Antibiotic and Antimicrobial Use in Treating Pulpal Infections

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LEARNING OBJECTIVES:
After reading this article, the individual will learn:

- Specific guidelines for use of antibiotics in the treatment of pulp infections.
- General guidelines for use of antibiotics in dental practice.

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Disclosure: Dr. Gopireddy reports no conflicts of interest.

INTRODUCTION

Dental clinicians encounter many types of infection, including infections of pulpal origin, which require a decision regarding the use of antibiotics. Further, there are certain antimicrobial agents in addition to antibiotics that serve useful therapeutic roles in controlling or preventing infections.

Use of antibiotics to treat an infection is highly variable depending on the type of bacterium, severity of the infection, susceptibility of the patient, age and weight of the patient, and the individual’s idiosyncratic responses to a given drug. When antibiotics were introduced, the accepted procedure was to first culture the bacteria and perform a susceptibility assay previous to prescribing antibiotics. However, this regimen eventually proved to be unrealistic and unnecessary for the vast majority of clinical situations requiring antibiotics. In most situations, antibiotics may be prescribed empirically based upon the clinical presentation. Furthermore, because testing of strict anaerobes may take several days or weeks, culture and sensitivity (C & S) testing is not practical. The best guideline is to use an antibiotic with the narrowest spectrum applicable and lowest incidence of toxicity and side effects; however, since the infection is usually of unknown origin, a broader spectrum is generally applied.

This article reviews and provides specific guidelines for the use of antibiotics in the treatment of pulpal infections. Further, general guidelines regarding the dentist’s use of antibiotics are included, and indications, dosages, and possible alternative medications are provided.

THE DECISION TO USE ANTIBIOTICS – STATUS OF INFECTION

The use of antibiotics mandates a tentative analysis of a
wide range of clinical parameters. An infection must either be persistent or systemic to justify the need for antibiotics. Pain alone or a localized swelling does not require antibiotic treatment. Most dental pain can be managed using non-narcotic analgesics such as nonsteroidal anti-inflammatory drugs.

The evaluation of the following signs and symptoms may assist in determining the status of an infection.

1. *Patient’s health:* Patients in poor health, including immunocompromise, (i.e., a white blood cell count less than 1,000 mm³), are more likely to need antibiotics.

2. *Severity of symptoms:* Swelling, cellulitis, or fever that escalates with time may indicate that an infection is spreading.¹

3. *Extent of soft tissue inflammation:* If an intraoral swelling is localized, the infection may be managed by surgical drainage. However, if the swelling spreads into extraoral musculofascial spaces or impedes breathing or swallowing, the patient should immediately be referred for emergency care. A large, diffuse swelling may require antibiotics as well as surgical drainage.¹

4. *Benefits versus risks:* An antibiotic allergic reaction may present as a minor rash or a significant life-threatening anaphylaxis. Patients may also develop adverse side effects such as gastrointestinal problems and secondary infections. Pregnant women should be evaluated with extra care due to a developing fetus.²

The following discussion is formatted in sections that are based on the area of clinical dentistry involved.

**ANTIBIOTICS/ANTIMICROBIALS IN ENDODONTICS**

As noted previously, at one time it was thought to be preferable to culture the bacteria in every infection and perform susceptibility testing before prescribing antibiotics, but routine C & S assays are not presently utilized because they have proven to be unrealistic and unnecessary. Most endodontic infections can be treated effectively without the use of adjunctive antibiotics. In a nonvital case, the decision is more challenging. Antibiotics are usually unnecessary in regard to the treatment of nonvital teeth that are draining or undergoing endodontic therapy. Some dentists have considered prescribing antibiotics in such cases and informing the patient not to have the prescription filled unless the patient begins to experience swelling.

Though individual clinicians may have a personal preference, as a generalization, antibiotics should be given until 2 or 3 days after resolution of major clinical signs and symptoms, usually totaling at most 6 to 10 days. In most cases, a high-dose regimen for a short period of time is better than a low-dose regimen for longer time; high-dose, short-term utilization helps prevent resistance.

Clinical trials have demonstrated that administering antibiotics before endodontic treatment does not reduce the incidence of flare-ups following treatment. There is a strong correlation between substandard technical quality and the presence of post-treatment periapical disease resulting in a high frequency of “failed” cases.³

Penicillin V Potassium (penicillin VK) remains the antibiotic of choice as it has a narrow spectrum of microbial activity that includes most of the bacteria associated with endodontic infections (both facultative and anaerobic) and because of its efficacy and low toxicity. The one drawback is that there is a 10% allergy rate.⁴ An oral loading dose of 1,000 mg should be followed by 500 mg every 6 hours for 6 to 10 days.

