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PREVALENCE OF MULTIDRUG-RESISTANT BACTERIA IN POST-DENTAL PROCEDURE INFECTIONS AMONG OUTPATIENTS

Original Research

Fawad Ali Shah[1]*, Bhavish Sachdev[2], Muhammad Sahal[3], Muqqudas Iqbal Awan[4], Gulzar Ahmed[5], Hafiz Nidaullah[6], Ahmed Yar Khoso[7]

[1]Assistant Professor, Khyber College of Dentistry, Peshawar, Pakistan.
[2]Final Year BS Microbiology Student, Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan.
[3]Department of Microbiology, Federal Urdu University of Arts, Science and Technology, Karachi, Pakistan.
[4]Dental Officer, Muskurahat Center, Karachi Medical and Dental College, Karachi, Pakistan.
[5]Lecturer, Department of Livestock and Poultry Production, Faculty of Veterinary and Animal Sciences, University of Poonch, Rawalakot, Pakistan.
[6]University of Veterinary & Animal Sciences, Swat, Khyber Pakhtunkhwa, Pakistan.
[7]Student, University of Karachi, Karachi, Pakistan.

Corresponding Author: Fawad Ali Shah, Assistant Professor, Khyber College of Dentistry, Peshawar, Pakistan, jawad.says1996@gmail.com

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ABSTRACT

Background: Post-dental procedure infections are a growing concern in outpatient settings, especially with the increasing emergence of multidrug-resistant (MDR) bacterial strains. These infections complicate treatment outcomes and highlight the need for localized surveillance to guide empirical antibiotic therapy.

Objective: To assess the prevalence and antibiotic susceptibility patterns of bacterial pathogens isolated from post-dental procedure infections among outpatients in Pakistan, and to identify trends in multidrug resistance for improving empirical treatment strategies.

Methods: A cross-sectional study was conducted over eight months across outpatient dental clinics in Lahore and Rawalpindi, Pakistan. A total of 210 adult patients presenting with clinical signs of infection within 7–14 days of dental procedures were enrolled. Pus swabs were collected and analyzed using standard microbiological techniques. Bacterial isolates were identified and subjected to antibiotic susceptibility testing via the Kirby-Bauer disc diffusion method. Data were analyzed using SPSS version 25, and associations were tested using Chi-square and t-tests with significance set at $p < 0.05$.

Results: Out of 210 samples, 196 (93.3%) showed positive bacterial growth. *Staphylococcus aureus* (27.6%) and *Enterococcus faecalis* (21.9%) were the most frequently isolated pathogens. High resistance was noted against amoxicillin-clavulanate (53.3%) and ceftriaxone (45.7%). Multidrug resistance was present in 58.2% of isolates, most commonly in *Klebsiella pneumoniae* (65.5%) and *Enterococcus faecalis* (60.9%). MDR was significantly associated with prior antibiotic use and diabetes mellitus.

Conclusion: The study reveals a high burden of MDR organisms in outpatient dental infections, emphasizing the need for routine microbiological diagnostics and stricter antibiotic stewardship to guide effective treatment strategies.

Keywords: Anti-Bacterial Agents, Bacterial Infections, Drug Resistance, Dental Infection, Empirical Therapy, Multidrug Resistance, Outpatients.

INTRODUCTION

Dental procedures, while commonly performed and generally safe, can occasionally lead to post-procedural infections that pose a significant clinical challenge. These infections, though often localized and manageable, are increasingly being complicated by the emergence of multidrug-resistant (MDR) bacterial strains (1). The rise of antimicrobial resistance across healthcare sectors has not spared dentistry, where inappropriate or empirical use of antibiotics continues to fuel a silent yet escalating public health concern. Despite ongoing antimicrobial stewardship campaigns, resistance patterns among oral pathogens have evolved, rendering standard therapeutic protocols less effective and increasing the burden on outpatient care (2,3). Oral infections following dental interventions, such as extractions, root canal treatments, or periodontal surgeries, are typically polymicrobial, involving both aerobic and anaerobic bacteria. Common culprits include *Staphylococcus aureus*, *Streptococcus spp.*, *Enterococcus spp.*, and various gram-negative bacilli (4). These organisms, under normal conditions, are part of the oral flora but can become opportunistic pathogens when tissue integrity is compromised. However, the shift toward more virulent, resistant strains in outpatient infections has complicated treatment outcomes and prolonged recovery times (5,6). Alarmingly, studies have noted an uptick in resistance not only to penicillins and macrolides but also to advanced-generation cephalosporins and even carbapenems, agents typically reserved for severe systemic infections.

