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Research Article

Prevalence of Multidrug Resistant *Pseudomonas aeruginosa* Post-Operative Surgical Site Infections in Exploratory Laparotomy

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Abstract

Objective: This study examines the antibiotic sensitivity of *Pseudomonas aeruginosa* strains that are resistant to several drugs and collected from surgical site infections in patients having exploratory laparotomies.

Methodology: This study determines the prevalence of multidrug resistant patterns in *P. aeruginosa* isolated from clinical wound swabs. The research was conducted at IIMT University Department of Microbiology in Meerut, Uttar Pradesh, India. A total of 82 pus specimens were incubated on Cetrimide and MacConkey agar for 24 hours at 37°C. Colony morphology, microscopy, and biochemical assays were employed to identify *P. aeruginosa*. The Kirby-Bauer disc diffusion method were used to perform the antibiotic susceptibility test, and the data analysis were done in compliance with the Clinical and Laboratory Standard Institute (CLSI) guidelines.

Result: In total, 82 post-surgical site clinical samples were collected from wound swabs. In 24 cases, *P. aeruginosa* were detected (29.27%). Overall, 10 isolates (41.67%) showed multidrug resistance, meaning they could withstand three or more classes of antibiotics. High sensitivity was demonstrated by piperacillin (70.83%) and ofloxacin (70.83%). The resistance to ciprofloxacin was 87.50%. The first antibiotic that *P. aeruginosa* isolates demonstrated resistance to ciprofloxacin, which were followed by ampicillin/sulbactam, gentamicin, amikacin, piperacillin, and ofloxacin.

Conclusion: In addition to harming patients, postoperative wound infections significantly impair healthcare systems in terms of financial costs, morbidity, and mortality.

Keywords: Exploratory Laparotomy, Multidrug resistant, *P. aeruginosa*, Surgical Site Infections, Wound swab, Disc-diffusion.

1. Introduction

Postoperative surgical site infections (SSIs) are among the most prevalent healthcare-associated diseases affecting surgical patients. Longer hospitalizations stay, more admission costs, and higher mortality rates are all caused by wound infections [1]. A substantial contributor to healthcare-associated infections, *P. aeruginosa* is the second most prevalent Gram-negative bacterium, according to the US National Infection Surveillance System. *P. aeruginosa* is a substantial contributor to wound-related problems worldwide, frequently resulting in considerable morbidity and mortality [2]. A key treatment challenge is the rising prevalence of MDR *P. aeruginosa* in SSIs after surgery, particularly in patients having exploratory laparotomy, a high-risk surgical procedure that is frequently associated with serious infections [3].

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SSIs are infections that arise after a surgical procedure. Within 30 days of surgery, these infections generally emerge at or around the surgical site or region of the body [4, 5]. However, microbiological methods such as culture media and disk diffusion method for identifying organisms and testing antibiotic sensitivity typically needs 48–72 hours. In this time, infection can spread if the appropriate empirical therapy is not given promptly [6]. The nature and complexity of the surgical procedure, as well as the abdominal organ involvement makes exploratory laparotomy a high-risk surgery with high proclivity for SSIs. Factors like overuse of antibiotics, biofilm formation and the production of resistance genes such as blaCTX M-15, which for some years now have been associated with infections caused by CTX-M producers *Klebsiella pneumoniae*, are also related to the occurrence of MDR *P. aeruginosa* in these infections [7].

Among non-fermenting bacteria, *P. aeruginosa* is the most clinically significant pathogen due to its several virulence markers like exotoxin "A",

lipopolysaccharides (LPS), extracellular slime, proteases, leukocidin, phospholipase. *P. aeruginosa* car separate plasmids that contain genes facilitating drug resistance. It has also led in the appearance of a huge number of antibiotic-resistant strains [8].

Recent surveillance studies show that MDR *P. aeruginosa* is being detected with increasing frequency in nosocomial post-operative infections, especially from surgical wards and intensive care units (ICU) [9]. The World Health Organization MDR *P. aeruginosa* an extremely important pathogen, requiring immediate attention and development of new therapies [10]. Understanding the epidemiology, risk factors, the patterns of antibiotic susceptibility and the MDR *P. aeruginosa* frequency in SSI after exploratory laparotomy is essential in order to formulate an appropriate tailored antibiotic treatment and effective infection management strategies. This study aims to assess the prevalence and patterns of antibiotic resistance caused by multidrug-resistant *P. aeruginosa* in postoperative SSIs in patients who have undergone exploratory laparotomies. The data gathered will provide useful information on the prevalence of multi-drug-resistant infections. Along with that, it will encourage development of appropriate strategies aimed at optimizing perioperative antibiotic prophylaxis and treatment.

