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Frequency of Multi-Drug Resistant (MDR) Proteus species in Clinical Sample at Tertiary care Hospital

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Abstract: **Background:** Multidrug-resistant (MDR) Proteus species are becoming significant hospital-related pathogens linked to infections in wounds, the urinary tract, and the bloodstream. The rise of antimicrobial resistance restricts treatment choices and presents a significant clinical hurdle. **Methods:** A cross-sectional study was performed involving 37 unique MDR Proteus isolates collected from different clinical specimens. Species identification and antimicrobial resistance testing were conducted using conventional microbiological techniques. **Results:** Out of 59 Proteus isolates 45 (76.6%) were Proteus mirabilis followed by 14 (23.7%) Proteus vulgaris. Out of 37 MDR of Proteus species isolates, *Proteus mirabilis* comprised 32 (86.5%) and *Proteus vulgaris* represented 5 (13.5%). Most cases were observed in patients older than 60 years (45.9%), with a higher prevalence in males (64.9%). Pus samples made up 56.8% of the isolates. Significant resistance was noted to cefepime (94.6%), ceftazidime (78.4%), and cefoperazone–sulbactam (70.3%). The resistance rate to piperacillin-tazobactam stood at 59.5%. **Conclusion:** *P. mirabilis*, are found leading factor to wound and systemic infections, exhibiting substantial resistance among the proteus species against cephalosporins. Ongoing monitoring and proper use of antimicrobials are crucial for managing their dissemination.

Keywords: Multidrug resistance, *Proteus mirabilis*, *Proteus vulgaris*, antimicrobial resistance, tertiary care hospital.

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INTRODUCTION

Proteus species are Gram-negative, motile bacilli belongs to the order Enterobacterales and also known as opportunistic pathogens. They frequently cause urinary tract infections, wound infections, bloodstream infections, and other hospital-acquired infections. Among the different species, *Proteus mirabilis* and *Proteus vulgaris* are the most frequently isolated from clinical specimens. *Proteus mirabilis* is particularly associated with urinary tract infections because of its urease-producing ability leads to alkalization of urine responsible for precipitation of dissolve solutes, urinary calculi formation and recurrent infections [1,2].

Proteus infections are more commonly seen in patients with predisposing factors such as Diabetes mellitus, chronic kidney disease, malignancy, prolonged catheterization, surgical interventions, and long hospital stays. These organisms can survive in hospital environments and easily spread in healthcare settings, contributing to nosocomial infections [3].

In recent years, antimicrobial resistance among Proteus species has emerged as a significant clinical problem. Increasing resistance has been reported against commonly used antibiotics such as penicillins, cephalosporins, fluoroquinolones, and aminoglycosides. The emergence of resistance mechanisms such as extended-spectrum beta-lactamase (ESBL) and AmpC

beta-lactamase production has further reduced available treatment options [4,5]. Isolates resistant to three or more classes of antimicrobial agents are categorized as multidrug-resistant (MDR). Infections caused by MDR Proteus species are associated with prolonged hospital stay, increased treatment costs, and poor clinical outcomes [6].

Several studies from India have highlighted the growing burden of multidrug-resistant Proteus species. Studies conducted in tertiary care hospitals across different regions of India have reported a high prevalence of MDR Proteus isolates, with significant resistance to third-generation cephalosporins, fluoroquinolones, and aminoglycosides. ESBL and AmpC production among Proteus species has also been frequently reported [7,8]. Indian studies have further shown that susceptibility is often retained only to carbapenems and beta-lactam/beta-lactamase inhibitor combinations, indicating limited therapeutic options [9].

MATERIAL & METHODS

Study Design - Cross-sectional study**.**

Study Area - The study was conducted in the Department of Microbiology, NIMS Hospital, NIMS & Research Institute, Jaipur, Rajasthan, India**.**

Study Period - The study was carried out for a period of one year October 2024 – October 2025 after obtaining Scientific and Ethical Committee approval**.**

Ethical Consideration - The study was accredited by the Ethics committee of Nims University Rajasthan, Jaipur (Proposal no. IEC/P-841/2024).

