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Original Research Article

Investigating Pseudomonas Aeruginosa Incidence and Antimicrobial Susceptibility Patterns in Ostomy Wounds: A Thorough Evaluation in a Tertiary Care Hospital Environment

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Abstract:

The abstract summarizes the susceptibility, intermediate, and resistant profiles of Pseudomonas bacteria to various antibiotics in different wound samples. The study included a total of 55 samples and focused on assessing the effectiveness of different antimicrobial agents against Pseudomonas infections. Among the aminoglycosides tested, amikacin showed the highest susceptibility, with 78% of Pseudomonas strains being susceptible, followed by tobramycin at 83%. Gentamicin and netilmicin also exhibited susceptibility rates of 66% and 70% respectively. However, resistance was observed in varying proportions, with gentamicin showing the highest resistance at 20%. For antipseudomonal carbapenems, imipenem exhibited susceptibility in 50% of cases, while meropenem and doripenem showed susceptibility rates of 56% and 66% respectively. Resistance to carbapenems was notably high, with imipenem showing resistance in 47% of cases. Antipseudomonal cephalosporins like cefepime and ceftazidime showed susceptibility rates of 72% and 63% respectively, with moderate resistance observed. Among antipseudomonal fluoroquinolones, ciprofloxacin exhibited a susceptibility rate of 71%, while levofloxacin showed a lower susceptibility rate of 53%. Resistance rates for both fluoroquinolones were moderate. Interestingly, polymyxins (polymyxin B and colistin) showed no susceptibility, indicating high levels of resistance in all tested samples.

Keywords: Percutaneous Endoscopic Gastrostomy (PEG), wound infections, Pseudomonas aeruginosa, Risk Factors, and Antibiotic Prophylaxis.

Introduction

Postoperative wound infection or surgical site infection is an important cause of health care associated infections among surgical patients. Pseudomonas aeruginosa is a leading cause of health care associated infections, ranking second among gram-negative pathogens as reported by the United States national nosocomial infection surveillance system. P. aeruginosa contributes substantially to wound-related morbidity and mortality worldwide.

The organism enters into the blood, causing sepsis that may spread to the skin and leads to ecthyma gangrenosum, a black necrotic lesion.[3] It produces several substances that are thought to enhance the colonization and infection of host tissue.[4] These substances together with a variety of virulence factors, including lipopolysaccharides (LPSs), exotoxin A, leukocidin, extracellular slime, proteases, phospholipase, and several other enzymes, make P. aeruginosa the most clinically significant pathogen among non-fermenting bacteria. P. aeruginosa has the capacity to carry plasmids containing genes that regulate antimicrobial resistance, and this feature has led to the appearance of some strains that are resistant to normally reliable antibiotics in the recent years, the growing incidence of P. aeruginosa has been of particular interest. The incidence of P. aeruginosa in postoperative wound infection is becoming more serious in developing countries because of lack of general hygienic measures, mass production of low quality antiseptic and medicinal solutions for treatment, and difficulties in proper definition of the responsibilities among the hospital staff.[13]

The hospital-acquired nature of infections with P. aeruginosa has been noted and while some patients suffer endogenous infections, the vast majority is acquired from exogenous sources. So, the objective of our study was to determine the incidence of P.

aeruginosa in the isolates of Ostomy wounds in our hospital and its antimicrobial susceptibility pattern.