1. Materials and Methods

The Department of Life Science and Technology performed the study in the microbiology laboratory at IIMT University in Meerut, Uttar Pradesh, India. Following recognized microbiological practices, all wound swab samples obtained from inpatients of the hospital during the period of December 2023 to June 2024 were processed for bacteria and pathogen isolation and classification [11]. By informed consent, all patients of any age who underwent surgery during the study period and later presented with postoperative wound infections were included. Conversely, patients with infected exploratory laparotomy and those with postoperative wound infections occurring beyond 30 days after the procedure were excluded [12].

1.1. Sample collection culture media and biochemical test

In this study, 82 emergency instances of abdominal exploratory laparotomies were included. Using sterile cotton swabs, we obtained aseptic postoperative wound swabs from several wards. In order to check for aerobic bacteria, every swab was immediately processed in the lab. Wound samples were used to inoculate cetrimide, MacConkey, and blood agar, which were then incubated at 37 °C for 24 hours. Following incubation, the bacteria were identified by Gram's staining, microscopy, and common biochemical tests, such as the production of catalase, indole, mannitol, citrate, and oxidase [13, 14]. Antimicrobial sensitivity has been evaluated using the disc diffusion method in compliance with accepted norms [15].

1.2. Antibiotic susceptibility testing

To validate *P. aeruginosa* isolates, Mueller-Hinton agar (MHA) was tested for antibiotic sensitivity test (AST) using commercially available antibiotic discs from PBL India. AST were performed using the disc diffusion technique in compliance with the clinical and laboratory standards institute's standards [16]. P. aeruginosa (ATCC27853) was used to monitor performance, ensure the accuracy and repeatability of all tests, and regulate quality. No further bacterial isolates were tested with antibiotics for this analysis. The antibiotics ampicillin/sulbactam (10/10 mcg), ofloxacin (5 mcg), ciprofloxacin (5 mcg), piperacillin (100 mcg), amikacin (30 mcg), and gentamicin (10 mcg) have all been tested against P. aeruginosa. At 37 °C the plates were incubated for 24 hours to determine their antibacterial susceptibility. After considering the zone of inhibition and a comparison to a standard chart, the findings were categorized as sensitive or resistant. When calculating the final proportion of resistant organisms, isolates that shown resistance during disc diffusion were considered. Multidrug-resistance was the term used to describe an isolate that shown resistance to three or more antibiotics [17]. Microsoft Excel was used to enter and analyze all of the data, and percentages were used to represent the findings.

1.3. Ethical Consent

The ethical review committees of IIMT University and LLRM Medical College Hospital in Meerut approved the collection of pus samples. Participants in the study provided written informed permission, as did legally authorized representatives of the minor and major subjects. The participants were informed about the study so they could submit their written consent. The attending physician received the laboratory findings from the trial participants so that they could be used to direct patient care.

2. Results

This study included 82 patients who had surgery and were admitted to the postoperative wards. This investigation specifically focused on surgical procedures such as exploratory laparotomy (Figure 1). Out of the 82 wound swab samples collected, 77 (93.90%) showed positive bacterial growth, while 5 samples (6.09%) were sterile with no microbial growth observed. The most often isolated pathogen were *Pseudomonas aeruginosa*, identified in 29.26% of the samples, afterwards *Staphylococcus aureus* (21.95%), *Klebsiella pneumoniae* (17.07%), *Escherichia coli* (13.41%), and *Acinetobacter baumannii* (12.19%) (Table 1), (Figure 2). Among the study subjects, *P. aeruginosa* was commonly isolated pathogens; accounting for 24 wound swab samples (29.26%). Out of 24 *P. aeruginosa*, 10 (41.67%) were found to be MDR,

meaning they were resistant to at least three or more antibiotic classes. Furthermore, a little higher percentage of male patients (66.67%) had positive results for this bacterium, while only 33.33 percent of female patients had the same result (Table 2). Most of *P. aeruginosa* isolates (41.67%) were found in patients aged 41–60 years (Table 3). For microscopic, biochemical, and morphological analysis, all of the isolates were cultivated on appropriate media. *P. aeruginosa* isolates were screened positive for catalase, citrate, and oxidase; they also did not ferment lactose on MacConkey agar and had a bluish-green color on cetrimide agar because of the presence of pyocyanin pigment and fluorescence (Figure 3A). In microscopic examination of *P. aeruginosa* shows Gram negative bacilli (rods) (Figure 3B).