METHODOLOGY

Sample Collection

Clinical specimens including blood, urine, pus aspirate, body fluids, respiratory samples, and various swabs were collected from patients using standard aseptic techniques. All samples were immediately transported to the Microbiology laboratory for further processing as per standard guidelines.

Sample Processing

Each specimen was subjected to direct smear preparation, followed by Gram staining and microscopic examination.

Culture and Isolation

All samples were processed using standard microbiological procedures. Specimens were inoculated onto Blood agar and MacConkey agar plates and incubated at 37°C for 18–72 hours. After incubation, the culture plates were examined for colony morphology, lactose fermentation, swarming phenomenon, and other characteristic features. Smears were prepared from the colonies for further microscopic examination.

Identification of Isolates & Antimicrobial Susceptibility Testing

Further Identification and Antimicrobial susceptibility testing (AST) of the confirmed *Proteus* isolates was performed using the Vitek® 2 Compact automated system (bioMérieux). The results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines 2024 and Vitek® 2 manufacturer recommendations.

RESULT

Out of 59 Proteus isolates 45 (76.6%) were *Proteus mirabilis* followed by 14 (23.7%) *Proteus vulgaris*. Of these, 37 (62.7%) were found to be multidrug-resistant (MDR). Species-wise distribution of the MDR isolates revealed that *Proteus mirabilis* was the predominant species 32 (86.5%), followed by *Proteus vulgaris* 5 (13.5%). P. mirabilis was the main contributor to the multi-drug-resistant Proteus infections in the present study, while P. vulgaris represented a smaller but clinically significant proportion of isolates. Many patients were admitted in intensive care units such as surgical ICU, medical ICU and nephrology ICU, while some were from medical and surgical wards and the outpatient department.

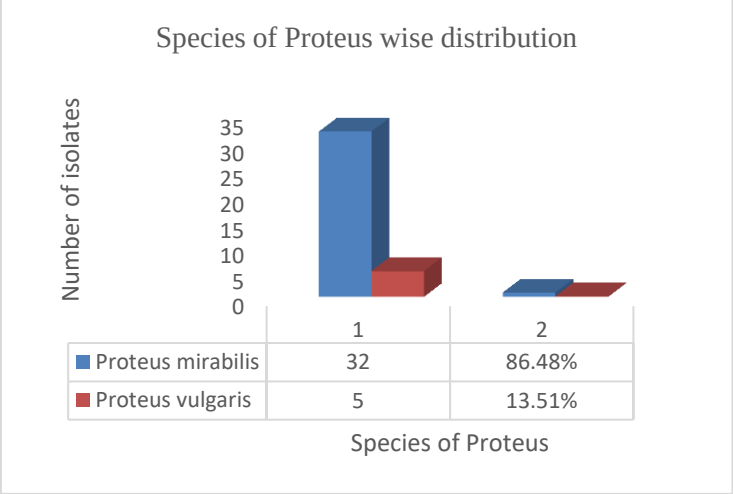

Figure-1: Distribution of *Proteus* species

The age of patients ranged from early childhood (around 5 years) to elderly (above 80 year in our study.