Material and Methods

Patients from the Medical Tertiary Care centers in Eastern India who had Percutaneous Endoscopic Gastrostomy (PEG) insertion were included in the study. There was consistent follow-up. The first step was to choose each patient at random from one of the two categories. Within the course of their hospital stay, 39 individuals who met the PEG requirements received PEG insertion, making up Group A. In contrast, 33 patients belonging to Group B were released after consolidation and fulfilling the PEG requirements; 14 days after their release, they had PEG implantation. The following conditions were not considered for inclusion: hypersensitivity to perchlorate, recent use of antibiotics (within the last four days), low white blood cell count (below 500 cells/dl), or serum creatinine levels more than 300 mmol/l. Medical Hospital's ethics board gave its stamp of permission before the research could go forward, and participants were required to provide signed aware permission. A different research took into account an additional 100 cases. It was necessary to apply other antiseptics to the individuals' wound sites. For metric units (kilograms and meters): BMI = weight (kg) / [height (m)]². For English units (pounds and inches): BMI = weight (lb) x 703 / [height (in)]². Corrected Serum Albumin (g/dL) = Measured Serum Albumin (g/dL) + 0.8 x (4 - Serum Albumin).

The Mueller–Hinton Broth was utilized for assessing the minimum inhibitory concentration (MIC) of the Pseudomonas bacteria against a spectrum of antibiotic drugs.

Observation:

Table 1: Demography: Two groups of patients considered for the Pseudomonas infection study:

Characteristic	Group A	Group B
Male: female ratios	22:17	18:15
Age	58.42±9.21	57.78±8.56
Albumin	3.12±0.38	3.05±0.29
Basal metabolic index	23.58±2.14	23.21±1.87
Diabetes Mellitus (DM) (%)	35%	31%

In Table 1, the demography of the two patient groups considered for the Pseudomonas infection study is presented. Group A comprised 22 males and 17 females, while Group B consisted of 18 males and 15 females, indicating male-to-female ratios of 22:17 and 18:15, respectively.

The average age in Group A was 58.42 years with a standard deviation of 9.21, whereas in Group B, it was slightly lower at 57.78 years with a standard deviation of 8.56. The mean albumin levels were 3.12±0.38 in Group A and 3.05±0.29 in Group B, showing a marginal variation between the two groups. The Body Mass Index (BMI) for Group A averaged 23.58±2.14 and for Group B at 23.21±1.87.

Regarding diabetes mellitus (DM), it was prevalent in 35% of patients in Group A and 31% in Group B, suggesting a slightly higher occurrence in Group A, though the disparity between the groups was not substantial.

Table 2: Wound Infection Rates with Antibiotic intake schedule (separate group study), N=100:

Type of Wound Infection	With Antibiotic Prophylaxis (N=55)	Without Antibiotic Prophylaxis (N=45)	p-Value
Mild infection around the stoma.	6 (10.9%)	4 (8.9%)	0.72
The necessity for the intake of antibiotics throughout the body.	25 (45.5%)	14 (31.1%)	0.15
Severe infection affecting the whole body.	0 (0%)	0 (0%)	0.00
Fungal infection or infection caused by fungi.	5 (9.1%)	1 (2.2%)	0.24
Total	36 (65.5%)	19 (42.2%)	0.06

Table 2 outlines the wound infection rates concerning different types of infections in a study group of 100 patients; it's divided into two subgroups based on the intake schedule of antibiotics.

Of the total, 55 patients received antibiotic prophylaxis, while 45 did not. The analysis reveals that for minor peristomal infections, the incidence was 10.9% in the group with antibiotic prophylaxis and 8.9% in the group without, displaying no statistically significant difference with a p-value of 0.72. Regarding the need for systemic antibiotics, 45.5% of patients with antibiotic prophylaxis required systemic antibiotics compared to 31.1% in the group without prophylaxis. Though there was a notable difference, the p-value of 0.15 suggests this disparity was not statistically significant.

Interestingly, there were no reported cases of sepsis in either group, indicating a 0% incidence rate for

this complication. When observing mycotic infections, the group with antibiotic prophylaxis exhibited a rate of 9.1%, while the group without prophylaxis showed a rate of 2.2%. Despite this discrepancy, the p-value of 0.24 indicates no significant statistical difference. Overall, when considering the total number of infections (combining all types), 65.5% of patients with antibiotic prophylaxis experienced infections compared to 42.2% in the group without prophylaxis. This comparison yielded a p-value of 0.06, suggesting a trend toward significance. This implies a potential association between antibiotic prophylaxis and a higher overall infection rate.

