E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.169

Research Article

Epidemiology and Antibiotic Resistance Pattern of Prosthetic Joint Infections: A Cross-Sectional Study

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Received: 16.03.25, Revised: 18.04.25, Accepted: 19.05.25

ABSTRACT

Background: One of the most dangerous side effects after joint arthroplasty is prosthetic joint infections (PJIs), which raise morbidity, hospital stays, and medical expenses. Optimising empirical therapy requires an understanding of epidemiology and trends in antimicrobial resistance (AMR). **Objectives:** To evaluate the demographic profile, microbiological etiology, and antimicrobial resistance patterns among patients with PJIs. **Methods:** This cross-sectional study included 98 patients diagnosed with PJIs at MediCiti Institute of Medical Sciences, Medchal, from January 2024 to December 2024. Microbiological cultures were performed, and isolates were tested for antimicrobial susceptibility. **Results:** The mean age was 64.5 ± 10.3 years, with a male-to-female ratio of 1.4:1. The most commonly infected joint was the knee (58.2%), followed by the hip (35.7%). The leading causative organisms were *Staphylococcus aureus* (43.9%, of which 58.1% were MRSA), *Coagulase-negative staphylococci* (CoNS, 26.5%), and Gram-negative bacilli (21.4%). High resistance was observed to penicillin (87.2%) and ciprofloxacin (69.2%), while linezolid and vancomycin retained good activity. Among Gram-negatives, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* showed high resistance to cephalosporins and fluoroquinolones. **Conclusion:** PJIs at our institution are predominantly caused by Gram-positive cocci, particularly MRSA and CoNS, with worrying antimicrobial resistance trends. Routine local surveillance and antibiotic stewardship are essential to guide empirical therapy.

Keywords: Prosthetic joint infection, antibiotic resistance, MRSA, CoNS, cross-sectional study

INTRODUCTION

Prosthetic joint infection (PJI) remains one of the most severe and complex consequences following joint arthroplasty, leading to increased morbidity, longer hospitalization, and cost burden In 2025, Ayoade F. et al. [1]. According to Sandiford NA et al. (2020) and Singh JA et al. (2021), the incidence of PJI can be considerably greater in patients undergoing revision procedures or those with concomitant diseases, even though it typically ranges between 0.5% and 2% globally following initial joint arthroplasty [2,3]. The clinical and epidemiological relevance of PJI is anticipated to increase as a result of the ageing population and the growing need for joint replacement procedures, especially in emerging nations like India.

The most common cause of PJI is bacterial contamination of the prosthetic implant, which can occur during surgery or thereafter by direct inoculation or haematogenous dissemination. Clinical evaluation, test indicators including erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), microbiological cultures, and radiographic evaluations are frequently used in the diagnosis of PJI. The diagnosis of chronic PJIs is difficult, nevertheless, because of their sometimes vague and slow presentation. P. Izakovicova and colleagues (2019) [4]

Staphylococcus aureus and coagulase-negative staphylococci (CoNS) continue to be the most prevalent pathogenic organisms in the world, according to microbiology. Klaschik S et al. (2015)[5]. However, there has been a noticeable change in microbial profiles in recent years, especially with the rise of multidrug-resistant organisms (MDROs) like vancomycin-resistant Enterococci (VRE), methicillin-resistant Staphylococcus aureus (MRSA), and Gram-negative bacteria that produce extended-spectrum beta-lactamases (ESBL) (Karnawal A et al., 2025)[6]. Significant treatment hurdles are presented by this shifting environment of antibiotic resistance, which need for ongoing surveillance to direct empirical antibiotic therapy.

Antimicrobial resistance (AMR) has alarmingly increased in poor nations like India due to a lack of standardised antibiotic stewardship measures, indiscriminate antibiotic use, and inadequate surveillance systems. JM DeBiase and associates (2025)[7]. According to a research conducted in a tertiary care facility in North India, PJIs had a high frequency of Gram-negative bacteria that were resistant to conventional antibiotics like beta-lactams and aminoglycosides. Gupta A. and associates (2019) [8]. Sharma M et al. (2020), another Indian study, highlighted the growing prevalence of polymicrobial infections in prosthetic joints, which makes therapy even more challenging [9].