This growing resistance can be partially attributed to the misuse and overprescription of antibiotics in dental settings. In many regions, particularly those with limited regulatory oversight, dentists may prescribe antibiotics prophylactically or inappropriately—without culture sensitivity tests—contributing to an ecological pressure that favors resistant strains (7-9). Furthermore, patients in outpatient settings often self-medicate or fail to complete prescribed courses, adding another layer of complexity. Research has highlighted a glaring gap in surveillance data related to antimicrobial resistance (AMR) in dentistry, especially concerning post-procedure infections treated outside hospital environments (10). While hospital-based infections and resistance patterns are well-documented, outpatient data remain sparse, outdated, or geographically limited. The lack of comprehensive local and global data has serious implications. First, it hampers clinicians' ability to make evidence-based choices for empirical treatment. Second, it undermines public health efforts to control the spread of MDR organisms (11). Lastly, it exposes a significant blind spot in antimicrobial stewardship programs that often overlook dental practices. Addressing this void requires robust studies that systematically assess the prevalence of MDR pathogens and their susceptibility profiles in the outpatient dental context (12). Doing so would not only refine therapeutic guidelines but also inform policy-making and educational initiatives targeting antimicrobial use in dentistry.

Several studies have already begun to hint at troubling trends. For instance, isolates of *Enterococcus faecalis*—a common species implicated in endodontic failures—have demonstrated high resistance rates to tetracyclines and aminoglycosides (13-15). Likewise, *Staphylococcus aureus*, particularly methicillin-resistant strains (MRSA), has been found in oral abscesses with increasing frequency. These findings, while alarming, often come from isolated reports and small-scale studies, reinforcing the need for broader cross-sectional analyses that capture the true scope of resistance patterns across diverse outpatient populations. Given these concerns, the present study aims to fill a critical gap in the existing literature by evaluating the prevalence of multidrug-resistant bacteria in post-dental procedure infections among outpatients. It further seeks to identify the antibiotic susceptibility profiles of these pathogens, providing a foundation for more effective empirical treatment strategies. By shedding light on the local burden of antimicrobial resistance in outpatient dental infections, this study hopes to contribute to a more nuanced and targeted approach to antimicrobial prescribing in dentistry. Ultimately, its objective is to support the development of informed, evidence-based guidelines that promote optimal patient outcomes while curbing the spread of resistance.

METHODS

This cross-sectional study was conducted over an 8-month period at three major outpatient dental clinics located in urban and peri-urban regions of Lahore and Rawalpindi, Pakistan. These centers were selected based on patient turnover, procedural volume, and laboratory support infrastructure, allowing for timely microbiological analysis. The study sought to assess the prevalence and antibiotic susceptibility profiles of bacterial pathogens isolated from patients presenting with post-dental procedure infections, with a focus on identifying trends in multidrug resistance to support improved empirical antibiotic strategies. The study population comprised patients

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INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

aged 18 years and above who developed localized signs of infection—such as swelling, pus discharge, erythema, or pain—within 7 to 14 days following common dental procedures including extractions, root canal treatments, periodontal surgeries, or implant placements. Participants were enrolled consecutively from outpatient follow-up visits. Inclusion criteria were the presence of clinical infection confirmed by a dentist, a dental procedure performed at the study site within the prior two weeks, and willingness to provide informed consent. Exclusion criteria included patients with a known immunocompromised state (e.g., HIV/AIDS, malignancies, or immunosuppressive therapy), those who had been hospitalized for infection management, and individuals who had received systemic antibiotics within the last 72 hours prior to sample collection, to avoid skewed culture results.