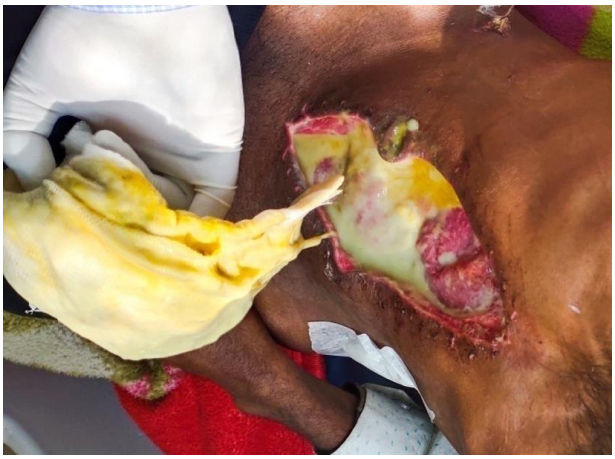

Figure 1. Surgery (Exploratory laparotomy)

Table 1. Isolated microorganisms in postoperative surgical site wound infections (N=82)

S.No.	Microorganisms	No. of Isolates	Frequencies (%)
1	*Pseudomonas aeruginosa*	24	29.26
2	*Staphylococcus aureus*	18	21.95
3	*Klebsiella pneumoniae*	14	17.07
4	*Escherichia coli*	11	13.41
5	*Acinetobacter baumannii*	10	12.19
6	No growth	5	6.09
Total		**82**	**100**

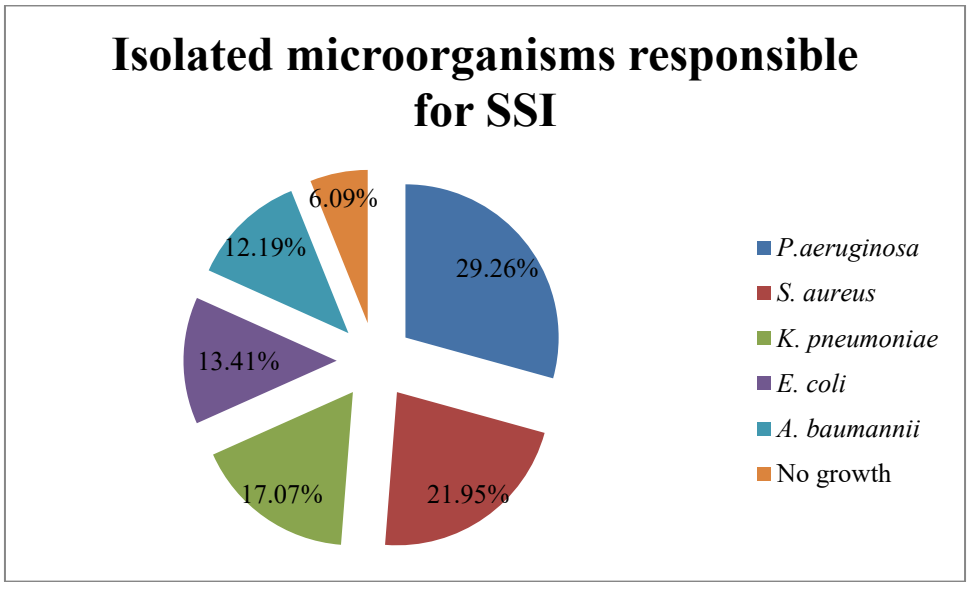

Figure 2. Isolated pathogens in postoperative surgical site infections

Table 2. *P. aeruginosa* isolates frequency by gender wise distribution

S.No.	Gender	No. of Isolates (24)	Frequency (%)
1	Male	16	66.67
2	Female	8	33.33

Table 3. *P. aeruginosa* isolates frequency by age wise distribution

S.No.	Age	No. of Isolates (24)	Frequency (%)
1	0 – 20	4	16.67
2	21 – 40	6	25
3	41 – 60	10	41.67
4	61 – 80	4	16.67

