



Review:

Antimicrobials: their use and misuse in pediatric dental practices

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Abstract

Antibiotics are medications that fight against bacterial infections and are often prescribed by dentists in dental practice, during dental treatment as well as for prevention of infection. Since most dental and periodontal diseases are best managed by operative intervention and oral hygiene measures, the indications for the use of systemic antibiotics in dentistry are limited. The injudicious use of antibiotics and lack of awareness among practitioners are one of the key contributors to the emergence of antibiotic-resistant bacterial strains. It is therefore mandatory that antibiotics are prescribed only when they are likely to clinically benefit the pediatric patient. Pediatric dentists can make a difference by the sensible use of antimicrobials by prescribing the correct drug, at the standard dosage and appropriate route only when systemic spread of infection is evident.

Keywords: Antimicrobials, Pediatric dentistry, Antibiotics

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Introduction

Antimicrobials are one of the most common class of medications prescribed to children.^[1] Antibiotics are beneficial to patient care when prescribed and administered precisely for bacterial infections. Antibiotics are used most commonly in dental practice as prophylactic agents for the preventive management of endocarditis.² In addition, antibiotics are used for therapeutic reasons in cases where infections of oral hard and soft tissues, such as teeth and gingiva, cannot be controlled by local debridement and can spread to distant organs and therefore require supplemental therapy.^[2] Recently, the widespread use of antibiotics has permitted common bacteria to develop resistance to drugs that once controlled them.^[3,4] Antimicrobial resistance happens when germs like bacteria and fungi develop the ability to defeat the drugs which are designed to kill them.^[3] Antibiotic exposure can also lead to *Clostridioides difficile* infections (CDIs), and other drug-related adverse events, such as end-organ toxicities, diarrhea, rashes, cytopenia, and anaphylaxis.^[5] To reduce the rate at which resistance is increasing, healthcare professionals must be prudent in the use of antibiotics.^[3,6]

The Centers for Disease Control and Prevention (CDC) estimates that antibiotic-resistant microbes cause nearly 3 million infections and 35,000 deaths each year in the United States.³ According to the CDC, appropriate antibiotic prescribing means antibiotics are only prescribed when needed, and the right antibiotic is selected and prescribed at the right dose and for the right duration. It should also follow evidence-based national and local clinical practice guidelines, when available.^[7] As dentistry prescribes approximately 10 percent of all the common antibiotics (penicillins, cephalosporins, macrolides, tetracyclines), a dentist's contributions to the problems of microbial resistance can be substantial.^[8] Antibiotic misuse in dentistry primarily involves the use of antibiotics in inappropriate situations or for too long a period.^[9]

Antibiotic misuse – How much is too much?

Giving antibiotics after a dental procedure is completed in an otherwise healthy patient to

prevent post-treatment infections by giving the drugs after the dental procedure violates all the principles of antibiotic prophylaxis and has not been demonstrated to be clinically effective.^[10] The use of antibiotics as “analgesics” to treat postoperative pain is irrational as better drugs are available as analgesics, and most studies indicate that antibiotics do not relieve postoperative edema, pain, and trismus.¹⁰ The use of antibiotics as “drugs of fear” to prevent lawsuits has also contributed substantially to antibiotic resistance problems.^[9] In certain scenarios if the infection to be prevented is common but not fatal or if the infection is rare but carries an unacceptably high mortality rate antibiotic prophylaxis is indicated. Antibiotic prophylaxis is theoretically beneficial in protecting healthy individuals from potentially serious infections and/or the prevention of infection of implanted foreign bodies.^[10] Some dentists still prescribe prophylactic antibiotics after various oral surgical procedures to prevent postoperative infectious sequelae in patients who are not at risk for serious infection from bacteremia. Surgical antibiotic prophylaxis is only indicated: 1) to prevent contamination of a sterile area, 2) where infection is unlikely but is associated with major morbidity, 3) in surgical procedures with high infection rates, and 4) during implantation of prosthetic material.^[10] The pharmacokinetics of antibiotics ensures that an antibiotic begun sometime after the dental procedure and without a loading dose may achieve significant blood levels six to twelve hours after the procedure or sometime the next day when the issue of whether infection occurs has already been decided.^[11,12]