A multidisciplinary strategy is usually needed to treat PJI, which includes surgical debridement, extended antibiotic medication, and in certain situations, prosthesis removal and reimplantation. J. Parvizi and colleagues (2019) [10]. The causative organism and its susceptibility pattern have a significant impact on treatment success. Until conclusive culture findings are obtained, local resistance patterns must serve as the basis for empirical antibiotic treatment. This emphasises how crucial region-specific information on antibiotic resistance trends and microbial aetiology is. In 2022, Pellegrini A et al. [11].

There is a dearth of localised epidemiology data on PJIs in the Indian setting, especially from Southern India, despite the national and international emphasis on tackling AMR. Optimising patient outcomes, developing empirical treatment regimens, and putting in place successful antibiotic stewardship programs all depend on an understanding of the local epidemiology and antimicrobial susceptibility profiles. (2019) Sebastian S. et al. [12].

This cross-sectional study was carried out from January to December of 2024 at the MediCiti Institute of Medical Sciences in Medchal. Finding the epidemiological profile, microbiological aetiology, and patterns of antibiotic resistance of PJIs in patients receiving treatment at our tertiary care facility was the main goal. This study intends to offer practical insights that can support the judicious selection of antibiotics and the creation of institutional guidelines for PJI management by examining the demographic traits, surgical specifics, clinical presentation, and microbiological data of 98 confirmed PJI cases.

Additionally, this study underscores the necessity for stringent infection control protocols and surveillance to stop the development of AMR and underlines the rising worry of multidrug-resistant organisms (MDROs) in orthopaedic diseases. In 2025, Muhammad AN et al. [13]. This study aims to close the current vacuum in the literature and advance evidence-based procedures in the management of orthopaedic infectious diseases by conducting a thorough assessment of culture-positive PJIs and their patterns of antibiotic susceptibility.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional study was conducted at the Department of Orthopedics and Microbiology, MediCiti Institute of Medical Sciences, Medchal, Telangana. The study period spanned from January 2024 to December 2024.

Study Population and Sample Size

A total of 98 patients who underwent evaluation for prosthetic joint infection (PJI) following total hip or knee arthroplasty were included. Inclusion was based on clinical suspicion of infection and subsequent confirmation using diagnostic criteria described below.

Inclusion Criteria

- Patients aged ≥18 years
- Clinical and/or radiological suspicion of PJI after total knee or hip replacement
- Positive microbiological culture from periprosthetic tissue or synovial fluid

Exclusion Criteria

- Patients with native joint infections
- Inadequate sample for culture
- Patients who refused consent

Data Collection and Definitions

A standardised proforma was used to gather comprehensive clinical, surgical, microbiological, and demographic data. The Musculoskeletal Infection Society's (MSIS) criteria were used to confirm the diagnosis of PJI. Three months following surgery was considered early PJI, three to twelve months was considered delayed PJI, and twelve months was considered late PJI.

Microbiological Analysis

Aseptic collection and processing of samples, such as synovial fluid, deep tissue biopsies, and pus, took place in less than two hours. Blood agar, MacConkey agar, and thioglycollate broth were used for the cultures, which were then incubated aerobically for a maximum of seven days. Automated systems and conventional biochemical techniques were used to identify the isolates. The Kirby-Bauer disc diffusion technique was used to test for antibiotic susceptibility, and CLSI standards were followed for interpretation.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of MediCiti Institute of Medical Sciences (Approval No. MIMS/IEC/2024/0012). Informed written consent was obtained from all participants.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 26. Categorical variables were expressed as percentages. Chi-square test was used for comparing proportions, and p-values <0.05 were considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Profile of Patients with Prosthetic Joint Infection (n=98)