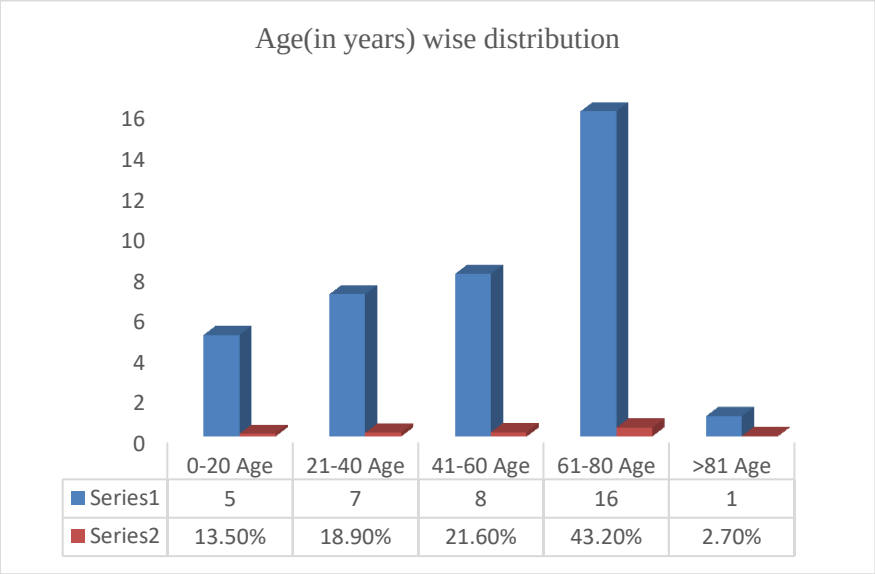

Figure-2: Age wise distribution

In our study, Proteus infection was seen in almost all age groups. There were children (0–20 years), young adults (21-40 years), middle-aged adults (41-60 years) and a large number of older adults (61-80 years) and (above 81 years). Out of 37 patients, the majority were aged >60 years17 (45.9%), followed by 21–40 years 8 (21.6%) and 41–60 years 8 (21.6%). Patients <20 years constituted 4 (10.8%).

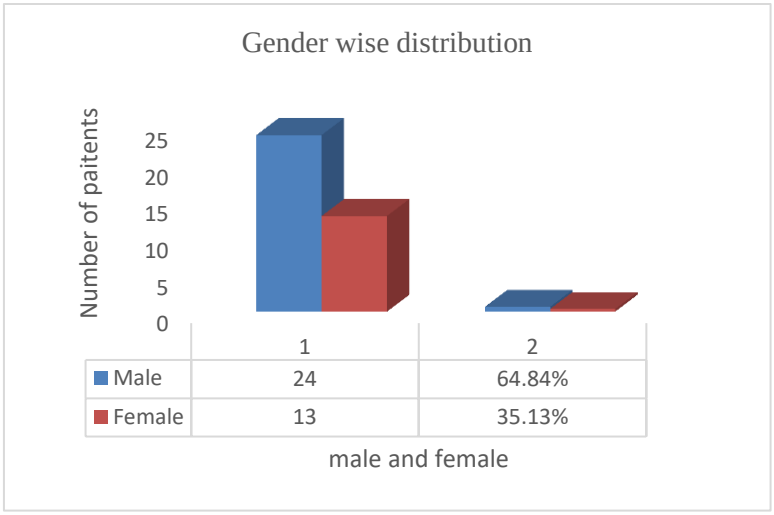

Figure-3: Gender wise distribution

Both males and females were detected, with a slight predominance of male patients in the study. Male patients 24 (64.9%) were more having MDR *Proteus* infection than females 13 (35.1%).