Proper adherence to the established guidelines for antibiotic prophylaxis to prevent metastatic infections as advocated by the American Heart Association for infective endocarditis and the American Dental Association/American Academy of Orthopaedic Surgeons for dental patients with orthopedic prosthetic joints will significantly reduce unnecessary antibiotic prophylaxis in dentistry.^[13,14]

In the treatment of periodontal diseases, antibiotic usage is advised only in the management of acute periodontal infections, primarily periodontal abscesses, and in the management of refractory or rapidly progressive periodontitis, which has failed to go into remission after standard treatment procedures.^[9]

Antimicrobials such as low-dose doxycycline as an adjunct to periodontal care for prolonged periods or in place of mechanical therapy in periodontitis management are considered to be yet another form of antibiotic misuse^[9] Antibiotics are rarely a substitute for surgical drainage (incision and drainage, extraction, endodontics) of an Infected area. Occasionally, an infected area is not amenable to incision and drainage (pericoronitis, indurated cellulitis) and antibiotics are the only available treatment, but the exception should not become the rule^[11,12] The duration for antibiotics can vary among individuals due to various factors like the ability to incise and drain the infection; host medical status and response to the infection; growth rate and virulence of the infection; the presence of resistant bacterial strains etc. Since each infection is unique and a standard protocol of the same dose and duration for every infection can lead to increased microbial resistance and in many cases treatment failure too.^[12, 13]

Prescribing trends of antibiotics in paediatric dentistry

The prescribing behavior of antibiotics in paediatric dentistry was assessed through cross-sectional surveys and studies conducted nationwide or regionally to identify the antibiotic prescription pattern.^[6] A global assessment of the prescribing practices revealed that the use of antibiotics by dental practitioners is approximately 7–11% of the total antibiotic consumption⁸ and some contribution from paediatric dentists has also been noted.^[15] Amoxicillin, considered the primary drug of choice for dental infections is effective against a wide variety of gram-positive bacteria and has a greater gram-negative coverage than penicillin.^[16] Amoxicillin is found to be well absorbed from the gastrointestinal tract, provide high, sustained serum concentrations, and have a low incidence of adverse effects.^[17] Doxycycline is recommended as a substitute for penicillin, cephalosporin, and macrolide allergy. There was no tooth discoloration noted in children under eight years of age with short-term use (less than 21 days) of doxycycline.^[17]

Azithromycin is one of the safest antibiotics for patients allergic to penicillins, but there are cardiac complications including cardiotoxicity.

^[18] American Heart Association no longer recommends clindamycin for prophylaxis against infective endocarditis due to frequent and severe reactions.^[19] Clindamycin has been associated with significant adverse drug reactions and up to 15 percent of community-acquired *C. difficile* infection has been attributed to antibiotics prescribed for dental procedures.^[19]

Recommendations on the use of Antibiotic Therapy for Pediatric Dental Patients

American Academy of Pediatric Dentistry (AAPD) recommends that pediatric dental practitioners should adhere to the following general principles for antibiotic usage^{17, 19, and 20}

- Prevention of dental diseases should be given more consideration to reduce the need for antibiotics.
- Antibiotics should be prescribed only when needed for a bacterial infection. It is advised only as an adjunct to, not considered as an alternative to, other interventions like pulp therapy, extraction, and scaling which control the infection source.
- Antibiotics should be selected based on properties of the agent like the spectrum of coverage, safety, etc, and patient factors like medical history, drug allergies, current medication use, previous history of antibiotic intake, etc.
- The most effective route of drug administration must be considered. If the patient is receiving parenteral antimicrobial therapy for the treatment of existing infections, the same antibiotic can be continued.
- The minimal duration of the drug regimen is five days or a five- to seven-day course of treatment, reliant upon the specific drug selected. To avoid antibiotic resistance, discontinuation of antibiotics should be considered following the determination of either ineffectiveness or cure before completion of a full course of therapy.
- If an infection is not responsive to the initial drug selection, culture, and sensitivity testing from the infection site or blood microbiology and culture sensitivity may be indicated.
- Prescriptions should be mentioned in the patient's dental record.
- Individuals assumed to have an allergy to antibiotics should receive testing to confirm or disprove the presence of a true allergy

Additional considerations for specific clinical circumstances recommended by AAPD are discussed below.

