

## SUMMARIZING ANTIBIOTICS IN DENTISTRY

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### ABSTRACT

Dental infections can be caused by dental caries, pulpal necrosis, trauma, and periodontal disorders, and they can have serious effects that impact both the soft and hard tissues of the oral cavity. Pain, fever, and edema are frequent signs of dental infections. Early treatment of infected teeth includes surgical and endodontic procedures, followed by antibiotic medication. Antibiotics are used to treat odontogenic infections, oral non-odontogenic infections, as well as to prevent local infection and spread to nearby tissues and organs. Furthermore, overprescribing antibiotics can have major consequences, including bacterial resistance, gastrointestinal and hematological disorders, and bacterial microbiota diversion. The purpose of this study is to outline the reasons for antibiotic therapy in dentistry and to highlight the most often used antibiotics in dental practice.

**Key Words:** Antibiotics, dentistry, odontogenic infections

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## INTRODUCTION

Antibiotic usage in dentistry is characterized by empirical prescription based on clinical and bacteriological epidemiological criteria, short-term use of broad-spectrum antibiotics, and the administration of a relatively restricted range of antibiotics. Patients with immunosuppressed diseases, infective endocarditis, metabolic problems, and patients with prosthetic joints are all administered antibiotic prophylaxis. Comprehensive recommendations should be devised to prevent the difficulties of needless antibiotic prescriptions, particularly bacterial resistance. Only approximately 12% of dentists are effectively and correctly prescribing antibiotics, demonstrating the significance of detailed guidelines. Antibiotics can cause side effects such as hypersensitivity responses, dermatological problems, and allergic reactions.

## INDICATIONS OF ANTIBIOTICS:

Antibiotics are recommended for local and focused infection prevention, as well as the treatment of odontogenic and nonodontogenic infections. Furthermore, antibiotics are indicated for all odontogenic infections (**Fig:1**); however, they should not be used instead of removing the infection's cause. In the event of an infection, incision and drainage, debridement, and endodontic care are advised, followed by systemic antibiotic therapy. Immunocompromised patients, patients with a history of cancer, people with infective endocarditis, people with metabolic disorders like diabetes and splenectomies, people with prosthetic joints, in-dwelling catheters, neurosurgical shunts, valvular heart diseases, surgical pulmonary shunts, hypertrophic cardiomyopathy, mitral valve prolapse, and prosthetic heart valves are all candidates for antibiotic prophylaxis. Dental extraction, surgical periodontal procedures, dental implant placement, reimplantation of teeth, endodontic procedures or endodontic surgeries, subgingival placement of antibiotic fibres or strips, and intraligamentary local anaesthetic injections are all procedures that have an increased risk of infection in susceptible patients<sup>(1-2)</sup>. In several dental procedures, such as surgery for benign tumours, bone grafting, implant insertion, periapical surgery, and removal of impacted teeth, prophylaxis is recommended for healthy individuals. In cases of necrotizing ulcerative gingivitis, stage III-grade C/incisor-molar pattern periodontitis (localised aggressive periodontitis), acute periapical abscess, cellulitis, local or systemic spreading of infection in the periodontal abscess, pericoronitis, periimplantitis, infection of the deep fascial layers of the head and neck, and infection of the deep

fascial layers of the head and neck region.

## COMMONLY PRESCRIBED ANTIBIOTICS:

Commonly prescribed antibiotics in dental practice includes:

### **Beta-lactam antibiotics**

Antimicrobial agents that contain beta-lactam ring in their molecular structure and the ring includes a three-carbon and one-nitrogen cyclic amine structure. These group of antibiotics is bactericidal agents that act against many Gram- positive, Gram-negative, and anaerobic bacteria via inhibiting the synthesis of the cell wall. Beta-lactam antibiotics are categorized into five classes: penicillin, cephalosporins, penems, carbapenems, and monobactams.