Amoxicillin is often used as a first choice because of its broader spectrum of activity. Amoxicillin is absorbed more rapidly than penicillin VK and provides a higher and more continuous serum level; therefore, it is appropriate for medically compromised patients. Amoxicillin also is known to have increased penetration compared to penicillin VK.⁵

Augmentin is amoxicillin with clavulanate potassium. It is recommended for endodontic infections containing beta-lactamase-producing bacteria. Clindamycin is recommended for patients with serious cellulitic infections and for patients who are allergic to penicillin VK or amoxicillin. It should be noted that pseudomembranous colitis is a possible side effect of clindamycin. Augmentin and clindamycin are the recommended “fall-back” antibiotics when infections do not respond to traditional dental antibiotics such as penicillin VK or amoxicillin. Augmentin is helpful when the infection is due to staphylococcal infections, and clindamycin is helpful when the infection is due to a Gram-negative infection.⁶
Another common alternative to amoxicillin allergy are the 2 drugs of the macrolide group—azithromycin and erythromycin. These have a similar profile as penicillin and are also resistant to cell wall deficient organisms (such as mycoplasma), but their use is restricted due to their bacteriostatic nature and also higher costs.  

**Suggestions for Periapical Endodontic Surgery**

Clinical trials have shown that in case of a flare-up and an immediate plan for periapical surgery there is no statistical advantage for antibiotic coverage; the patient can be expected to heal normally without an antibiotic. If the surgery is planned for a later date, it may be advisable to prescribe antibiotics to decrease the infection prior to the surgical procedure to contain infection for a temporary period of time.  

Antibiotics are not recommended for irreversible pulpitis, acute apical periodontitis, a draining sinus tract, following endodontic surgery, to prevent flare-ups, or after incision for drainage of a localized swelling (without cellulitis, fever, or lymphadenopathy).  

**Antimicrobial Intracanal Medicaments**

Apart from systemic antibiotics, locally delivered antimicrobial agents of various types to control intracanal infections are commonly used in endodontic therapy. These agents include:

1. **Calcium hydroxide** (Ca(OH)₂): Ca(OH)₂ is bactericidal, neutralizes the remaining tissue debris in the canal system, has an alkaline pH, and promotes an alkalizing osteogenic environment, making it an attractive choice for root canal dressings. Ca(OH)₂ further helps to cleanse the root canal by mediating the neutralization of lipopolysaccharides of the bacterial cell wall. Its effectiveness is related to hydroxyl ion diffusion through the dentinal tubules and accessory canals, reaching any pockets of bacteria or their byproducts.  

2. **Chlorhexidine**: The antimicrobial action of chlorhexidine is linked to the cationic molecule binding to negatively charged bacterial cell walls and altered osmotic equilibrium. Thus, it has antimicrobial activity against Gram-negative and Gram-positive microorganisms.  

3. **Camphorated paramonochlorophenol (PMCC)**: This causes cell growth inhibition.  

4. **Chlorine dioxide**: Oxidizing properties and radical nature make it an effective bactericidal agent.  

5. **Betadine and betadine scrub**: These act by drying the canal, rendering the protein barrier covering the bacteria ineffective. The addition of a surfactant improves the bactericidal activity and is reportedly more effective in this regard than Ca(OH)₂.  

6. **Sodium hypochlorite (NaOCl)**: This is an oxidizing agent; the radical form of oxygen kills the bacterial cells in the root canal.  

7. **Formocresol (formaldehyde and cresol)**: Its use is controversial due to the fact that it is a mutagen and genotoxic, but a recent review supports its use, particularly with regard to pulpectomy/pulpotomy procedures and pediatric pulp therapy with inconsequential risks. However, there is no rationale to use additional intrapulpal medications such as formocresol or PMCC after preliminary antibacterial endodontic cleansing agents such as NaOCl have been utilized.  