Oral wounds

Patient factors like age, systemic illness, comorbidities, malnutrition, and type of wound must be evaluated when determining the need for antibiotics. Lacerations on the face and puncture wounds may require topical antibiotic agents.^[21] Intraoral puncture wounds and lacerations that give the impression of being contaminated by extrinsic bacteria, debris, foreign body, open fractures, and joint injury should be managed by systemic antibiotics.^[21] If antibiotics are helpful to the healing process, the timing of their administration is critical to supplement the natural host resistance in bacterial killing. For the best outcome, the drug should be administered as soon as possible.

Pulpitis/apical periodontitis/ draining sinus tract/localized intraoral swelling

If acute symptoms of pulpitis are presented in a child, treatment in the form of pulpotomy, pulpectomy, or extraction should be rendered. If the dental infection is limited within the pulpal tissue or the immediately surrounding tissue antibiotic therapy is not recommended nor effective.^[22]

Acute facial swelling of dental origin

A child presenting with facial swelling or facial cellulitis secondary to an odontogenic infection should receive prompt dental attention. The clinician should consider age, cooperation, the ability to obtain adequate anesthesia, the severity of the infection, the medical status, and any social issues of the child.^[23, 24] If the odontogenic infection is found to be not localized and presented with progressive swelling and systemic manifestations (e.g., fever, difficulty breathing, or swallowing), immediate surgical intervention and medical management with intravenous antibiotic therapy contribute to a more rapid cure. Systemic involvement and septicemia are more likely presented with fever, malaise, asymmetry, facial swelling, lymphadenopathy, tachycardia, and airway compromise that warrant emergency management. Additional imaging modalities like radiographs, ultrasound, computed tomography scans, and tests like complete blood examination, C-reactive protein, bacterial culture,

and sensitivity testing can aid in the assessment and diagnosis.^[23, 24] For odontogenic infections penicillin derivatives remain the primary choice, and metronidazole is considered for anaerobic bacterial involvement. An alternative choice for the management of odontogenic infections, when a child has had a previous course of penicillin/amoxicillin or if the child has a penicillin allergy is cephalosporins.^[25]

Avulsions

In the case of avulsed permanent incisors with an open or closed apex systemic antibiotic have been recommended as adjunctive therapy.^[26] Amoxicillin or penicillin is considered to be the primary drug as it is effective against oral flora with minimal adverse effects.^[26] Doxycycline is frequently considered an alternate drug to penicillin. Doxycycline exhibits its antimicrobial, anti-inflammatory, and anti-resorptive properties which make its use appropriate for dental trauma.^[26] Antibiotics can be warranted in cases of concomitant soft tissue injuries.

Pediatric periodontal diseases

Patients diagnosed with aggressive periodontal disease may require adjunctive antimicrobial therapy along with localized treatment.^[27] Pediatric periodontal diseases associated with systemic conditions such as severe congenital neutropenia, leukocyte adhesion deficiency, Papillon Lefèvre syndrome, where the immune system is not able to restrict the growth of periodontal pathogens antibiotic therapy or antibiotic prophylaxis is advised.^[27] Culture and susceptibility testing of isolates from the suspected sites helps determine drug selection.

Viral diseases

Acute primary herpetic gingivostomatitis should not be treated with antibiotic therapy.^[28]

Salivary gland infections

Antibiotic therapy is indicated for acute salivary gland swellings of bacterial cause.^[29] If the patient's condition does not improve in 24-48 hours on antibiotics alone, incision and drainage may be required.^[3] Amoxicillin/clavulanate is used as first-line therapy to cover both staphylococcal and streptococcal species as maximum bacterial infections of the salivary glands originate from oral flora.^[29] In the case of acute bacterial submandibular sialadenitis and chronic recurrent submandibular sialadenitis, antibiotic therapy is included as part of the treatment.

