae* family, it is a non-fermenter and is highly adaptable due to its comparatively large genome, which spans approximately 5.5 to 7 million base pairs[8].This genetic diversity allows it to inhabit a wide range of environments, produce multiple virulence factors, and develop resistance to many modern antibiotics.[9,10]

Drug resistance in *Pseudomonas aeruginosa* can be intrinsic as well as extrinsic. *Pseudomonas aeruginosa* has been shown to develop resistance to multiple antibiotic groups, including beta-lactams, carbapenems, aminoglycosides, fluoroquinolones, and polymyxins. Phenotypes of MDR, Extensive Drug Resistant (XDR) and Pan Drug Resistant (PDR) are frequently encountered in *P.aeruginosa* causing nosocomial infections are associated with higher rates of mortality, morbidity, and overall healthcare costs [11]

According to the AMR Surveillance Network, Indian Council of Medical Research, 2023 the positivity rate of *Pseudomonas aeruginosa* was found as 15.47% (554/3582) from OPD, 11.2% (450/4018) from Ward and 12.09% (122/1009) from ICU[12]. The prevalence rate of *Pseudomonas aeruginosa* of pus sample was 58.82% in 2023 from the rural area of Haryana[13]

This study was carried out to assess the occurrence of *Pseudomonas aeruginosa* and to evaluate its pattern of resistance to antimicrobial agent from pus samples in tertiary care hospital from SGT Medical College Hospital and Research Centre.

Material and Methods

This was a cross-sectional study done in Department of Microbiology, SGT Medical college and Research Centre, Haryana, India from July, 2023 to September, 2024. Ethical approval was taken from Institutional Ethics Committee (Ethical letter no.IEC/FMHS/MD/MS/2023-04).

Inclusion Criteria

Total of 35 isolates of *Pseudomonas aeuruginosa* from Pus sample of patients attending different outdoor departments and admitted in this hospital was included.

Exclusion Criteria

- Repeat isolates from the same patient were excluded.
- Mixed flora i.e More than three types of colonies

Laboratory Diagnosis.[14-20]

Steps of Identification of bacterial isolates was done by standard microbiological procedure as follow

Samples of pus were gathered from different body locations, including various skin infections (for example, boils, small pus-filled lesions, and scratches), nasal injuries, ear infections, limbs, as well as from specimens were collected from organs such as the lungs, kidneys, and urinary bladder, along with samples obtained from catheter devices. These samples were transported using Cary-Blair medium until further processing for Gram staining and culture. The samples were carefully inoculated onto blood agar plates containing 5% sheep blood and onto MacConkey agar plates using sterile techniques. These culture plates were then incubated under aerobic conditions at temperatures between 35°C and 37°C for a period of 24 to 48 hours. Bacterial identification and characterization were conducted based on Gram stain results, microscopic morphology, colony appearance, and a series of biochemical tests, following established microbiological procedures.[21]

Antimicrobial Agents

Antibiotic discs containing amikacin(30µg), tobramycin(10µg), cefepime(30µg), meropenem(10µg), piperacillin /tazobactam(100/10µg), gentamicin10µg), levofloxacin(5µg), co-trimoxazole(25µg), imipenem(10µg), dorepenem(10µg), ceftriaxone(30µg), ciprofloxacin(5µg), minocycline(30µg), netilin(30µg), ceftazidime(10µg), tigecycline(10µg) were obtained from Himedia Laboratories (Mumbai, India).[22]

Antibiotics Susceptibility Testing

The antibiotic susceptibility of the bacterial isolates was assessed using the protocol outlined by the CLSI. For each isolate, a bacterial suspension was prepared and adjusted to match the turbidity of a 0.5 McFarland standard.14 This suspension was then evenly spread onto Mueller-Hinton agar plates. Antibiotic-impregnated discs from Himedia (Mumbai, India) were placed on the agar surface, and the plates were kept at 37°C for 24 hours to allow bacterial growth. After incubation, the diameters of the inhibition zones were measured, and the bacterial isolates were categorized as susceptible, intermediate, or resistant based on the interpretive criteria provided by CLSI guidelines.[23]

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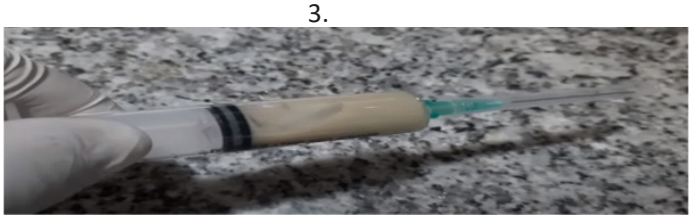
1. Sample Collection :Specimens (pus) was received in the Bacteriology laboratory From OPD and IPD
2.
3.