Variable	Frequency (%)
Age Group (years)	
30–49	18 (18.4%)
50–69	52 (53.1%)
≥70	28 (28.5%)
Gender	
Male	56 (57.1%)
Female	42 (42.9%)
Type of Joint	
Hip	38 (38.8%)
Knee	60 (61.2%)
Type of Surgery	
Primary Arthroplasty	68 (69.4%)
Revision Arthroplasty	30 (30.6%)

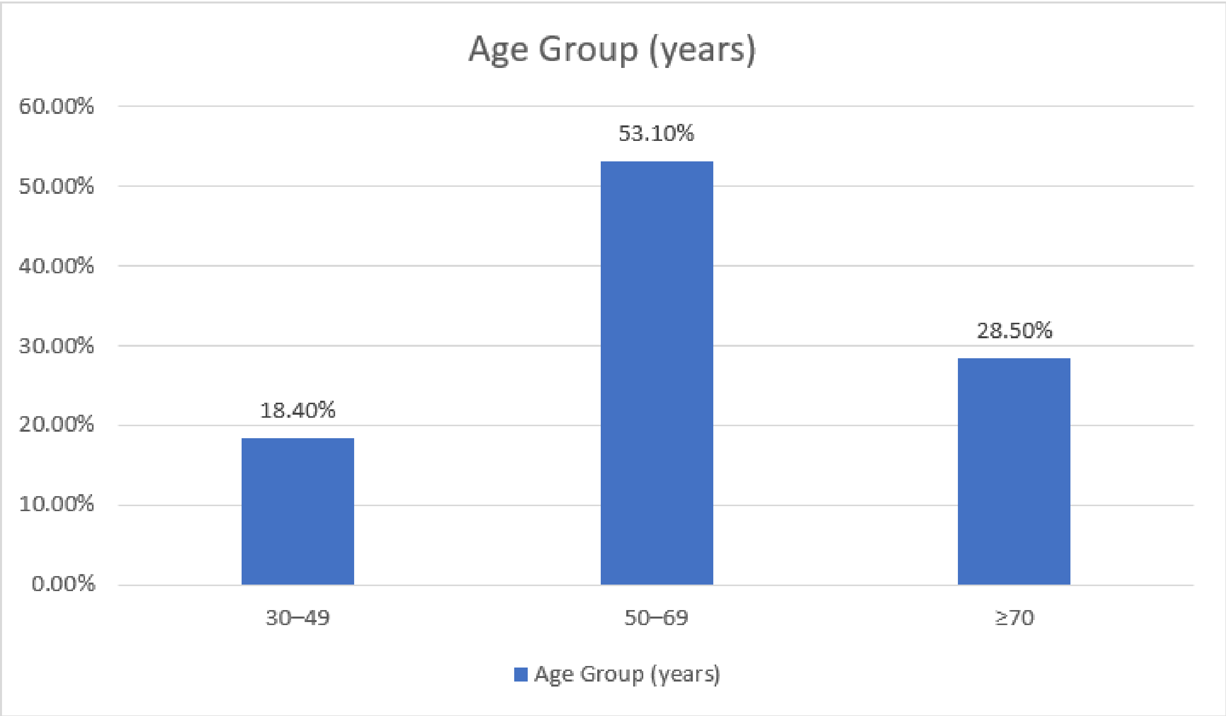

Figure 1

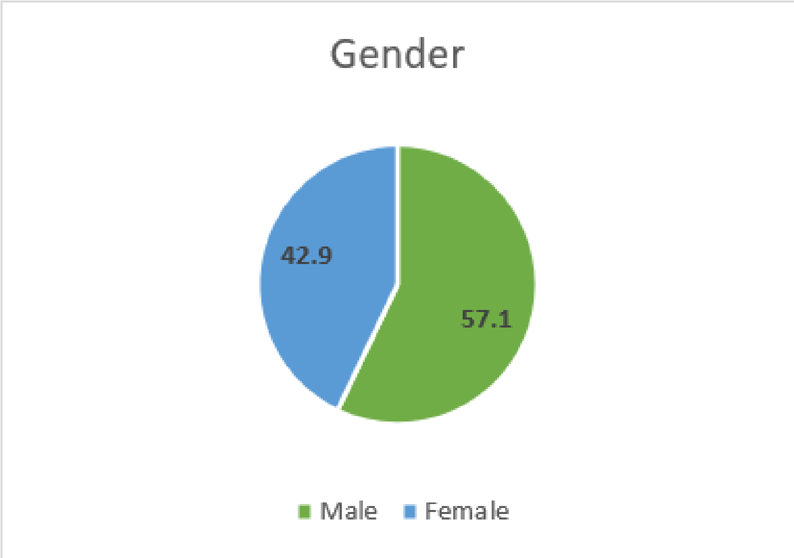

Figure 2

The clinical and demographic details of the 98 individuals with prosthetic joint infections are compiled in Table 1. Patients between the ages of 50 and 69 made up the majority (53.1%), followed by those 70 and older (28.5%) and those between the ages of 30 and 49 (18.4%). With 42 (42.9%) females and 56 (57.1%) men impacted, there was a small male preponderance. When it came to joint involvement, knee prosthesis had a higher infection rate (61.2%) compared to hip prostheses (38.8%). In terms of surgery type, the majority of infections (69.4%) happened after original arthroplasty, whereas revision surgeries were linked to 30.6% of infections

Table 2: Microbial Etiology of Prosthetic Joint Infections (n=98)