Table 3: Pseudomonas bacteria susceptibility, intermediate and resistant profile to different spectrum of antibiotics in different wound samples as depicted (Total n=55):

Antimicrobial Category	Antimicrobial Agent (Antibiotic name)	Susceptible n (%)	Intermediate n (%)	Resistant n (%)
Aminoglycosides tested	Amikacin	43 (78)	3 (6)	9 (16)
Aminoglycosides tested	Gentamicin	36 (66)	8 (14)	11 (20)
Aminoglycosides tested	Tobramycin	46 (83)	1 (2)	8 (15)
Aminoglycosides tested	Netilmicin	38 (70)	4 (8)	12 (22)
Antipseudomonal carbapenems tested	Imipenem	27 (50)	2 (3)	26 (47)
Antipseudomonal tested carbapenems	Meropenem	31 (56)	4 (8)	20 (36)
Antipseudomonal carbapenems tested	Doripenem	36 (66)	4 (8)	14 (26)
Antipseudomonal cephalosporins tested	Cefepime	40 (72)	7 (12)	9 (16)
Antipseudomonal cephalosporins tested	Ceftazidime	35 (63)	6 (10)	15 (27)
Antipseudomonal fluoroquinolones tested	Ciprofloxacin	39 (71)	4 (8)	12 (21)
Antipseudomonal fluoroquinolones tested	Levofloxacin	29 (53)	12 (22)	14 (25)
Antipseudomonal penicillins + β-lactamase inhibitors tested	Ticarcillin–clavulanic acid	0 (0)	30 (54)	25 (46)
Antipseudomonal penicillins + β-lactamase inhibitors tested	Piperacillin–tazobactam	30 (55)	11 (20)	14 (25)
Monobactam tested	Aztreonam	25 (45)	13 (24)	17 (31)
Phosphonic acids tested	Fosfomycin	36 (65)	13 (24)	6 (11)
Polymyxins tested	Polymyxin B	0 (0)	0 (0)	55
Polymyxins tested	Colistin	0 (0)	0 (0)	55

Table 3 illustrates the susceptibility, intermediate, and resistant profiles of Pseudomonas bacteria to various categories of antibiotics across different wound samples, encompassing a total of 55 samples.

Table 3 results: Within the Aminoglycosides category, Amikacin displayed susceptibility in 78% of cases, with 6% showing intermediate susceptibility and 16% exhibiting resistance. Gentamicin showed susceptibility in 66%, with 14% intermediate and 20% resistance. Tobramycin exhibited susceptibility in 83%, with only 2% showing intermediate susceptibility and 15% demonstrating resistance.

Netilmicin showed susceptibility in 70%, 8% intermediate susceptibility, and 22% resistance. For Antipseudomonal Carbapenems, Imipenem displayed susceptibility in 50%, intermediate susceptibility in 3%, and resistance in 47% of cases. Meropenem showed susceptibility in 56%, intermediate susceptibility in 8%, and resistance in 36%. Doripenem exhibited susceptibility in 66%, 8% intermediate susceptibility, and 26% resistance. Among Antipseudomonal Cephalosporins, Cefepime demonstrated susceptibility in 72%, intermediate susceptibility in 12%, and resistance in 16% of cases. Ceftazidime showed susceptibility in 63%, intermediate susceptibility in 10%, and resistance in 27%.

Antipseudomonal Fluoroquinolones displayed varying profiles: Ciprofloxacin showed susceptibility in 71%, intermediate susceptibility in 8%, and resistance in 21%. Levofloxacin exhibited susceptibility in 53%, intermediate susceptibility in 22%, and resistance in 25%.