[14]

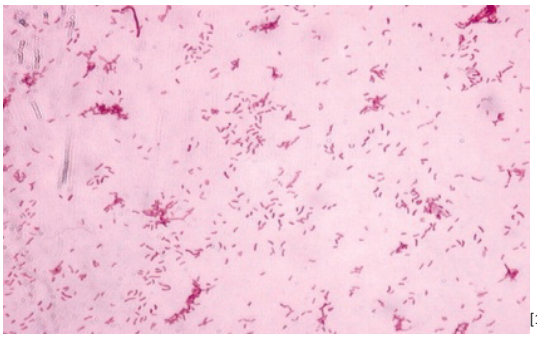
4. Culture on the Nutrient agar, Blood Agar, MaCconkey Agar



[15-17]

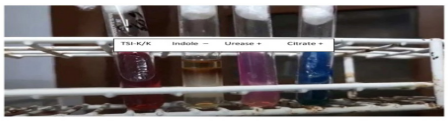
5. Keep the plate in a BOD incubator set at 37°C for duration of 18 to 24 hours

6. Gram staining



[18]

5.Biochemical reactions



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Statistical Analysis

A chi-square test was conducted, and a significance level of $p < 0.05$ was used to determine statistical significance.

Result

Demographic Details

A total 35 samples of pus were collected from IPD and OPD. The demographic details given as follow:

The study includes 35 patients, 57 % female and 40% male with significant P-value <0.01. There are 15 men and 20 women. The prevalence rate of infection caused by *Pseudomonas aeruginosa* is higher in female (57%) as compared to male (40%)(Table 1, Fig 1.). The prevalence rate of *Pseudomonas aeruginosa* is 40%.

The age-wise distribution of the study population shows that the highest number of cases was observed in the 30–40 years age group. In this group, a total of 13 cases were recorded, comprising 6 males and 7 females. This was followed by the 10–20 years and 50–60 years age groups, each contributing 5 cases. The 40–50 years and 60–70 years age groups showed 4 and 3 cases respectively. The least number of cases was observed in the 70–80 years age group with only 2 cases[Table2,Fig2]

TGC: Tigecycline, CAZ: Ceftazidime, AK: Amikacin,, GEN: Gentamycin, CIP: Ciprofloxacin, PIT: Piperacillin-Tazobactum, CoT: Co-trimoxazole, LE- levofloxacin, MRP: Meropenem, CTR: Ceftriaxone, CPM: cefepime, DOR: Dorepenem, TOB-Tobramycin, MI: Minocycline, ETP Etrapenem, NET- Netilin, IMP- Imipinem

Pseudomonas aeruginosa showed highest resistance against Cefepime(45%) followed by Ciprofloxacin(42%),Levofloxacin(39% Tigecycline(39%),Ceftriazone(33%), Gentamicin(27%), Amikacin (27%), Tobramycin(24%), Co-trimaxozole(24%), Ceftazidime(24%), Etrapenem(21%), Imipinem(21%), Meropenem(15%), Minocycline(15%), Netilin(12%), Dorepenem(12%), Piperacillin-Tazobactum (6%)[Table 3, Fig3]

Table 1.Demographic Characteristics of Study Population

Characteristics	Number(%)	P-value
Total	35	
Female	20(57%)	<0.01
Male	15(40%)	