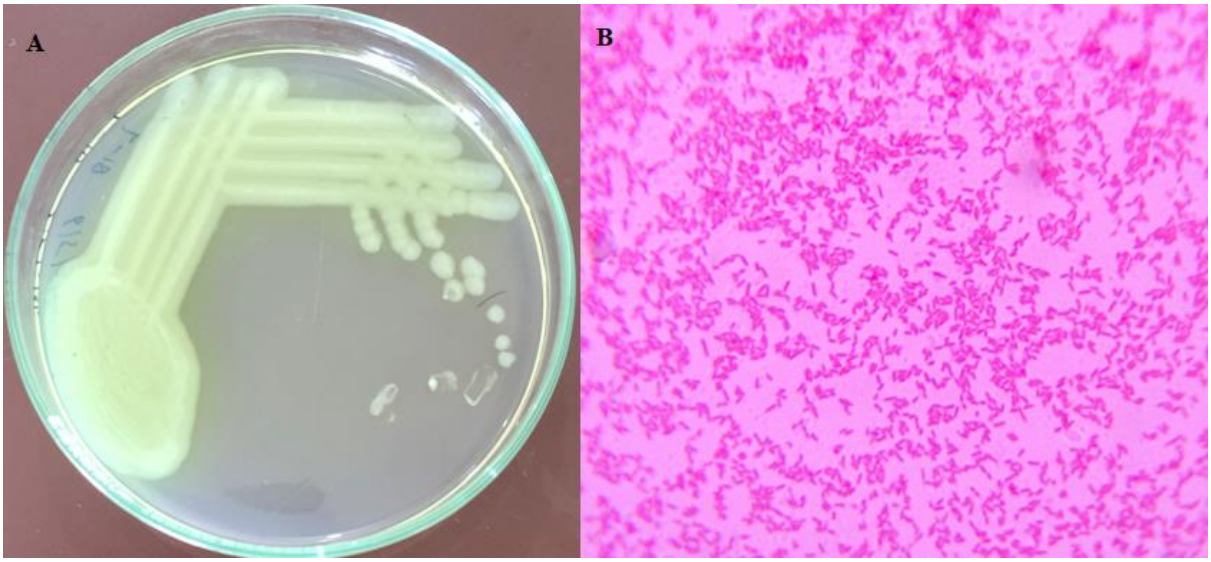

Figure 3. Identification of *P. aeruginosa* **(A)** Growth on Cetrimide agar

(B) Microscopic view of Gram-negative bacilli (rod)

Table 4. The susceptibility and resistance patterns of *P. aeruginosa* from postoperative surgical site wound infections (24)

S.No.	Antibiotics	S (%)	R (%)
1	Ampicillin/Sulbactam (A/S)	9 (37.50)	15 (62.50)
2	Piperacillin (PC)	17 (70.83)	7 (29.16)
3	Ciprofloxacin (RC)	3 (12.50)	21 (87.50)
4	Ofloxacin (ZN)	17 (70.83)	7 (29.16)
5	Gentamicin (GM)	12 (50)	12 (50)
6	Amikacin (AK)	14 (58.33)	10 (41.67)