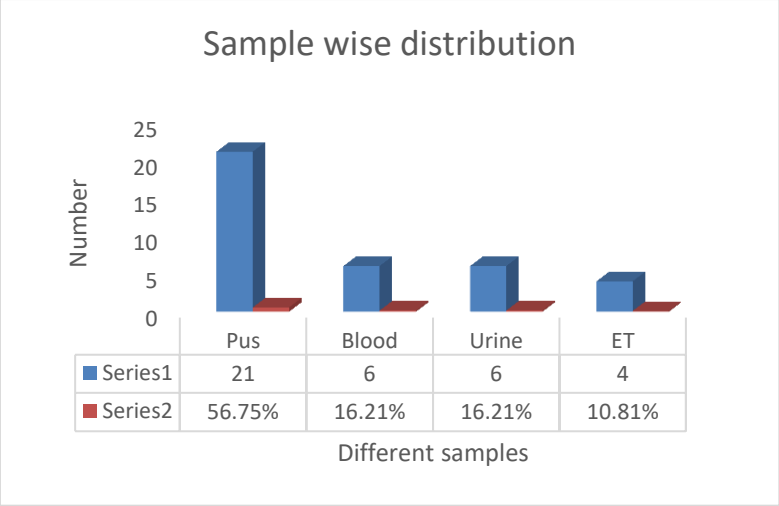

Figure-4: Sample wise distribution

Out of the total 37 multidrug-resistant *Proteus* isolates, the majority were recovered from pus samples, accounting for 21 cases (56.8%). Blood and urine samples each contributed 6 isolates (16.2% each), while 4 isolates (10.8%) were obtained from endotracheal secretions. The predominance of isolates from pus specimens indicates that multidrug-resistant *Proteus* species were mainly associated with wound and soft tissue infections in the present study, followed by bloodstream and urinary tract infections.

Antimicrobial Resistance Pattern-

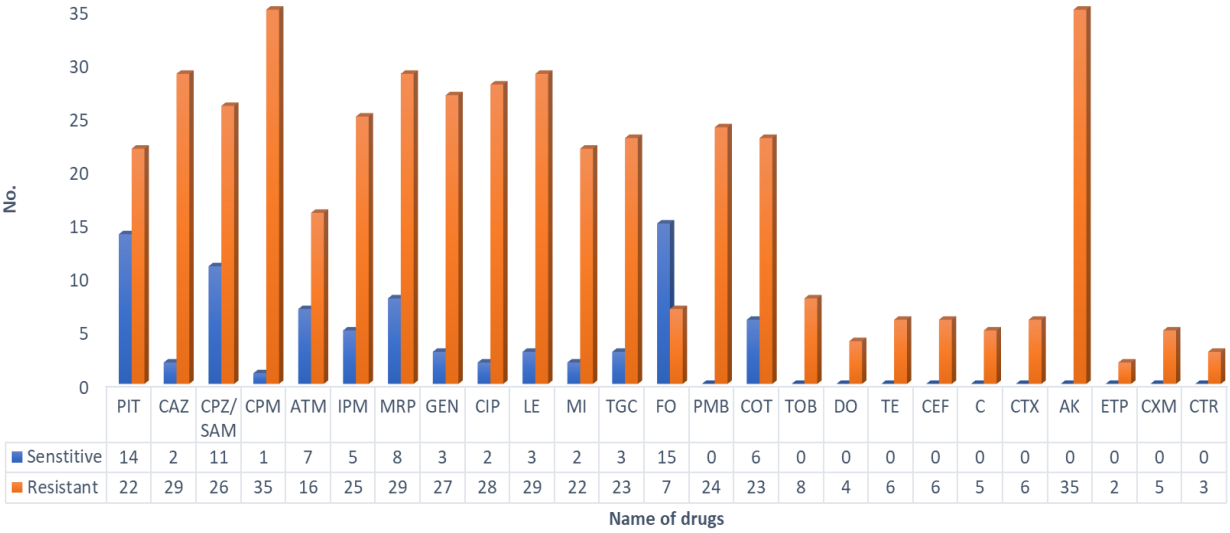

Figure- 5: Antimicrobial susceptibility pattern of *Proteus* species

Antimicrobial susceptibility testing revealed a high level of resistance among the isolates. The highest resistance was observed against cefepime and amikacin with 35 out of 37 isolates (94.6%) being resistant. Resistance to ceftazidime, meropenem, levofloxacin was noted in 29 isolates (78.4%), while 26 isolates (70.3%) were resistant to cefoperazone–sulbactam. Piperacillin–tazobactam resistance was observed in 22 isolates (59.5%). Additionally, 16 isolates (43.2%) demonstrated resistance to aztreonam. Both *P. mirabilis* and *P. vulgaris* demonstrated high resistance to cephalosporins, with *P. vulgaris* showing comparatively broader resistance. Fosfomycin (45.5%) was the highest sensitive drug followed by Piperacillin–tazobactam (37.8%) and cefoperazone–sulbactam (29.7%).