**Penicillin:** Penicillin is a narrow-spectrum antibiotic that was discovered from *Penicillium notatum*. Common types of penicillin that are being administered for treatment of odontogenic infections are penicillin V, amoxicillin, and amoxicillin/clavulanic acid. Penicillin is considered to be the first-line drug and the gold standard for the treatment of odontogenic infections<sup>(3)</sup> because of its cost-effectiveness and appropriate antimicrobial activity. Despite these benefits, the drug might cause various side effects including rash, nausea, gastric irritation, diarrhea, and hypersensitivity reactions such as skin reactions.

**Penicillin V:** Compared with penicillin G, penicillin V stays for a longer time in blood circulation. Tablet of 500 milligrams (mg) penicillin V is every 6 hours by mouth route. Moreover, 2–4 g penicillin V every 4–6 hours combined with 500 mg metronidazole intravenous (IV) or orally every 8 hours could also be prescribed.

**Amoxicillin:** Amoxicillin is a penicillin antibiotic that acts against Gram- negative bacilli. Amoxicillin is commonly considered to be the first line of treatment in nonallergic patients. Dosage for amoxicillin: 500 mg every 8 hours or 1000 mg every 12 hours.

**Amoxicillin with Clavulanic Acid (Co-Amoxiclav):** Amoxicillin with clavulanic acid (co-amoxiclav) is a broad spectrum antibiotic and is the most prescribed antibiotic by dentists. It has been shown that all the bacteria that were extracted from an odontogenic abscess were susceptible to the agent. In the case of amoxicillin resistance, the administration of coamoxiclav or metronidazole is suggested. A high dose of co-amoxiclav (875/125 mg every

8 hours or 2000/125 mg every 12 hours) is a proper choice in the cases of severe odontogenic infections, such as abscess and pulpitis. Overuse could result in some levels of hepatotoxicity; change the orogastrointestinal normal microbiota causing candidiasis or even *Clostridium difficile* infection.

**Ampicillin:** Ampicillin is a broad spectrum beta-lactam antibiotic that has bactericidal activity mostly covers the Gram positive bacilli. Moreover, ampicillin mainly acts against aerobic bacteria, and it could be simultaneously prescribed with metronidazole to more efficiently fight anaerobic bacteria of odontogenic infections. Commonly used for patients who cannot orally take drugs, and the prophylaxis dosage is 2 mg IV or intramuscular (IM) half an hour before the procedure. Coadministration of ampicillin and clindamycin could increase the risk of pseudomembranous.

### **Cephalosporin**

Cephalosporins inhibits the biosynthesis of bacterial cell walls. Cephalexin and cefazolin are 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<sup>(4)</sup>. Studies shows that cephalosporins have few side effects and better antimicrobial activity, amoxicillin is still the drug of choice for the treatment of odontogenic infections. Patients treated with cephalosporins have high risks of colonization of *Candida albicans* and yeast.

Overuse and misuse of penicillin and cephalosporins has resulted in an increased rate of bacterial resistance, caused by the production of beta-lactamase.

### **Nitroimidazoles**

Nitroimidazoles are administered to treat parasitic and anaerobic bacterial infections. Nitroimidazoles include metronidazole, nimorazole, and tinidazole. Dental practitioners prescribe metronidazole for the treatment of acute infections, as it has great anti-anaerobic bacterial activity and low risk of toxicity.

### **Metronidazole:**

Metronidazole has bactericidal activity and acts against

anaerobic microorganisms by inhibiting the nucleic acid synthesis; shows antiprotozoal activity and does not disrupt the protective aerobic microbiota. Combined administration of amoxicillin and metronidazole could cover most of the oral bacteria. Prescription of this combination or metronidazole is also recommended for the treatment of periodontal infections. Dosage of 500–750 mg every 8 hours is usually given.

### **Macrolides**

Macrolides have a macrocyclic lactone ring, which are bacteriostatic agents that inhibit protein synthesis; these agents have translation modulators that act against bacterial ribosomes. Macrolides mainly act against beta-hemolytic streptococci.

**Erythromycin:** Erythromycin has bacteriostatic activities and is usually prescribed for dental caries and dental plaque. Most common microorganism that causes dental caries is *Streptococcus mutans*, which is highly sensitive to erythromycin. Erythromycin can inactivate the caries, and it also can decrease the growth and formation of dental plaque. Erythromycin should be prescribed with a dosage of 250–500 mg every 6 hours. However, the drug is not regularly recommended as it could cause several short-term and long-term adverse effects, such as gastrointestinal problems, hepatotoxicity, and also bacterial resistance.