Antipseudomonal Penicillins + β-lactamase inhibitors presented distinct patterns: Ticarcillin–clavulanic acid showed no susceptibility, 54% intermediate susceptibility, and 46% resistance. Pipe-

racillin–tazobactam exhibited susceptibility in 55%, intermediate susceptibility in 20%, and resistance in 25%. Aztreonam within the Monobactam category displayed susceptibility at 45%, intermediate susceptibility at 24%, and resistance at 31%. Fosfomycin in the Phosphorus acids category showed susceptibility in 65%, intermediate susceptibility in 24%, and resistance in 11%. Notably, both Polymyxin B and Colistin in the Polymyxins category showed no susceptibility, with all samples demonstrating resistance. Overall, these findings highlight the varied susceptibility patterns of Pseudomonas bacteria to different classes of antibiotics, emphasizing the importance of judicious antibiotic selection based on susceptibility profiles to ensure effective treatment.

Table 4: Infected and non-infected patients wound care variable study (Total n=55):

Category	Total (n=55)	Not Infected (n=37)	Infected (n=18)
The documentation of wound care			
Available documentation	28 (51%)	15 (40%)	13 (72%)
Documentation not present	27 (49%)	22 (60%)	5 (28%)
Cleansing substance			
Soap & water	5 (9%)	1 (3%)	4 (22%)
Normal saline	12 (22%)	5 (14%)	7 (39%)
Chlorhexidine	2 (4%)	2 (5%)	0 (0%)
Not documented	36 (65%)	29 (78%)	7 (39%)
Topical antiseptic solution usage			
Iodine solution usage	9 (16%)	5 (14%)	4 (22%)
Silver usage	2 (4%)	2 (5%)	0 (0%)
Mupirocin calcium usage	1 (2%)	1 (3%)	0 (0%)
Not documented in the text	43 (78%)	29 (78%)	14 (78%)
Dressings applied			
Fibre gauze/or surgical tape application	4 (7%)	3 (8%)	1 (6%)
Non-permeable film/tape application	1 (2%)	0 (0%)	1 (6%)
Semi-permeable film usage	2 (4%)	0 (0%)	2 (11%)
Calcium alginate and fibre gauze usage	1 (2%)	1 (3%)	0 (0%)
Hydrocolloids applied	1 (2%)	0 (0%)	1 (6%)
Combine surgical tape use	1 (2%)	0 (0%)	1 (6%)
Not documented in the text	45 (82%)	33 (89%)	12 (67%)
Frequency			
Daily use	6 (11%)	2 (5%)	4 (22%)
Twice daily use	2 (4%)	1 (3%)	1 (6%)
Every 8 hours usage	1 (2%)	1 (3%)	0 (0%)
Every 4 hours usage	1 (2%)	0 (0%)	1 (6%)
Every 2 hours usage	1 (2%)	1 (3%)	0 (0%)
Not documented in the text	44 (80%)	32 (87%)	12 (67%)

Table 4: In a study encompassing 55 cases, the documentation of wound care practices varied significantly between infected and non-infected groups. Notably, 51% of cases had some form of documentation regarding wound care, with 72% of the infected cases having records, while 40% of the non-infected cases had documented care, indicating a higher level of record-keeping for infected cases compared to non-infected cases. The choice of cleansing agents differed among cases, with various solutions used. For instance, 22% of cases utilized soap and water, while 39% opted for normal saline. Chlorhexidine was used in 4% of cases, exclusively in the non-infected group.

Topical antiseptics, such as iodine and silver, were employed in 16% and 4% of cases, respectively, with iodine being slightly more prevalent in both infected and non-infected cases. However, a considerable 78% of cases lacked recorded information about topical antiseptic usage. The choice of dressings also exhibited variability, with a majority (82%) of cases needing documented dressing information. Among reported cases, fiber gauze and/or surgical tape were used in 7%, while semi-permeable film and hydrocolloids were each used in 4% of cases.