DISCUSSION

In the present study conducted at a tertiary care hospital in Rajasthan, India, a moderate number of *Proteus* isolates were found to be multidrug-resistant (MDR). In our study, *Proteus mirabilis* (86.5%) was the most common species, followed by *Proteus vulgaris* (13.5%). MDR means the bacteria are resistant to three or more groups of antibiotics. *Proteus* species are well-

known opportunistic pathogens and commonly cause hospital-acquired infections such as urinary tract infections, wound infections, and bloodstream infections. Slightly increasing number of MDR isolates in our study shows that antibiotic resistance is becoming a serious problem in hospitals [10,11].

Most MDR *Proteus* infections in our study were seen in older patients, especially those above 60 years of age, and males were more commonly affected. The majority of there isolates were obtained from pus samples, followed by blood and urine samples. Elderly patients are more likely to develop MDR infections because they often have other illnesses like diabetes, kidney disease, or cancer. Prolonged stay in hospitals, using urinary catheters and receiving surgical traetments, all these factors increase their exposure to strong antibiotics and raise the risk of developing resistant infections. Similar findings have been reported in other Indian and international studies, where *Proteus* infections were more common in elderly and critically ill patients [12,13].

In our study, high resistance was seen against third- and fourth-generation cephalosporins and fluoroquinolones. Datta *et al*. and singh *et al*. also reported similar pattern of resistance from other tertiary care hospitals in India [14,15]. The overuse and misuse of these antibiotics in hospitals and in the community may be one of the main reasons for this high resistance. Resistance to cephalosporins in *Proteus* species is often due to the production of extended-spectrum beta-lactamases (ESBLs), which break down the antibiotic and make it ineffective [11,16].

We also found resistance to piperacillin–tazobactam and carbapenems in some isolates. This is worrying because carbapenems are usually considered strong or "last-resort" antibiotics. Resistance to these drugs suggests the possible presence of ESBL-producing or carbapenemase-producing bacteria, which further limits treatment options. Recent Indian studies like Bedenić *et al* and Tamma *et al* have also reported increasing resistance to carbapenems among *Proteus* and other Gram-negative bacteria [12,17].

Although aminoglycosides and carbapenems are generally effective against *Proteus* species, our study showed that some isolates were resistant even to these antibiotics. Similar trends have been seen in other Indian studies, including research from Rajasthan, Singh *et al.* reported increasing resistance among clinical *Proteus* isolates and also found that ESBL producing proteus spp. were most susceptible to imipenem followed by piperacillin-tazobactam combination and found effective in treating the resistant Proteus species [15]. This shows that even higher-level antibiotics are slowly losing their effectiveness.

Overall, the moderate number of MDR *Proteus* species (62.7%) in our hospital highlights the urgent need for strict infection control practices, regular monitoring of antibiotic resistance, and proper antibiotic policies. Doctors should choose antibiotics based on local antibiogram data, and treatment should be adjusted once culture and sensitivity reports are available. Early detection of resistant strains and strong antimicrobial stewardship programs are very important to prevent the spread of MDR *Proteus* in tertiary care hospitals.

CONCLUSION

Proteus species, mainly *Proteus mirabilis* and *Proteus vulgaris*, were important causes of infections in a tertiary care hospital in Rajasthan, India, particularly in older and critically ill patients. A high proportion of isolates were multidrug-resistant, with marked resistance to cephalosporins, uoroquinolones and several other antibiotics and found sensitive to Fosfomycin followed by Piperacillin–tazobactam and cefoperazone–sulbactam.

Regular monitoring of antimicrobial resistance patterns, strict infection prevention control measures and rational use of antibiotics are necessary to control the spread of MDR Proteus. Local data such as those presented in this study can help clinicians choose appropriate empirical therapy and can guide hospital antibiotic stewardship programmes.

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Conflict of Interest: The authors declare no conflict of interest.
Source of Fund: None
Ethical Consideration - The study was accredited by the Ethics committee of Nims University Rajasthan, Jaipur (Proposal no. IEC/P-841/2024).

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