**Azithromycin:** Azithromycin is a bacteriostatic antibiotic that has a great potency against Gram-negative pathogens and is considered to be the safest among the macrolides drug is usually prescribed as an alternative in penicillin-allergic patients. Dosage of the drug is 500 mg once a day for three days, in case of therapeutic prescription, and 500 mg 1 hour before the oral procedure, in case of prophylactic administration.

**Clarithromycin:** Clarithromycin inhibits bacterial protein synthesis and matrix metalloproteinase (MMP) regulating activities that could fight against intracellular pathogens by penetrating the cells. Standard dose for prophylaxis is 500 mg orally 1 hour before the dental procedure. Common side effects of clarithromycin are gastrointestinal complications, such as nausea and diarrhea. It is indicated that clarithromycin has some new effects such as modulating myocarditis, cardiac rejection, and change of inflammatory signs.

### **Lincosamides:**

Lincosamides are bacteriostatic agents that mostly fight against Gram-positive anaerobic pathogens, by binding to the

functional spot of the bacterial ribosome and restricting the protein synthesis. Lincomycin and clindamycin are the drugs that are classified in the group of lincosamides antibiotics<sup>(5)</sup>. While, among lincosamides, the prescription of clindamycin is more common than the others.

**Clindamycin:** Clindamycin is a broad-spectrum bacteriostatic antibiotic that covers both aerobic and anaerobic pathogens. Previous investigations shows that nearly 75% of all bacteria causing odontogenic infections are sensitive to the drug. Clindamycin could be prescribed in the case of persistent infections, as it has more efficacies in comparison with penicillin and metronidazole. Clindamycin is also an excellent choice for patients who have an allergy to beta-lactam group antibiotics. The therapeutic dosage of the drug is 600 mg or 300 mg every 8 hours orally or intravenously. Usual prophylactic dose is 600 mg before procedure orally or 600 mg intravenously in both penicillin-allergic patients and those who cannot take medication by mouth. Furthermore, more recent studies showed that clindamycin might reduce the risk of dry socket after extraction. Common side effects of clindamycin are vomiting, nausea, diarrhea, exanthem, jaundice, hepatitis, neutrophil reduction, eosinophilia, agranulocytosis, blood platelet count change, and pseudomembranous colitis.

#### **Fluoroquinolones:**

Fluoroquinolones are broad-spectrum bactericidal antibiotics that mostly act against Gram negative bacilli, Gram-positive aerobic cocci, and anaerobic organisms, by preventing the synthesis of DNA. Fluoroquinolones are commonly prescribed for non-odontogenic infections, such as respiratory, genitourinary tract, joint, and bone infections. Gastrointestinal reactions and cartilage, joint, tendon, and the central nervous system involvement are the common side effects.

**Ciprofloxacin:** Ciprofloxacin is among the second generation of fluoroquinolone antibiotics and is active against Gram-positive and Gram-negative pathogens. Antibiotic showed excellent antibacterial potency, whilst having minimum side effects. The drug is usually administered orally with a dosage of 500 mg every 12 hours to treat odontogenic infections. Most common side effect of ciprofloxacin is gastrointestinal problems, including, nausea, vomiting, and diarrhea.

**Moxifloxacin:** Moxifloxacin is a broad-spectrum bactericidal agent and a fourth-generation fluoroquinolone. Drug acts against aerobic, anaerobic, Gram-positive, and Gram-negative bacteria and is commonly administered to

control chronic bronchitis, pneumonia, skin infections, and bacterial sinusitis. Moxifloxacin can be considered as a good choice to treat odontogenic and periodontal infections as well, since it has high penetration capacity through periodontal and bone tissues. Moreover, this could be prophylactically prescribed to beta-lactam-allergic patients to prevent bacteremia. Effective dose of the agent to control odontogenic infections is 400 mg once a day.