A calculated sample size of 196 was determined using OpenEpi software, with a confidence level of 95%, a precision of 5%, and an expected prevalence of multidrug-resistant organisms set at 15% based on preliminary regional data. To compensate for potential dropout or sample contamination, a total of 210 participants were recruited (1,2). Pus or exudate samples were collected from infected sites using sterile cotton swabs and immediately transported in Amies medium to the central microbiology laboratory at a collaborating university facility. All specimens were processed within two hours of collection. Standard culture techniques were employed using blood agar, MacConkey agar, and chocolate agar plates, incubated at 37°C for 24–48 hours under appropriate atmospheric conditions. Isolated organisms were identified through Gram staining, colony morphology, and biochemical testing using the API 20E system for Enterobacteriaceae and the catalase-coagulase test for *Staphylococcus* species. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. A panel of commonly prescribed antibiotics in dental practice was included, such as amoxicillin-clavulanate, metronidazole, clindamycin, ceftriaxone, ciprofloxacin, and linezolid. Multidrug resistance was defined as resistance to three or more classes of antibiotics (13,14). Quality control strains including *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 were used to validate the procedures.

Demographic data and clinical details including type of dental procedure, timing of infection onset, comorbidities, and previous antibiotic exposure were recorded using a structured pro forma. Data were manually double-entered into Microsoft Excel and then analyzed using SPSS version 25. Descriptive statistics were used to summarize frequencies and percentages for categorical variables and mean ± standard deviation for continuous variables. The prevalence of individual bacterial species and MDR organisms was expressed as proportions. The Chi-square test was applied to assess associations between categorical variables, such as the type of procedure and occurrence of MDR infections. Independent samples t-test was used to compare mean infection onset times between groups. A p-value of <0.05 was considered statistically significant. The study received ethical approval from the Institutional Review Board (IRB). Informed consent was obtained in writing from all participants prior to enrollment, and confidentiality of personal data was strictly maintained. All laboratory analyses were conducted anonymously with coded samples. By integrating microbiological surveillance with statistical analysis in this structured manner, the study aimed to contribute actionable insights into antibiotic resistance trends in the outpatient dental setting, thereby strengthening empirical treatment protocols and supporting the broader framework of antimicrobial stewardship in Pakistan.

RESULTS

Out of the 210 participants enrolled, the mean age was 34.7 ± 10.3 years, with a slight male predominance (53.3%). A majority of participants resided in urban areas (63.8%), and approximately 29% reported a history of prior antibiotic use within the last six months. Common comorbidities included diabetes mellitus (21.0%) and hypertension (18.6%). A total of 210 clinical specimens were processed for culture and sensitivity testing. Positive bacterial growth was observed in 196 samples (93.3%), with the remaining 14 showing no significant growth. Among the 196 positive cultures, *Staphylococcus aureus* was the most frequently isolated pathogen (27.6%), followed by *Enterococcus faecalis* (21.9%), *Escherichia coli* (18.1%), *Klebsiella pneumoniae* (13.8%), and *Pseudomonas aeruginosa* (8.1%). The remaining 10.5% consisted of mixed or less common isolates, including coagulase-negative staphylococci and *Proteus* species. Antibiotic susceptibility testing revealed notable resistance patterns across the bacterial spectrum. Resistance to amoxicillin-clavulanate was highest, observed in 53.3% of isolates. Clindamycin resistance was found in 41.4% of isolates, while 45.7% showed resistance to ceftriaxone. Ciprofloxacin and metronidazole resistance were noted in 35.2% and 31.0% of isolates, respectively. Linezolid resistance remained low at 13.8%, primarily confined to *Enterococcus faecalis* isolates.

Multidrug resistance, defined as resistance to three or more antibiotic classes, was identified in 114 of the 196 bacterial isolates, indicating a prevalence of 58.2%. The highest rates of MDR were observed in *Klebsiella pneumoniae* (65.5%), followed by *Enterococcus*

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faecalis (60.9%), *Staphylococcus aureus* (60.3%), *Escherichia coli* (57.9%), and *Pseudomonas aeruginosa* (58.8%). These findings were statistically significant when correlated with prior antibiotic exposure ($p < 0.01$) and presence of comorbid conditions such as diabetes mellitus ($p = 0.03$). The frequency distribution of bacterial species and the resistance profile of each antimicrobial agent are presented in Tables 2 and 3, respectively. Table 4 further illustrates the multidrug resistance proportions across the major species isolated. Figure 1 and Figure 2 visually display the bacterial species distribution and resistance burden, respectively.