**PROPHYLACTIC ANTIBIOTICS FOR MEDICALLY COMPROMISED PATIENTS**

Antibiotic prophylaxis may be indicated if the infection to be prevented is common but not fatal or if it is rare but carries an unacceptably high mortality rate. The principles of antibiotic prophylaxis include the following: (1) satisfactory risk and cost-benefit ratios should exist in which benefit to the patient significantly outweighs medical and financial risks, (2) the antibiotic must be in high concentrations at the target site (blood or tissue) before the onset of the bacteremia or surgery, (3) an antibiotic loading dose (2 to 4 times the maintenance dose) must be used, (4) the antibiotic chosen should be active against the single most likely microorganism to cause the infection (antibiotic prophylaxis is not effective against polymicrobial infections), and (5) the antibiotic is continued only as long as microbial contamination of or from an operative site continues.  

Regarding antibiotic prophylaxis before dental procedures such as simple single tooth extractions, research indicates that the bacteremia due to routine oral hygiene procedures is usually of comparable levels. According to American Hospital Association (AHA) guidelines, the use of antibiotic
prophylaxis for infective endocarditis should be considered only if there is a very high risk of adverse outcomes. Prophylaxis is not recommended based solely on an increased lifetime risk of acquisition of infective endocarditis.\(^{18,19}\)

For high-risk patients, the AHA recommends antibiotic endocarditis prophylaxis for root canal instrumentation or surgery beyond the root apex and for intraligamentary injections of a local anesthetic. Endocarditis prophylaxis is not recommended for nonintraligamentary local anesthetic injections, rubber dam placement, or the taking of radiographs\(^{19}\) (Table 20).

According to AHA guidelines, conditions which require antibiotic premedication to prevent endocarditis are\(^{19}\):

1. Artificial heart valves.
2. A history of having had infective endocarditis.
3. Certain specific, serious congenital heart conditions, including:
   - Unrepaired or incompletely repaired cyanotic congenital heart disease including those with palliative shunts and conduits.
   - A completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter interventions, during the first 6 months after the procedure.
   - Any repaired congenital heart defect with residual defect at the site or adjacent to the site of a prosthetic patch or prosthetic device.
4. A cardiac transplant which develops a problem in a heart valve.

Patients who may require prophylaxis for surgical dental therapy include:\(^{9,21}\)

- Patients with total joint replacements (guidelines for antibiotic prophylaxis for patients with total joint replacements have been recently updated. Those considered at risk include immunocompromised patients, patients with insulin-dependent diabetes mellitus, patients who had joint replacement surgery less than 2 years previously, patients who have had previous prosthetic joint infections, malnourished patients, and patients with hemophilia).

The ADA and American Academy of Orthopaedic Surgeons and their expert consultants recently reviewed the 1997 statement. The 2003 statement includes some modifications of the classification of patients at potential risk and of the incidence stratification of bacteremic dental procedures, but includes no changes in terms of suggested antibiotics and antibiotic regimens. The statement concludes that antibiotic prophylaxis is not indicated for dental patients with pins, plates, or screws, nor is it routinely indicated for most dental patients with total joint replacements. However, it is advisable to consider premedication in a small number of patients who may be at potential increased risk of experiencing hematogenous total joint infection.\(^{22}\)

- Immunocompromised/immunosuppressed patients: (ie, rheumatoid arthritis (RA), systemic lupus, drug or radiation induced immunosuppression).
- Patients with comorbidities (ie, previous joint infection, insulin-dependent [type I] diabetes, malnourishment, hemophilia, HIV infection, malignancy, inflammatory arthropathies [ie, RA]). Instances in which antibiotic prophylaxis may be considered include white blood cell counts of less than 1,000 mm\(^3\), immunocompromization, and ongoing cellulitis.\(^{23}\)

ANTIBIOTICS IN PEDIATRIC DENTISTRY FOR PULPAL INFECTIONS

A series of differential characteristics should be explained in relation to antibiotic treatment in children\(^{24}\):

- Young children tend to lack medical antecedents suggesting the possibility of drug allergies or adverse reactions.
- The greater proportion of water in the tissues of children, and their increased bone sponginess, facilitate faster diffusion of infection. On the other hand, such patients require adequate dose adjustment of the prescribed medication.

In case of doubt, the dental professional should consult the pediatrician or specialist habitually in charge of the care of the child. The standard dosages for antibiotic premedication for a child based on weight are presented in the Table.
Any type of drug, however safe it is, should be avoided during pregnancy if possible. The risk benefit analysis plays a bigger role in this situation. Every medication is assigned to a category (B, C, D, or X) based on how safe or risky it is to use during pregnancy. Category B — There is no known association with birth defects or other pregnancy-related complications and the drug is probably safe. This category includes amoxicillin, ampicillin, augmentin, azithromycin, cefaclor, cepalexin, clindamycin, dicloxacillin, duricef, erythromycin (except estolate form), and metronidazole.