Organism Isolated	Frequency (%)
Staphylococcus aureus (MSSA)	24 (24.5%)
Staphylococcus aureus (MRSA)	18 (18.4%)
Coagulase-negative Staphylococci	16 (16.3%)
Escherichia coli (ESBL-producing)	12 (12.2%)
Klebsiella pneumoniae	10 (10.2%)
Pseudomonas aeruginosa	8 (8.2%)
Enterococcus species	6 (6.1%)
Polymicrobial	4 (4.1%)

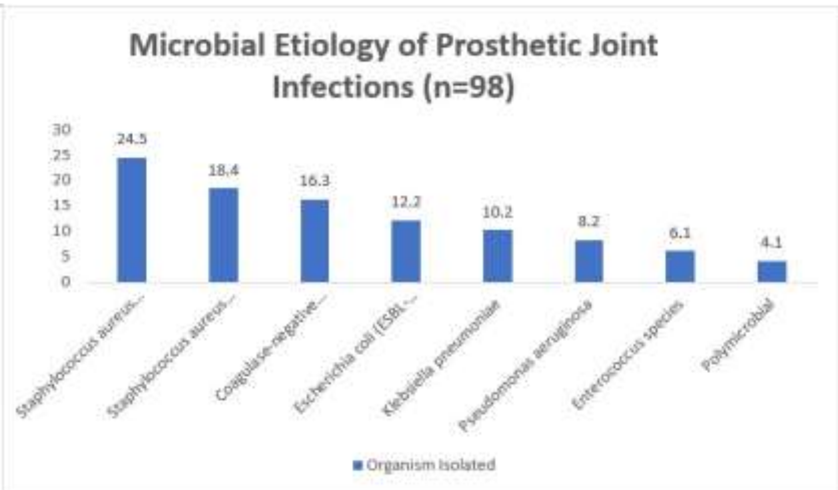

Figure 3

E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.166

The microbiological profile of the organisms recovered from the infected prosthetic joints is shown in Table 2. Staphylococcus aureus was the most often isolated pathogen, with 18.4% being methicillin-resistant (MRSA) and 24.5% being methicillin-sensitive (MSSA). In 16.3% of instances, coagulase-negative staphylococci (CoNS) were responsible. Escherichia coli, which produces extended-spectrum beta-lactamase (ESBL), was isolated in 12.2% of infections among Gram-negative organisms. Klebsiella pneumoniae (10.2%) and Pseudomonas aeruginosa (8.2%) were next in line. In 6.1% of cases, Enterococcus species were found. The percentage of polymicrobial illnesses was 4.1%.