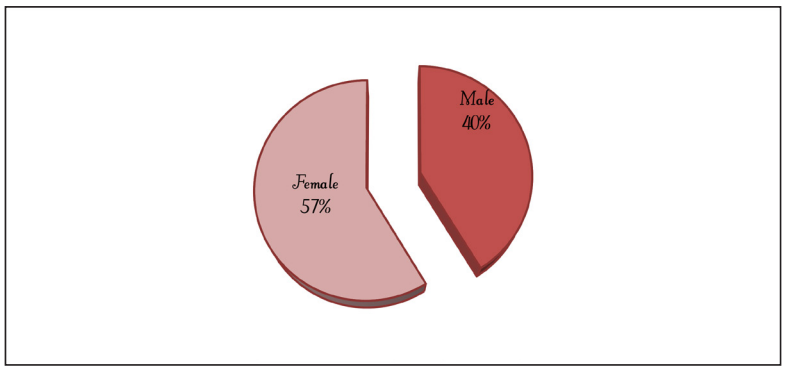

Figure 1.Gender wise distribution

Table 2.Age-wiseDistribution

Age	Male(%)	Female(%)
10-20	2(13%)	3(15%)
20-30	1(6%)	2(10%)
30-40	6(40%)	7(35%)
40-50	2(13%)	2(10%)
50-60	2(13%)	3(15%)
60-70	1(6%)	2(10%)
70-80	1(6%)	1(5%)
Total	15	20

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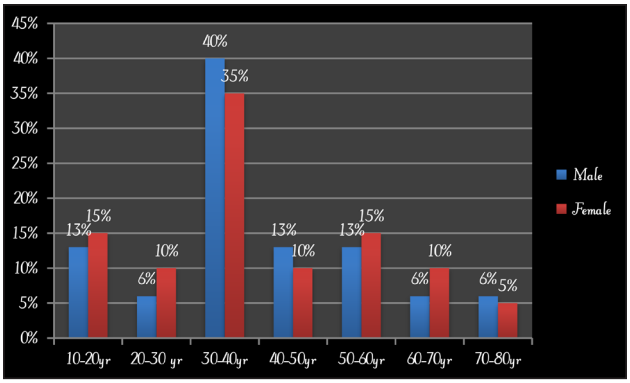

Figure 2.Age-wise distribution of Male\ Female

Table 3.Antimicrobial Resistance Profile of *Pseudomonas aeruginosa*

Antibiotic	Resistant(%)
Cefepime	45%
Ciprofloxacin	42%
Levofloxacin	39%
Tigecycline	39%
Ceftriazone	33%
Gentamicin	27%
Amikacin	27%
Tobramycin	24%
Co-trimaxozole	24%
Ceftazidime	24%
Etrapenem	21%
Imipinem	21%
Meropenem	15%
Minocycline	15%
Netilin	12%
Dorepenem	12%
Piperacillin-Tazobactum	6%

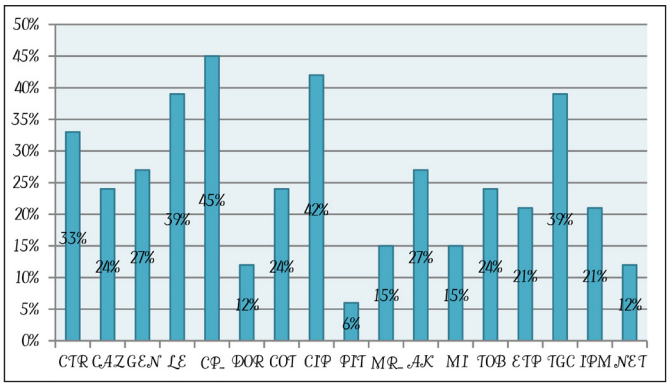

Figure 3.Antibiotic Resistance pattern of *Pseudomonas aeruginosa*

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Disscusion

The global issue of antimicrobial resistance in surgical site infections (SSI) is leading to extended hospitalization periods for patients, as well as increased rates of death and morbidity. *Pseudomonas aeruginosa* is a significant contributor to surgical site infections and wound infections in gram-negative non-fermentative bacteria. It is the predominant bacterium found in surgical site infections (SSIs) and wound infections. The emergence of antibiotic-resistant strains has made treating both infections acquired in the community and those acquired in hospitals particularly difficult. Accurate identification of the organism and selection of suitable antibiotics based on AST values are crucial for initiating the proper treatment[24]