Category C — These drugs have some concerns arising from animal studies, but no confirmation of problems such as birth defects in humans. These include: bactrim, ciprofloxacin, clarithromycin, and trimetoprim.

Category D — These medications have clear-cut problems in pregnancy and should not be used unless there are no better alternatives. These include: doxycycline, minocycline, sulfa drugs (if the patient is near delivery, because they can increase the chance of serious newborn jaundice), and tetracycline and tetracycline derivatives (which can cause discoloration of teeth).

Category X — Unclassified antibiotics for pregnancy which are to be completely avoided—chloramphenicol, nalidixic acid, spectinomycin, troleandomycin.

Complications associated with bacterial resistance to antibiotics dictate that clinicians do not prescribe antibiotics unless they are clearly indicated. A breakthrough study demonstrated that postsurgical antibiotic therapy was not efficacious in healthy patients. The results of this study have since been repeatedly confirmed, ie, that antibiotic postsurgical therapy does not enhance healing or prevent negative outcomes. The reasons for utilizing postsurgical antibiotic therapy are few, and include: ongoing cellulitis, decreasing white blood cell count (overall or specific), immune system compromised (HIV, cancer, diabetes mellitus, etc).

Other important considerations which apply to the reality of clinical dentistry include lack of time for incision and drainage or even lack of experience in the procedure. The decision to use or not use antibiotics, and the potential to misuse these drugs, is a routine issue in dental practice. When treating a patient with any of the conditions discussed in this article, the dentist must seek to avoid systemic infection originating from the oral cavity. An excellent review of this topic by Pallasch and Wahl[28] notes the important role that clinical judgment plays regarding prophylaxis for certain patients who may be at greater risk for hematogenous bacteremias.

### Table. Antibiotic Prophylaxis for Prevention of Bacterial Endocarditis

<table>
<thead>
<tr>
<th>SITUATION</th>
<th>AGENT</th>
<th>REGIMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>General prophylaxis</td>
<td>Amoxicillin</td>
<td>Adults: 2 g&lt;br&gt;Children: 50 mg/kg given orally 1 hour before procedure</td>
</tr>
<tr>
<td>Patient unable to take oral medicines</td>
<td>Ampicillin</td>
<td>Adults: 2 g&lt;br&gt;Children: 50 mg/kg IM/IV 30 minutes before procedure</td>
</tr>
<tr>
<td>Allergic to penicillin</td>
<td>Clindamycin</td>
<td>Adults: 600 mg&lt;br&gt;Children: 20 mg/kg given orally 1 hour before procedure</td>
</tr>
<tr>
<td>Allergic to penicillin and unable to take oral medication</td>
<td>Azithromycin or clarithromycin</td>
<td>Adults: 500 mg&lt;br&gt;Children: 15 mg/kg</td>
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REFERENCES

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1. Testing of strict anaerobes can be accomplished within one or 2 days. Because of this, culture and sensitivity testing is practical for most oral infections.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

2. Pain alone or a localized swelling does not require antibiotic treatment. Most dental pain can be managed using non-narcotic analgesics.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

3. Amoxicillin is absorbed more rapidly than penicillin V potassium (penicillin VK). Amoxicillin provides a lower and less continuous serum level than penicillin VK.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

4. Which antibiotic is recommended for endodontic infections containing beta-lactamase-producing bacteria?

5. Pseudomembranous colitis is a possible side effect of which antibiotic?

6. Calcium hydroxide is bacteriostatic. It neutralizes the remaining tissue debris in the root canal system.
   a. The first statement is true, the second is false.
   b. The first statement is false, the second is true.
   c. Both statements are true.
   d. Both statements are false.

7. According to AHA guidelines, the following condition(s) require antibiotic premedication to prevent endocarditis:
   a. Artificial heart valves.
   b. A history of having had infective endocarditis.
   c. A cardiac transplant which develops a problem in a heart valve.
   d. All of the above.

8. Which category of antibiotics has no known association with birth defects or other pregnancy-related complication?
   a. Category B. c. Category D.
   b. Category C. d. Category X.
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2. ☐ a ☐ b ☐ c ☐ d          6. ☐ a ☐ b ☐ c ☐ d
3. ☐ a ☐ b ☐ c ☐ d          7. ☐ a ☐ b ☐ c ☐ d
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