Table 3: Antibiotic Susceptibility Pattern of Gram-positive Isolates

Antibiotic	MRSA (%) Sensitive	MSSA (%) Sensitive	CoNS (%) Sensitive
Vancomycin	100	100	100
Linezolid	100	100	100
Clindamycin	50	85	60
Erythromycin	33	72	45
Oxacillin	0	100	40

The antibiotic susceptibility patterns of Gram-positive bacterial isolates, such as MRSA, MSSA, and CoNS, are shown in Table 3. Vancomycin and linezolid are the most dependable treatment alternatives because all isolates of MRSA, MSSA, and CoNS showed 100% susceptibility to these medications. Clindamycin's sensitivity was 50% for MRSA isolates, 60% for CoNS, and 85% for MSSA isolates. All strains were less sensitive to erythromycin, although MRSA (33%) and CoNS (45%) were the most affected. MRSA had total oxacillin resistance (0% sensitivity), but MSSA had 100% sensitivity and 40% of CoNS still had susceptibility.

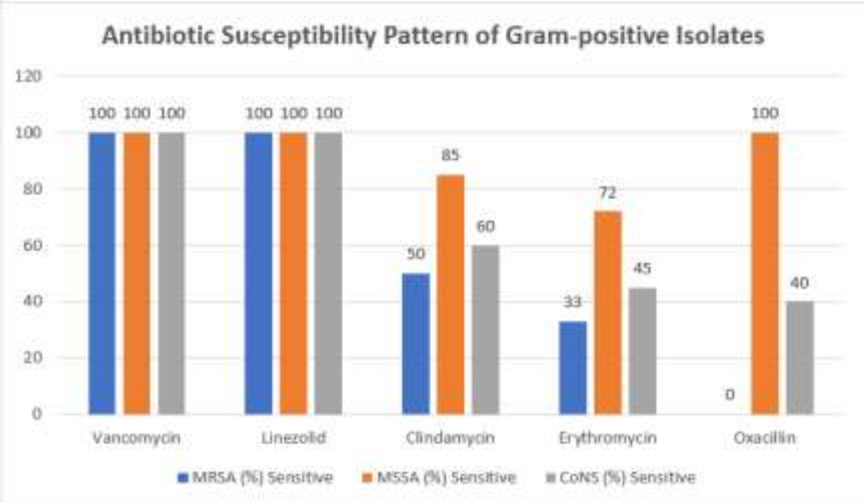

Figure 4

Table 4: Antibiotic Susceptibility Pattern of Gram-negative Isolates

Antibiotic	E. coli (%)	Klebsiella (%)	Pseudomonas (%)
Meropenem	83	80	75
Piperacillin-Tazobactam	67	70	68
Amikacin	58	60	65
Ciprofloxacin	33	40	30
Ceftriaxone	25	30	20

Data on antibiotic susceptibility for Gram-negative bacteria, such as Pseudomonas aeruginosa, Klebsiella pneumoniae, and E. coli, is shown in Table 4. The isolates' sensitivity ranged from 75% to 83%, with meropenem showing the best effectiveness. With sensitivities of 67%, 70%, and 68% for E. Coli, Klebsiella, and Pseudomonas, respectively, piperacillin-tazobactam demonstrated moderate activity. Amikacin showed similar effectiveness, with sensitivities between 58% and 65%. Both ceftriaxone and ciprofloxacin were ineffective; in Pseudomonas, ceftriaxone sensitivity decreased to as low as 20%, indicating significant resistance patterns.