Table 1: Demographic Characteristics

Variable	n (%) / Mean ± SD
Total Patients	210
Mean Age (years)	34.7 ± 10.3
Gender	
Male	112 (53.3%)
Female	98 (46.7%)
Residence	
Urban Residence	134 (63.8%)
Peri-Urban Residence	76 (36.2%)
History of Prior Antibiotic Use	61 (29.0%)
Diabetes Mellitus	44 (21.0%)
Hypertension	39 (18.6%)

Table 2: Distribution of Bacterial Isolates

Bacterial Species	n (%)
Staphylococcus aureus	58 (27.6%)
Enterococcus faecalis	46 (21.9%)
Escherichia coli	38 (18.1%)
Klebsiella pneumoniae	29 (13.8%)
Pseudomonas aeruginosa	17 (8.1%)
Others	22 (10.5%)

Table 3: Antibiotic Resistance Profile

Antibiotic	Resistant Isolates (%)
Amoxicillin-Clavulanate	112 (53.3%)
Clindamycin	87 (41.4%)
Ceftriaxone	96 (45.7%)
Ciprofloxacin	74 (35.2%)
Metronidazole	65 (31.0%)
Linezolid	29 (13.8%)

Table 4: Multidrug Resistance by Species

Bacterial Species	MDR Isolates (%)
Staphylococcus aureus	35 (60.3%)
Enterococcus faecalis	28 (60.9%)
Escherichia coli	22 (57.9%)
Klebsiella pneumoniae	19 (65.5%)
Pseudomonas aeruginosa	10 (58.8%)