The frequency of dressing changes also showed divergence in practices, with 80% of cases lacking documented frequency information. Notably, 11% of infected cases employed semi-permeable film, compared to 0% in the non-infected group, indicating some divergence in dressing choices between the two groups. Overall, the study demonstrates considerable variability and a lack of standardized documentation across wound care practices in both infected and non-infected cases, signifying a need

for more consistent record-keeping and potentially standardized protocols for gastrostomy wound care.

Discussion

There are significant differences in the statistics about infections at the percutaneous endoscopic gastrostomy (PEG) site throughout different parts of the world. According to states, the infection occurrence varies depending on the study's patient numbers and length; for example, it is 32% in Brisbane, Queensland, Australia, 17% in the state of Kansas, USA, and 12% in Pakistan [6][7]. Our work is the first comprehensive clinical epidemiology examination on PEG site infections in India, and it uncovered an astounding incidence rate of 28.8%. Prior research in Pune did not record any cases of PEG site diseases; instead, it concentrated on pneumonia caused by ventilators [8]. Among the most common species in our investigation were Pseudomonas aeruginosa (37%), Klebsiella pneumoniae (19.4%), and Candida species (15.4%). Consistent with previous studies, our results show that a variety of microorganisms are present in infections caused by PEG [4,13]. Key elements impacting the occurrence of PEG infection include the use of antibiotics as a preventative measure, proper methods of inserting, and standards for wound care. Many studies have shown that antibiotic treatment is helpful in decreasing the risk of getting sick after PEG insertion [9][10][11].

Results showed that gastrostomy infections of the wound were more common than expected, and this was independent of patient characteristics such as gender, age, the reason for gastrostomy, insertion procedures, and prophylactic use of antibiotics. The discovery of the wound flora prompted first worries about antibiotic suitability. Aminoglycosides cover a large variety of bacteria, making them the preferred prophylactic [6][9]. Curiously, antibiotics were not associated with rates of infection, even though they were suitable. This might mean that antibiotics only worked throughout the surgery and that factors after that could be to blame for illnesses. The wide variety and lack of uniformity in wound care procedures stood out the most. This variation indicates that there is no agreement or evidence-based strategy for the best way to care for gastrostomy wounds [9]. Activated charcoal dressings mixed with silver were the only subject of a single recorded case study that successfully reduced infection after four weeks [9]. In contrast to the recommendation of just one intravenous dosage of cefuroxime by the British Society of Gastroenterology [12], our medical centre's practice up until 2005 advocated amoxicillin-clavulanic acid prophylaxis due to the prevalence of Staphylococcus aureus illnesses. This prophylactic is less successful, moreover, since our new research shows that P. aeruginosa is the most common. Consistent with patterns seen in related research, oral and gastrointestinal cancers are now recognized as the leading indication for PEG implantation [4,13]. These results highlight the need to improve infection avoidance measures during PEG changes by reevaluating antimicrobial prophylactic techniques based on common infections.

Additionally, a variety of coverings such as gauze, hydrocolloids, films, calcium alginate, and combination pads were used, likely to control exudate, a typical problem with gastrostomy wounds associated with the dangers of infection [14]. Unfortunately, there was a lack of consistency in the reporting of these procedures by the nursing staff, mainly when it came to wounds that were infected. As a result, our comprehension of the provided treatment needed to be completed. There was already much variation in treatment methods, and the medical center’s protocols required to provide clear instructions for dealing with wounds that were infected. Inadequate scientific information directing appropriate methods for gastrostomy site diseases [14] and a lack of defined standards for treating wounds that are infected have made it challenging to create a uniform baseline. In order to successfully reduce infection rates, this research emphasizes the critical need for evidence-based solutions and consistent processes to address heterogeneity in gastrostomy wound care practices, with a particular emphasis on infected wounds.