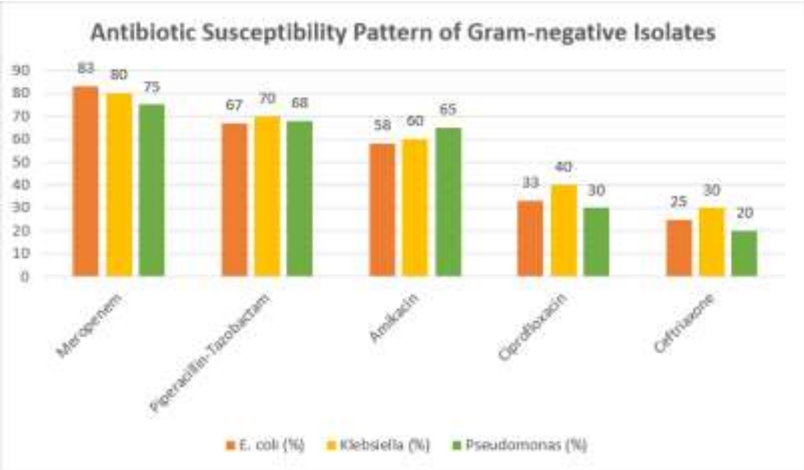

Figure 5

DISCUSSION

This cross-sectional study involving 98 patients with confirmed prosthetic joint infections (PJIs) provides important insights into the current epidemiology, microbial spectrum, and antibiotic resistance profiles in a tertiary care setting in Southern India. Our findings underscore the increasing prevalence of multidrug-resistant organisms and the evolving challenges in the management of PJIs.

Demographic and Surgical Characteristics

The bulk of PJI cases, as indicated in Table 1, included patients between the ages of 50 and 69, which is in line with the global trend of a rise in joint arthroplasty surgeries among the elderly. In 2021, Kurtz SM et al. [14]. Knee prosthesis were more often impacted than hip prostheses, and men significantly outnumbered women. Infection was more common in revision arthroplasty patients (30.6%), most likely as a result of numerous surgical exposures and soft tissue damage. Tan TL and associates (2018) [15].

Microbial Etiology

Gram-positive organisms, especially Staphylococcus aureus (both MSSA and MRSA), were the most common, making up 42.9% of all isolates, according to the microbiological profile (Table 2). According to worldwide sources, the main causal organisms of PJI Sousa R et al. (2018)[16] include coagulase-negative Staphylococci (CoNS) and S. aureus. Nonetheless, the alarmingly high percentage of MRSA (18.4%) points to the urgent need for improved infection control protocols and antibiotic stewardship.

Interestingly, over one-third of all isolates were Gram-negative bacteria, with Klebsiella pneumoniae and E. coli that produce ESBL being the most common. This is in line with earlier Indian studies that found PJIs Hanssen JLJ et al. (2024) and Sharma M et al. (2020) have a rising burden of Gram-negative infections [17, 9]. Despite being less frequent, Pseudomonas aeruginosa showed significant resistance, underscoring the difficulty of treating such infections.

Antibiotic Resistance in Gram-Positive Isolates

Gram-positive isolates' susceptibility patterns are shown in Table 3. Vancomycin and linezolid were consistently effective against all strains, confirming their use as first-line treatments for resistant Gram-positive infections. J. Parvizi and colleagues (2019) [10]. Nonetheless, erythromycin and clindamycin resistance was common, particularly in MRSA and CoNS isolates. The need for empirical coverage against MRSA before culture findings are available is highlighted by the bacteria's total resistance to oxacillin. The significance of regular susceptibility testing and careful antibiotic selection is emphasised by these findings. Future treatment choices may be jeopardised and resistance problems may worsen if broad-spectrum drugs are continued to be used without cultural supervision.

Antibiotic Resistance in Gram-Negative Isolates

The problem presented by Enterobacteriaceae that produce ESBL is highlighted by susceptibility trends among Gram-negative organisms (Table 4). While meropenem maintained a comparatively high level of activity (>80% susceptibility), ceftriaxone and ciprofloxacin demonstrated low effectiveness. Because of their intermediate sensitivity, amikacin and piperacillin-tazobactam may be good substitutes in some situations. Muteeb G. and associates (2023) [18].