In our present study, 35 Pus samples were included after positive cofirmation which is received in Microbiology laboratory with a prevalence rate 40% and resistance show by drugs areas followCefepime(45%)Ciprofloxacin (42%),Levofloxacin(39%),Tigecycline(39%),Ceftriazone(33%),Gentamicin(27%),Amikacin(27%),Tobramycin(24%), Co-trimaxozole(24%)Ceftazidime(24%), Ertapenem(21%), Imipinem(21%), Meropenem(15%), Minocycline(15%), Netilin(12%), Dorepenem(12%), Piperacillin-Tazobactum (6%). In a study by Kumar A *et al* in 2021[25] included 139 with prevalence rate 60.70% and drug –resistance reported as follow amikacin and tobramycin was 23.6% and 20.1%, ciprofloxacin was 33.2%,ceftazidime, cefoperazone and cefepime were 21.8%, 45.9%, and 25.7%. Imipenem and meropenem showed 26.2% and 20.5% piperacillin-tazobactam was only 13.5%. In another study from Rajput *et al* in 2023[26] shows the sample size 24 with prevalence rate 20.93% and drug resistance reported as Prevalence rate-20.93% Resistance profile : Amikacin(54%), Gentamicin(50%), Imipiem(54%), Meropenem(50%), Etrapenem & cefoxitin(Intrisic resistance), ceftazidime(54%), cefepime(70%), piperacillin-tazobactam(50%), Ciprofloxacin(70%), Levofloxacin(66%)

There are 57% Female whereas 40% male was affected from *psedomonas aerugiosa* causing Skin or wound abscess. Whereas the study of Salman *et al* [27] they show the percentage of female and male is 36.67% & 63.33% respectively. In another study from Saffar *et al* in 2019 [28]

shows that the Female (66.7%) and Male (33.3%) frequency were positive from infection. The age group between the 30-40yr is the highly affected age group. A study by Singh *et al*[13] in which the age of patients infected with *P.aeruginosa* ranges from ≤20 years to ≤60 years. Another similar study from Rajan *et al* in 2020 [29] in which the most frequent isolation of the *P. aeruginosa* was noted in the age group of 21–40 years. In our study the prevalence rate of MDR(70%), XDR(20%) o confirmed PDR strains. In the study by a Ahmed *et a*l shows the MDR (36.5%), XDR (12.0%), PDR (3.7%). Another study of Hafiz *et al* in 2021[30]shows the prevalence rate of MDR (9.7) XDR(11.8%0 and PDR (0.3%)

Table 4.Comparison Table

Study title and reference	Study place	Samples size	Key findings
Present study	Gurguram, Haryana	35	Prevalence rate-40% Resistance profile: Cefepime(45%) Ciprofloxacin(42%),Levofloxacin(39%), Tigecycline(39%),Ceftriazone(33%), Gentamicin(27%), Amikacin (27%), Tobramycin(24%), Co-trimaxozole(24%), Ceftazidime(24%), Etrapenem(21%), Imipinem(21%), Meropenem(15%), Minocycline(15%), Netilin(12%), Dorepenem(12%), Piperacillin-Tazobactum (6%)
kumar A *et al* in 2021[25]	Puducherry, Tamil Nadu	139	Prevalence rate – 60.70% Resistance profile: Resistance to amikacin and tobramycin was 23.6% and 20.1%, ciprofloxacin was 33.2%,ceftazidime, cefoperazone and cefepime were 21.8%, 45.9%, and 25.7%. Imipenem and meropenem showed 26.2% and 20.5% piperacillin-tazobactam was only 13.5%.
Rajput *et a*l in 2023[26]	Gwalior, Madhya Pradesh	24	Prevalence rate-20.93% Resistance profile : Amikacin(54%), Gentamicin(50%), Imipiem(54%), Meropenem(50%), Etrapenem & cefoxitin(Intrisic resistance), ceftazidime(54%), cefepime(70%), piperacillin-tazobactam(50%), Ciprofloxacin(70%), Levofloxacin(66%)

Conclusion

The prevalence rate of *Pseudomonas aeruginosa* in pus sample is 40%. *Pseudomonas aerugiosa* commonly diagnosed from the type of sample like Pus formation in abscess, Pus formation on Surgical site due to contaminated or inappropriate sterilization of medical devices like mechanical ventilator, catheter r and another factors like fomite and improper hygiene. Today, the antimicrobial

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sensitivity pattern of *Pseudomonas aeruginosa* is highly resistance to all drug.

So, for avoid and protect from this type of infection, follow the proper sterilization procedure for medical equipments. Beside this proper hygiene should be maintained like properly hand washing, Proper surface cleaning. To best way to prevent the drug resistance is to use antibiotic correctly.

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