Systemic antibiotic prophylaxis

Several medical conditions have been identified by the American Academy of Pediatric Dentistry that predisposes patients to bacteremia-induced infections. Prophylactic antibiotics are suggested in invasive oral/ dental

procedures in patients with a high risk of adverse consequences from bacteremia and infection.³⁰ Table 1 denotes the incidence of bacteremia associated with some dental treatment and oral hygiene methods.¹⁰

Table 1. The incidence of bacteremia with dental treatment and oral hygiene procedures

Dental treatment bacteremia	Oral hygiene bacteremia
Tooth extraction: 51-85%	Toothbrushing: 0-26%
Periodontal surgery: 36-88%	Dental flossing: 20-58% ¹
Scaling and root planing: 8-80%	Toothpicks: 20-40%
Periodontal prophylaxis: 0-40%	Irrigation devices: 7.50%
Endodontics: 0-15%	Chewing: 17-51%

Except for patients with the highest risk of adverse outcomes resulting from infective endocarditis antibiotics before dental procedures are not recommended (Table 2).

Table 2: Cardiac conditions associated with the highest risk of adverse outcome from endocarditis for which prophylaxis with dental procedures is reasonable.

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Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
Previous IE
Congenital heart disease (CHD)*
Unrepaired cyanotic CHD, including palliative shunts and conduits
Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure†
Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
Cardiac transplantation recipients who develop cardiac valvulopathy

Antibiotic prophylaxis is not recommended for the following dental procedures such as routine anesthetic injections through noninfected tissue; taking dental radiographs; placement of removable prosthodontic or orthodontic appliances or the adjustment of these appliances; placement of orthodontic brackets;

shedding of deciduous teeth and bleeding from trauma to the lips or oral mucosa.[19,31] Table 3 shows the antibiotic regimen for patients at risk of infective endocarditis undergoing invasive dental procedures. Recent changes to the American Heart Association (AHA) guidelines have removed the use of clindamycin owing to its frequent and severe reactions.

Table 3: Antibiotic regimens for a dental procedure regimen: single dose 30 to 60 minutes before the procedure.

Situation	Agent	Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin OR	2 g IM or IV	50 mg/kg IM or IV
	Cefazolin or ceftriaxone	1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillin or ampicillin —oral	Cephalexin OR	2 g	50 mg/kg
	Azithromycin or clarithromycin	500 mg	15 mg/kg
	Doxycycline	100 mg	< 45 kg, 2.2 mg/kg > 45 kg, 100 mg
Allergic to penicillin or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone†	1 g IM or IV	50 mg/kg IM or IV

Patients with shunts, indwelling vascular catheters, or medical devices

The AHA found no substantial evidence that microorganisms associated with dental procedures cause infection of cardiovascular implantable electronic devices (CIED) and nonvalvular devices after implantation.^[30, 19] The causative organisms for infections occurring after device implantation are often *Staphylococcus aureus* and coagulase-negative staphylococci or other microorganisms that are non-oral in origin but are associated with surgical implantation or other active infections. [30, 19] AHA does not recommend antibiotic prophylaxis for dental procedures are listed in Table 4.

Table 4: Antibiotic prophylaxis for a dental procedure not suggested

Implantable electronic devices such as a pacemaker or similar devices
 Septal defect closure devices when complete closure is achieved
 Peripheral vascular grafts and patches, including those used for hemodialysis
 Coronary artery stents or other vascular stents
 CNS ventriculoatrial shunts
 Vena cava filters
 Pledgets

Patients with compromised immunity

Noncardiac patients with a compromised immune system may be at risk for complications of bacteremia and distant site infection following invasive dental procedures. For the management of patients with a Compromised immune system consultation with the patient's physician is recommended.^[30] High-risk patients who should be considered for the use of prophylaxis include those with:^[30]

- [1] Immunosuppression secondary to
 - a. Human immunodeficiency virus (hiv);
 - b. Severe combined immunodeficiency (scids) and other primary immunodeficiency diseases;
 - c. Neutropenia and other neutrophil-related disorders (e.g., severe congenital neutropenia, leukocyte adhesion deficiency, chédiak-higashi syndrome);
 - d. Cancer chemotherapy, immunosuppressive therapy, and/or radiation therapy;

- e. Hematopoietic stem cell or solid organ transplantation.
- [2] History of head and neck radiotherapy.
- [3] Autoimmune disease (e.g., juvenile arthritis, systemic lupus erythematosus).
- [4] Sickle cell anemia.
- [5] Asplenism, post-splenectomy, or complement deficiencies.
- [6] Chronic high-dose steroid usage.
- [7] Uncontrolled diabetes mellitus.
- [8] Medication-related osteonecrosis of the jaw
- [9] Hemodialysis.