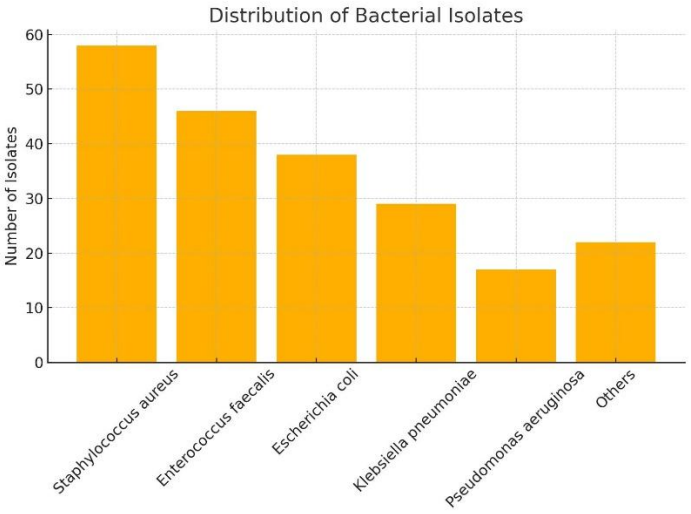

Figure 1 Distribution of Bacterial Isolates

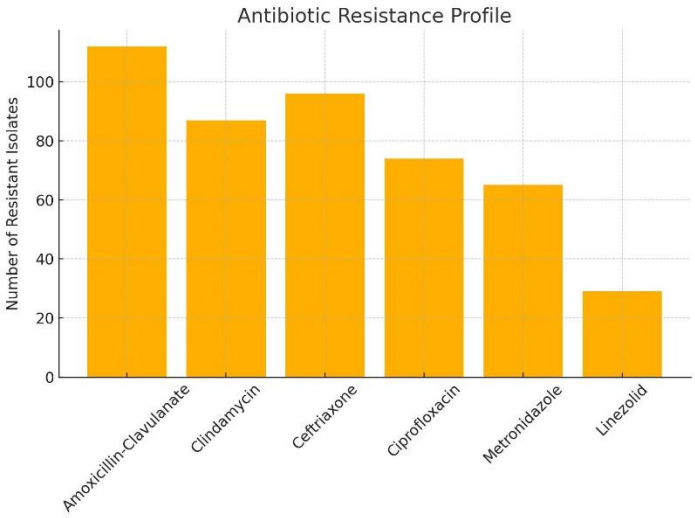

Figure 2 Antibiotic Resistance Profile

DISCUSSION

The findings of this study reflect the escalating concern surrounding antimicrobial resistance in post-dental procedure infections, particularly in outpatient settings. With a 93.3% culture positivity rate and a multidrug resistance (MDR) prevalence of 58.2%, the data affirm the increasing threat posed by resistant bacterial pathogens such as *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli*, and *Klebsiella pneumoniae*. These results align closely with recent evidence from similar regional and global studies, confirming an emerging pattern of resistance that demands immediate clinical and policy-level attention (14,15). The high frequency of *S. aureus* (27.6%) and *E. faecalis* (21.9%) mirrors trends observed in studies conducted in dental and maxillofacial settings across Pakistan and South Asia. For example, a study identified *Streptococcus mutans*, *S. mitis*, and *E. coli* as prominent pathogens in dental infections, noting high resistance rates to ciprofloxacin and ampicillin (16). Similarly, another study reported *S. aureus* and *Prevotella buccalis* as dominant isolates in post-maxillofacial surgical infections, with resistance rates exceeding 60% for penicillin, gentamicin, and tetracycline (17). The antibiotic susceptibility trends identified here are consistent with broader patterns observed globally. Resistance to amoxicillin-clavulanate, ceftriaxone, and clindamycin was particularly high, reflecting patterns seen in outpatient and primary healthcare settings as documented by a study noted similarly elevated resistance rates in gram-positive and gram-negative bacteria in Pakistan's primary care context (18,19). Resistance to linezolid remained low in the present study, mirroring the findings from studies which emphasized the preserved efficacy of linezolid and azithromycin in combating MDR strains (20-22). One strength of this study lies in its cross-sectional design across multiple outpatient settings, providing robust surveillance data on antimicrobial resistance patterns in a population often excluded from institutional monitoring frameworks. The inclusion of culture-confirmed infections and standardized susceptibility testing enhanced the reliability and clinical relevance of the data. Moreover, the statistical correlations observed between MDR infections and prior antibiotic exposure or comorbidities such as diabetes offer actionable insights for empirical decision-making.

However, certain limitations warrant consideration. The exclusion of hospitalized cases and immunocompromised individuals, while justifiable for the outpatient focus, may limit generalizability. Additionally, resistance genotyping was not performed, which could have provided deeper insight into the molecular mechanisms underlying resistance. The reliance on disc diffusion methods, though standardized, may also lack the sensitivity of newer automated platforms or MIC-based techniques. Recent findings underscore the significance of demographic factors in shaping resistance trends. Studies emphasized age and sex as critical variables influencing resistance dynamics, with MRSA prevalence rising significantly with age (23,24). These demographic nuances, though not the primary focus of this study, suggest that future research should incorporate age-stratified and sex-disaggregated analyses to refine empirical antibiotic strategies. Future studies should consider a multicenter longitudinal design to monitor evolving trends in resistance and include genetic profiling of MDR strains to understand resistance propagation. Additionally, integrating patient antibiotic history with

INSIGHTS-JHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION

prescription auditing could offer more definitive insights into the impact of prior antimicrobial exposure on current resistance profiles. In conclusion, this study highlights a troublingly high prevalence of multidrug-resistant bacteria in post-dental procedure infections among outpatients in Pakistan. The resistance profiles identified suggest a diminishing efficacy of commonly used antibiotics, thereby complicating routine dental infection management. These findings advocate for urgent reinforcement of antimicrobial stewardship practices within dental outpatient care and call for sustained surveillance to mitigate the rising threat of antimicrobial resistance.

CONCLUSION

This study highlights a concerning prevalence of multidrug-resistant bacteria in post-dental procedure infections among outpatients in Pakistan, with over half of the isolates demonstrating resistance to multiple antibiotic classes. These findings underscore the urgent need for localized antibiotic stewardship, routine culture-based diagnostics, and updated empirical treatment protocols to curb resistance and improve patient outcomes in dental outpatient care.

AUTHOR CONTRIBUTION

Author	Contribution
Fawad Ali Shah*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Bhavish Sachdev	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Sahal	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muqqudas Iqbal Awan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Gulzar Ahmed	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hafiz Nidaullah	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Ahmed Yar Khoso	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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