Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Antibiotics and Dentistry: A Comprehensive Review of Literature

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ABSTRACT:
Antibiotics have played a crucial role in the field of dentistry, offering therapeutic solutions for various dental infections and procedures. This review comprehensively examines the use of antibiotics in dentistry, highlighting their indications, effectiveness, and potential complications. The literature suggests a growing concern over antibiotic resistance, prompting the need for judicious use in dental practice. This review synthesizes clinical guidelines, studies on antibiotic prophylaxis for dental procedures, and alternative treatment strategies, ultimately emphasizing the importance of balanced antibiotic application to optimize patient outcomes and mitigate risks of microbial resistance.
Keywords: Antibiotics, Dentistry, Indications

Received: 23 January, 2025 Accepted: 20 February, 2025

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This article may be cited as: Lokhande A, Panchamiya A, Patil YB, Mhaske GA, Thajudheen DS, Kamarthy K. Antibiotics and Dentistry: A Comprehensive Review of Literature. J Adv Med Dent Scie Res 2025; 13(3):1-5.

INTRODUCTION

Antibiotics have become indispensable in modern dentistry, serving not only to manage infections but also as a preventive measure in specific situations. The use of antibiotics can be broadly categorized into therapeutic and prophylactic applications. While therapeutic use addresses existing infections such as periodontal disease or dental abscesses, prophylactic use aims to prevent infections in patients at risk, particularly during invasive procedures.

The emergence of antibiotic-resistant bacteria poses a significant challenge, urging dental professionals to reconsider traditional prescribing practices. This review aims to explore the multifaceted role of antibiotics within dentistry, shedding light on current guidelines, the spectrum of dental infections managed with antibiotics, and the implications of inappropriate use. By critically analyzing available literature, the review aims to inform dental practitioners about best practices whilenavigating the complexities of antibiotic utilization in their clinical workflows.[1-3]

Objectives of Antibiotics Uses in Dentistry: The uses of antibiotics in dentistry serve several important objectives, including:[1,2,4-6]

Infection Control: Antibiotics are employed to manage and prevent infections associated with dental treatments, such as during tooth extractions or periodontal procedures.

Treatment of Oral Infections: They are prescribed to treat oral infections like abscesses, cellulitis, and osteomyelitis, alleviating pain and preventing the spread of infection.

Postoperative Prophylaxis: Antibiotics can be administered preventively in patients with certain medical conditions, such as heart murmur or joint replacements, to avoid infective endocarditis or other complications post-surgery.

Management of Systemic Diseases: In patients with systemic diseases like diabetes or compromised immune systems, antibiotics may be necessary to prevent or control oral infections that could exacerbate their overall health.

Adjunctive Therapy: They can be used along with other therapeutic measures in the management of periodontal disease, reducing bacteria in periodontal pockets and promoting healing.

These objectives emphasize the crucial role antibiotics play in enhancing dental care, ensuring patient safety, and improving treatment outcomes.

Commonly Used Antibiotics: Several classes of antibiotics are commonly prescribed in dental practice, each targeting specific bacterial species that are prevalent in oral infections. The choice of antibiotic depends on the type of infection, its severity, and patient-specific factors such as allergies or comorbid conditions.[1,2,5-7]

1. **Penicillins**: Penicillins, such as amoxicillin, are among the most commonly prescribed antibiotics in dentistry due to their efficacy against a broad range of oral pathogens, including *Streptococcus* and *Enterococcus* species. They are often used to treat infections like dental abscesses and periodontitis.
   - **Indications**: Amoxicillin is frequently prescribed for bacterial infections in the oral cavity, including abscesses and postoperative infections.
   - **Contraindications**: Penicillin should be avoided in patients with a known allergy to penicillins or cephalosporins.
   - **Side Effects**: Common side effects include gastrointestinal disturbances (e.g., nausea, diarrhea), allergic reactions (e.g., rash, anaphylaxis), and, in rare cases, C. difficile-associated diarrhea.
2. **Clindamycin**: Clindamycin is often used in patients who are allergic to penicillin or for infections caused by *Anaerobes*, which are commonly found in the oral cavity. It is particularly effective in treating infections that do not respond to penicillin, such as those involving the deep tissues of the mouth or jaw.
   - **Indications**: Clindamycin is often used to treat severe infections such as abscesses, osteomyelitis, and periodontitis in patients with penicillin allergies.
   - **Contraindications**: It should be used with caution in patients with a history of gastrointestinal disorders, especially colitis.
   - **Side Effects**: Potential side effects include gastrointestinal disturbances, including diarrhea, and, in rare cases, Clostridium difficile-associated colitis (Rosen, 2017).
3. **Metronidazole**: Metronidazole is an antibiotic that is particularly effective against *Anaerobic* bacteria, which are prevalent in many oral infections, particularly in periodontal disease and periapical infections.
   - **Indications**: Metronidazole is frequently used in conjunction with other antibiotics (such as penicillin or amoxicillin) to treat abscesses, periodontal infections, and post-surgical infections.
   - **Contraindications**: Metronidazole should be avoided in patients with a history of alcohol use, as it can cause a disulfiram-like reaction.
   - **Side Effects**: Side effects may include nausea, vomiting, metallic taste, and rarely, neurotoxicity or seizures.
4. **Tetracyclines**: Tetracyclines, such as doxycycline, are commonly used in the treatment of periodontal diseases. They are effective against a broad range of bacteria and can be used both systemically and topically (e.g., in slow-release periodontal fibers).
   - **Indications**: Tetracyclines are used to treat chronic periodontitis and are often prescribed as part of a multidrug regimen.
   - **Contraindications**: Tetracyclines should not be prescribed to pregnant women, children under 8 years old, or individuals with kidney disease.
   - **Side Effects**: Common side effects include gastrointestinal upset, photosensitivity, and the potential for tooth discoloration in children (Berkow, 2019).
5. **Cephalosporins:** Cephalosporins are classified in beta-lactam antibiotics and can inhibit the biosynthesis of bacterial cell walls. Cephalosporins can act against aerobic bacteria, and their combination with metronidazole could cover both aerobic and anaerobic bacteria. Cephalexin and cefazolin are among the most commonly prescribed first-generation cephalosporins in dental practice. Cephalexin could be prescribed for penicillin-allergic patients, with the dosage of 2 g orally 1 h before dental procedures. Cefazolin is suggested for patients who are allergic to penicillin and cannot take the medication by mouth, with the dosage of 1 g IV or IM 30 minutes before the procedure**.**