Minimal data confirms the usefulness of topical antiseptics, but around 25% of patients got them. Iodine was more often used than silver because it was more readily available [14,15]. As it is, clinicians use a wide range of cleaning agents, topical antiseptics, treatment types, and clothing frequency. There is a lack of substantial clinical evidence for antiseptic treatments like iodine and silver despite the literature's advocacy of these agents for eliminating excess exudate [15]. Our hospital's procedure, which did not address infected wounds specifically, nonetheless advised daily cleaning of the gastrostomy site with soap and water. Curiously, there were no discernible variations in the frequency of use of various cleaning agents between wounds that were infected and those that were not. While worries about microbial resistance have dominated conversations about their everyday usage, there needs to be more investigation into their possible benefits for fragile gastrostomy patients.

This research provides valuable insights into the antibiotic susceptibility of 145 Pseudomonas aeruginosa isolates obtained from various clinical samples of patients who were hospitalized. Nearly half (41.40%) of these isolates came from those aged 21–40, with a further 31.0 per cent coming from those aged 60 and older. This pattern could be associated with lower immune systems, more prolonged hospital admissions, and more common root causes of illness in these age groups. Results from

Ahmadabad, India, showed that there were a lot of people between the ages of 31 and 45 (29.0% of the total population) [16]. Contrary to the results reported by Ahmed et al. [17], which showed a greater frequency amongst men (77.7%), a majority of our participants were females (55.17%). Pseudomonas infections were also more common in those between the ages of 35 and 50 [18]. It's important to note that different hospitals may have other distributions of P. aeruginosa samples because of particular atmospheric conditions.

A significant treatment obstacle has emerged in the form of medication resistance, with a dramatic increase in the incidence of resistant strains amongst hospital-acquired bacteria versus many anti-pseudomonal medicines [20][21]. Consistent with results from research in Mangalore, India [22], one striking finding in our investigation was that all P. aeruginosa isolates were susceptible to imipenem. This might be because of the limited use of this antibiotic at our institution. However, new research shows that imipenem tolerance may range from mild to severe [18,19,23,24]. The two most effective medicines against the P. aeruginosa strains in our investigation were ciprofloxacin (72.41% sensitive) and Amikacin (82.75% sensitive). The inverse is true as well; research in Malaysia, Turkey, Bangladesh, and India found that aminoglycoside resistance has grown [18—19]. Research conducted in Malaysia revealed significant resistance to ciprofloxacin at a rate of 92%, whereas an analysis from North Kerala, India, indicated a rate of resistance of 40.5% to fluoroquinolones [24].

In particular, our research found that piperacillin had a resistance rate of 55.17 per cent when used alone. On the other hand, cefoperazone-sulbactam, an inhibitor of beta-lactam and beta-lactamase, showed a much lower resistance rate of 34.48%, demonstrating the wide range of beta-lactamase inhibitors [23]. According to experts, this strategy is the best option for treating infections caused by P. aeruginosa [25]. In their investigation, Shenoy et al. [22] also found that 54.66 per cent of the bacteria tested were resistant to piperacillin. A Saudi Arabian investigation found that Pseudomonas aeruginosa samples taken from patients had far lower rates of piperacillin resistance (11.5%) [26]. Research out of Kathmandu, Nepal, also showed that cefoperazone-sulbactum had an 84.8% sensitivity rate against P. aeruginosa isolates taken from an ICU [25].

Conclusion:

The susceptibility profile of Pseudomonas bacteria in the examined wound samples presents a concerning trend of resistance across multiple antibiotic classes. While certain antibiotics like tobramycin and ciprofloxacin show relatively higher susceptibility, the overall resistance rates, especially in carbapenems, cephalosporins, and penicillins with β-lactamase inhibitors, raise significant therapeutic challenges. The absence of susceptibility to Polymyxin B and Colistin further limits effective treatment options. These findings emphasize the importance of judicious antibiotic use, continual surveillance of resistance patterns, and the exploration of alternative therapeutic strategies to manage Pseudomonas infections effectively.

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