#### **Tetracyclines**

Tetracycline is a bacteriostatic antibiotic that is active against Gram-positive and Gram-negative bacteria, acting by blocking the synthesis of protein through binding to the ribosomal subunit. Drug could be a reasonable prescription for the treatment of periodontal diseases, as it has anti-inflammatory activity, collagenase inhibition potential, and bone resorption inhibitory capacity; besides, it could help the fibroblasts to attach to the root surface. Tetracycline is recommended in cases of periodontal diseases, improving marginal attachment and enhancing bone graft. The drug has a long half-life, preserves its antimicrobial activity for a long time, and is released from the tooth surface gradually. Side effects includes widespread resistance of pathogens, photosensitivity, nausea, vomiting, diarrhea, loss of appetite, hepatotoxicity, and discoloration of primary and permanent teeth. Drug is usually not recommended for young children and pregnant women because it can cause intrinsic tooth staining during the calcification phase.

#### **APPROPRIATE CHOICE OF ANTIBIOTICS:**

The antibiotic used and its dosage are determined by the severity of the infection as well as the causative microorganisms. Patients who are allergic to penicillin should benefit from clindamycin; which is active against some oral anaerobic and facultative bacteria and has the advantage of good bone penetration. Patients who are allergic to penicillin should benefit from clindamycin; which is active against some oral anaerobic and facultative bacteria and has the advantage of good bone penetration<sup>(7)</sup>. The ideal duration of antibiotic treatment is the shortest cycle capable of preventing both clinical and microbiological relapse. Most acute infections are resolved within 3–7 days. When oral antibiotics are used, a high dose should be considered to help achieve therapeutic levels more rapidly. Short-course antibiotic therapy requires antibiotics to have certain characteristics, such as: rapid onset of action; bactericidal activity; lack of propensity to induce resistant mutants; ease of infection conditions (low pH,

anaerobiasis, presence of pus, etc., administration at an optimal dose; and an optimal dosing regimen.

### Antibiotic regimen for children:

According to WHO EMLc model list and BNFC (British National Formulary for Children), antibiotic regimen for children [2 months to 12 years] <sup>(8,9)</sup>

### Contradictions of antibiotics during pregnancy:

Antibiotics contradicted during pregnancy

M METRONIDAZOLE- HEPATIC FAILURE

C CHLOREMPHENICOL-GRAY BABY SYNDROME

A AMINOGLYCOSIDES-OTOTOXICITY

T TETRACYCLINE-INTRINSIC TOOTH DISCOLORATION HEPATIC FAILURE

### CONCLUSION:

Antibiotic treatment is required in both medicine and dentistry. Even though recommendations are accessible, dentists are not always aware of the most up-to-date clinical guidelines for antibiotic prophylaxis. This is the cause for antibiotics being prescribed on an ad hoc basis, as well as the negative repercussions of antibiotic usage. Antibiotic usage has been linked to a variety of negative side effects, including gastrointestinal problems, deadly anaphylactic shock, and the development of antimicrobial resistance. The prevention of antibiotic misuse and abuse has worldwide consequences for the control of antibiotic-resistant bacterium strains <sup>(10)</sup>. Microbes developing drug resistance is a normal occurrence, however it is exacerbated by the overuse of antimicrobials. As a result, a few naturally resistant and acquired resistance strains emerge as the dominant types. The antibiotic sensitivity of the bacteria found within the oral cavity is gradually decreasing, and a growing number of resistant strains have been detected – particularly *Porphyromonas* and *Prevotella* – although the phenomenon has also been reported for *Streptococcus viridans* and for drugs such as the macrolides, penicillin and clindamycin. Resistance has been reported against all beta-lactam antibiotics (including penicillin derivatives and cephalosporins), clindamycin, ciprofloxacin, erythromycin and tetracycline.

Hence, the correct administration of antibiotics is linked to infection management concepts, infectious agent microbiology and host response, and the pharmacology of the specific agent. A variety of factors influence these concepts

in the therapeutic context. To ensure appropriate antibiotic prescription, these aspects must be understood. These factors need to be understood to ensure appropriate prescribing of antibiotics.

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