Table 1 summarizes emerging antibiotics and their potential applications in dentistry. These newer drugs may offer solutions for managing resistant infections and improving outcomes for patients undergoing dental treatments.

Table 1 Recent Drug Developments in Antibiotics for Dentistry

Antibiotic	Development Focus	Mechanism of Action	Potential Benefits	Current Research/Application in Dentistry
Delafloxacin	New-generation fluoroquinolone with improved Gram-positive activity.	Inhibits bacterial DNA gyrase and topoisomerase IV, disrupting DNA replication.	Stronger activity against Gram-positive pathogens, including resistant strains.	Investigated for severe dental infections, including periodontitis and abscesses.
Tigecycline	Broad-spectrum antibiotic	Binds to the 30S ribosomal subunit,	Effective against resistant	Being explored for complicated dental

	effective against multidrug-resistant bacteria.	inhibiting protein synthesis.	pathogens, especially in soft tissue infections.	infections, especially those caused by resistant bacteria.
Fosfomycin	Used for resistant Gram-negative infections.	Inhibits bacterial cell wall synthesis by interfering with UDP-N-acetylglucosamine enolpyruvyl transferase.	Useful for urinary and soft tissue infections, including in dental cases.	Studied for use in dental abscesses and bone infections due to its broad-spectrum action.
Ceftaroline	Advanced cephalosporin with activity against resistant Gram-positive bacteria.	Inhibits bacterial cell wall synthesis, especially effective against MRSA.	Effective against resistant bacteria, including methicillin-resistant Staphylococcus aureus (MRSA).	Being tested for severe periodontitis and surgical site infections in dental practice.
Pretomanid	New drug for treating resistant infections in combination therapies.	Disrupts bacterial cell wall synthesis and interferes with mycobacterial growth.	Effective against multidrug-resistant organisms, particularly in combination with other antibiotics.	Investigated for use in dental infections caused by multidrug-resistant bacteria.
Lefamulin	Pleuromutilin class antibiotic with efficacy against Gram-positive and anaerobes.	Inhibits bacterial protein synthesis by binding to the 50S ribosomal subunit.	Broad-spectrum, useful for polymicrobial infections.	In early research for treating oral infections caused by both aerobic and anaerobic bacteria.
Meropenem/Vaborbactam	Combination therapy targeting resistant Gram-negative infections.	Meropenem inhibits cell wall synthesis, while vaborbactam inhibits beta-lactamases that degrade meropenem.	Enhanced efficacy against resistant Gram-negative pathogens, including carbapenem-resistant Enterobacteriaceae.	Exploring use in severe infections in dental patients, including those with resistant pathogens.
Cefepime/Tazobactam	Combination therapy for resistant infections in hospitals and dental settings.	Cefepime inhibits cell wall synthesis; tazobactam inhibits beta-lactamase enzymes.	Improved activity against resistant Gram-negative bacteria.	Under investigation for severe dental infections and surgical prophylaxis in high-risk patients.
Rifamycin SV	Rifamycin derivative with increased activity against Gram-positive bacteria.	Inhibits bacterial RNA synthesis by binding to RNA polymerase.	High efficacy against Gram-positive pathogens, including Streptococcus species.	Research focuses on potential use for chronic dental infections and as a treatment adjunct in periodontal therapy.
Daptomycin	New lipopeptide antibiotic targeting resistant Gram-positive infections.	Disrupts bacterial cell membrane integrity, leading to cell death.	Effective against MRSA and other resistant Gram-positive bacteria.	Investigated for use in refractory oral infections, particularly in patients with immunocompromised conditions.