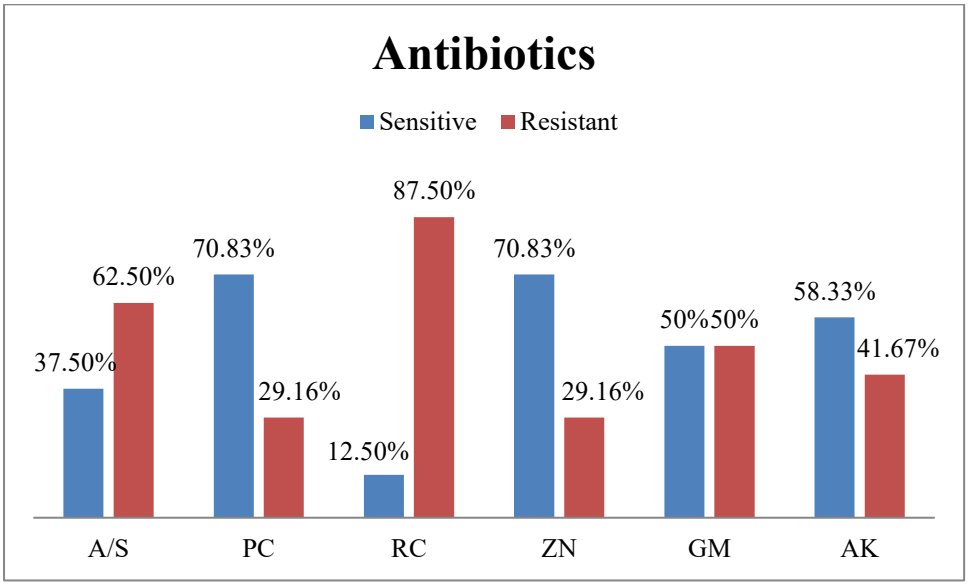

Figure 4 *P. aeruginosa* sensitive and resistance to different antibiotics

*Ampicillin/Sulbactam (A/S); Piperacillin (PC); Ciprofloxacin (RC); Gentamicin (GM); Ofloxacin (ZN); Amikacin (AK)

According to *P.* aeruginosa antibiotic susceptibility profile, the most sensitive antibiotics were piperacillin and ofloxacin (70.83%), followed by amikacin (58.33%), Gentamicin (50%), ampicillin/sulbactam (37.50%), and ciprofloxacin (12.50%) (Table 4).
According to Table 4 (Figure 4), *P. aeruginosa* antimicrobial resistance pattern reveals that it is most resistant to ciprofloxacin (87.50%), followed by ampicillin/sulbactam (62.50%), gentamicin (50%) and amikacin (41.67%), as well as piperacillin and ofloxacin (29.50%).

4. Discussion

The leading cause of infections linked to healthcare in surgical patients is SSIs. SSIs are associated with longer stays in hospitals, a higher incidence of morbidity and mortality, and more costly healthcare services. The underdeveloped and quickly growing resistance to the variety of antimicrobial medicines that are currently our only option for treating infections has made the issue worse. 93.90% of the wound swab samples in this study verified aerobic bacterial growth, it is similar to the findings of [8], who reported a 91% rate, and [18], who reported a 90.91% culture positivity rate. The study found that *P. aeruginosa* infections were more common in male patients (66.67%) than in female patients (33.33%). These results are in agreement with [18]. Our investigation showed that *P. aeruginosa* isolates were most frequently detected in individuals aged 41-60. The findings of our investigation contradicted those of [18, 8], who discovered that *P. aeruginosa* isolates were more prevalent in people aged 20–40 and 60–80, respectively. According to available data, *P. aeruginosa* (29.26%), *S. aureus* (21.95%), *K. pneumoniae* (17.07%), *E. coli* (13.41%), and *A. baumannii* (12.19%) are the most common bacterial isolates in SSIs. Recent research on the pathogenic pattern that causes SSI infections differs from earlier findings [19]. The fact that the majority of those affected underwent abdominal surgery may account for the greater prevalence of Gram-negative bacteria in our study. Gram-negative bacteria are generally linked to intra-abdominal SSIs, according to prior study [20]. The most frequent infection found in surgical incisions was *P. aeruginosa* (29.26%). Our findings were consistent with recent research by [8], which revealed that *P. aeruginosa* was present in 29.6% of the isolates. It was 18.89%, according to [21] investigation.

P. aeruginosa antibiotic susceptibility pattern shows that it is most sensitive to piperacillin and ofloxacin (70.83%), followed by amikacin (58.33%) and gentamicin (50%) and most resistant to ciprofloxacin (87.50%), followed by ampicillin/sulbactam (62.50%) and gentamicin, 50%. All reported similar outcomes [22, 21, 8, 23]. In the current investigation, 10 (41.67%) out of 24 *P. aeruginosa* were identified as MDRs, exhibiting resistance to three or more antibiotic classes. Similar results were obtained by [22] (10.60%) and [21] (16.18%).

5. Conclusion

Patients and healthcare systems are both impacted by postoperative surgical site wound infections, which raise morbidity, mortality, and expenses. 41.67% of isolates are resistant to three or more antibiotic classes, according to statistics, suggesting that MDR bacteria are become more dangerous in clinical settings. The increased incidence of ciprofloxacin resistance and other commonly used antibiotics raises the likelihood of

treatment failure and severely restricts the range of viable treatment choices. On the positive side, higher sensitivity to piperacillin and ofloxacin suggests some therapeutic potential. These findings necessitate immediate reinforcement of antimicrobial stewardship programs, regular resistance monitoring, and the investigation of alternative medicines.

6. Conflict of Interest: Nil

7. References

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