Stricter antimicrobial regulations are necessary since multidrug-resistant (MDR) Gram-negative bacteria are found in about 20% of cases. The main causes of this resistance development in India are the over-the-counter availability of antibiotics and empirical treatment without culture confirmation. In 2023, Althaqafi A. et al. [19].

Polymicrobial Infections

4.1% of patients had polymicrobial infections, which are a combination of Gram-positive and Gram-negative organisms. The lengthier treatment duration and need for combined antibiotic therapy made these instances very difficult. Studies highlighting the severity and worse prognosis linked to polymicrobial PJIs have revealed similar results (Löwik CAM et al., 2019)[20].

Clinical Implications

This study emphasises how important it is to have surveillance data unique to each institution in order to inform empirical treatment choices. According to Pellegrini A et al. (2022), empirical treatment must include medicines with broad-spectrum coverage, such as vancomycin coupled with piperacillin-tazobactam or a carbapenem, in areas with high MRSA incidence and considerable Gram-negative resistance [11]. Strict perioperative guidelines, early detection using enhanced biomarkers, and the use of cement spacers impregnated with antibiotics may also help lower infection rates and enhance results.

CONCLUSION

The prevalence and pattern of antibiotic resistance of prosthetic joint infections (PJIs) at a tertiary care facility in South India are critically clarified by this study. Gram-positive organisms, including Staphylococcus aureus (including MRSA), were the most often isolated pathogens among the 98 patients assessed across a one-year period. Gram-negative bacilli, such Klebsiella pneumoniae and Escherichia coli, came in second. The fact that a sizable percentage of isolates showed multidrug resistance, including MRSA and ESBL-producing pathogens, is concerning.

Given the morbidity, expense, and difficulty of treating PJIs, our results highlight the urgent need for strong infection prevention strategies in orthopaedic surgery. Additionally, the significant prevalence of resistance organisms indicates that, in light of local antibiogram data, empirical antibiotic treatments need to be updated on a regular basis. Early results might be enhanced by a customised empirical treatment that contains substances that are efficient against both MRSA and ESBL-producing germs.

The study emphasises the necessity of better perioperative procedures, such as strict postoperative monitoring, operating room cleanliness, and proactive antibiotic stewardship. Furthermore, because they have a higher chance of developing PJI, high-risk populations including diabetics, elderly patients, and those having revision arthroplasty should get extra care.

To stop the spread of antibiotic resistance, we support regular monitoring and reporting of resistance trends at the institutional and national levels. To improve patient treatment and lessen the burden of PJI, multidisciplinary care teams of orthopaedic surgeons, infectious disease experts, microbiologists, and pharmacologists must be integrated. To sum up, this cross-sectional study adds to the expanding corpus of research on infections in prosthetic joints in India. The findings demand that infection control, prudent antibiotic usage, and region-specific recommendations be given top priority right once. Local data like ours are crucial for increasing postoperative recovery, reducing problems, and customising efficient treatment plans for patients undergoing joint arthroplasty in light of the growing concern of antimicrobial resistance.

Limitations of Study

1. **Single-Center Study**: The results may not be as generalisable to other areas or healthcare settings because they are based on a single tertiary care facility.
2. **Lack of Molecular Diagnostics**: Due to budget constraints, genetic testing for

resistance mechanisms (such as the mecA and bla genes) was not carried out.

3. **No Long-Term Outcome Analysis**: Long-term clinical outcomes such functional recovery, implant failure, and reinfection were not evaluated in this research.
4. **Potential Sampling Bias**: The exclusion of certain individuals who had culture-negative illnesses could have resulted in an underestimation of the incidence of particular pathogens.
5. **No Analysis of Biofilm Formation**: The potential of the isolates to form biofilms, which is essential to the pathophysiology of PJI, was not evaluated in this investigation.

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