Antibiotics in Pediatric Dentistry: When prescribing antibiotics for children, it is essential to consider anatomical and physiological differences compared to adults. These include variations in body water and fat composition, the maturation of the immune system, protein volume, and the levels of liver enzymes.

Dentists often prescribe antibiotics to mitigate the risk of bacteremia from dental infections in children; however, antibiotic therapy should not be viewed as a substitute for eliminating the source of infection. A pressing global concern is the rise of antibiotic resistance stemming from inappropriate use, such as prescribing antibiotics in unsuitable situations or for prolonged periods in pediatric patients.

Consequently, dental practitioners must be knowledgeable about appropriate antibiotic selections and indications for use in children under the age of 13. A list of common antimicrobial agents and their forms utilized in pediatric dentistry can be found in Table 2.[8]

Table 2: Antibiotics in Pediatric Dentistry

Agent	Situation	Dose	Maximum dose	Available forms
Amoxicillin	First choice in dental infection	20–40 mg/kg /day, 8h	2 g/day	Tablet 125 mg, capsule 250 mg and 500 mg, and oral suspension 125 mg/5 ml and 250 mg/5 ml
Amoxicillin + clavulanic acid	Failure of first choice antibiotic		1000–2800 mg amoxicillin/143–400 mg clavulanic acid	Tablet 375 mg, 625 mg, and 1000 mg and oral suspension 228.5 mg/5 ml
Metronidazole	Anaerobic bacteria	30 mg/kg /day, 8 h	2 g/day	Tablet 200 mg, 250 mg, 400 mg, and 500 mg, infusion solution 500 mg/5 ml, and oral suspension 200 mg/5 ml
Clindamycin	Penicillin hypersensitivity	10–20 mg/kg /day, e6 h		Suspension 75 mg/5 ml

Antibiotics in Pregnancy: Prescribing medication during pregnancy requires careful consideration, as inappropriate use could potentially harm the fetus irreparably. In dental practice, commonly used agents during pregnancy that are generally regarded as safe include analgesics, anesthetic agents, and antibiotics. The Food and Drug Administration (FDA) classifies drugs into five categories (A, B, C, D, and X) based on their risk factors during pregnancy, with most antibiotics falling into Class B. Additionally, pregnant patients should receive a complete adult dose with the standard duration of treatment.

During pregnancy and breastfeeding, Penicillins and Cephalosporins are considered the drugs of choice. It is important to avoid quinolones, tetracyclines, aminoglycosides unless faced with severe or life-threatening infections, as well as high-dose metronidazole, trimethoprim during the first trimester due to its status as a folate antagonist, and nitrofurantoin at term due to the risk of neonatal hemolysis. According to BNF guidance regarding antibiotic use during pregnancy, penicillins and cephalosporins are safe to use throughout pregnancy. However, sulphonamides should be avoided if delivery is imminent due to their interference with the bile conjugating mechanism of the neonate. Tetracyclines are contraindicated as they can stain developing bones and teeth in the fetus, and their intramuscular administration may occasionally lead to maternal liver failure. Erythromycin is not known to be harmful, while manufacturers advise against high-dose regimens of metronidazole. Streptomycin may pose a risk of fetal auditory nerve damage, and although trimethoprim is considered safe after the first trimester, similar warnings apply to trimethoprim-sulphonamide preparations.[9,10]

Antibiotic Resistance and Appropriate Selection: The overuse and misuse of antibiotics in dentistry contribute to the growing problem of antibiotic resistance. Bacteria can evolve to become resistant to the effects of antibiotics, rendering treatments ineffective and complicating the management of infections. To combat antibiotic resistance, dental professionals must adhere to evidence-based guidelines that recommend the appropriate use of antibiotics.[9,10]

- **Selecting the Right Antibiotic**: The selection of antibiotics should be based on the type of infection, the suspected bacterial pathogens, and the patient's medical history. For example, narrow-spectrum antibiotics are preferred when possible to target specific pathogens, thereby reducing the risk of developing resistance.
- **Prophylactic Antibiotics**: Prophylactic antibiotics should only be prescribed for patients at high risk for developing infections, such as those with artificial heart valves or compromised immune systems.

CONCLUSION

In conclusion, the use of antibiotics in dental practice is a critical aspect of patient care, particularly when considering their implications for specific populations such as pregnant women. The literature demonstrates

that while certain antibiotics, such as penicillins and cephalosporins, are generally regarded as safe for use during pregnancy, others pose risks that must be carefully considered. Knowledge of drug classifications and the potential effects on both the mother and the fetus is essential for dental professionals. Additionally, proper usage, indications for prophylaxis, and awareness of antibiotic resistance are crucial in ensuring effective and safe treatment. Overall, a thorough understanding of antibiotic applications in dentistry is vital for optimizing patient outcomes and preventing adverse effects, thereby emphasizing the importance of continuous education and adherence to best practices within the profession.

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