Antibiotic prophylaxis is no longer recommended for patients with VA (Ventriculoatrial) and VP (ventriculoperitoneal) shunts or in patients with a history of total joint arthroplasty or prosthetic joint infections. If unsure of medical history or risk, consultation with the child's physician is recommended for invasive dental management.^[30] Randomized controlled clinical trials justifying the efficacy and use of antibiotic prophylaxis are limited in the pediatric population. Many recommendations are based on expert consensus.^[30,19,32] A study found 80 percent of preprocedural antibiotic prescriptions unnecessary as risk factors were not present, highlighting a concern regarding the appropriateness of prescribed prophylaxis.^[33] Conservative use of antibiotics helps minimize the risk of developing resistance to current antibiotic regimens. While the use of antibiotic prophylaxis is indicated for certain patients undergoing invasive dental procedures, the prevention of oral disease by the maintenance of good home care habits and regular dental care is considered more important.^[30, 19] This may prevent the frequent need for the use of antibiotic therapy and, thus, decrease the risks of resistance and adverse events related to use of antibiotics.^[30, 19]

Prevention of antibiotic misuse

When the pattern of antibiotic use amongst the AAPD members was evaluated it was found that there existed a tendency to overprescribe and overuse antibiotics in situations like irreversible pulpitis and abscess with or without sinus tract and draining fistula.³⁴ On the other hand, the importance of educational intervention as a marker for improvement in prescription patterns was highlighted in a study by Yesudian et al.^[35] Most of the

studies done in the pediatric population revealed an interesting deduction that is: none of these studies, surveys, and reviews checking for prescribing practices showed the use of antimicrobial sensitivity testing or microbial culture reports before the actual antibiotic prescription. There was a shortcoming of consensus or clear-cut specification regarding the age or weight-specific dosages and duration of antibiotic therapy.^[6]

Antibiotic stewardship

Antibiotic stewardship is a practice dedicated to ensuring that antibiotics are used precisely and only when found essential. When antibiotics are considered necessary, to optimize clinical outcomes and minimize the undesirable consequences utmost importance should be given to their spectrum of activity, appropriate dose, route, and duration of therapy.^[5] The increase in multidrug-resistant infections has outpaced the development of novel antibiotics capable of treating them.^[36] The prior studies also reported the role of antibiotics in dental practice.^[37-40]

Antibiotic stewardship is the effort to quantify and improve how antibiotics are prescribed by clinicians and how well are they used by patients. Improving antibiotic prescribing and use is critical to treat infections effectively protecting patients from harm caused by unnecessary antibiotic use, and battling antibiotic resistance. CDC recognizes that there is no “one size fits all” method to adjust antibiotic use for all settings.^[7] U.S. Antibiotic Awareness Week (USAAW) is an annual observance to promote worldwide awareness of the threat of antibiotic resistance and the importance of appropriate antibiotic use. The theme for WAAW (World Anti-microbial Resistance Awareness Week) in 2023 is the same as that in 2022 - “Preventing Antimicrobial Resistance Together”.^[7] AMR is a danger to humans, animals, plants, as well as the environment. Henceforth this year’s theme collaborates across various sectors to preserve the efficacy of these critical medicines. Fighting AMR is a global effort and must be addressed through a one-health approach. Factors like lack of knowledge, uncertainty in the diagnosis, and parental, and patient pressure have been considered leading to increased use of antibiotics.

Clearer nationwide guidelines are required for an actual understanding of the indications of antibiotics. Holistic approaches like antibiotic stewardship can be considered to guarantee prudent antibiotic use.^[6]

Conclusion

The global problem of microbial resistance to antibiotics is serious in its extent as well as in the rapidity with which microorganisms are attaining and maintaining resistance. It is not a time for us to panic, but it is time for all to realize that the problem cannot be solved without a concerted effort on the part of all concerned: patients, parents, healthcare professionals, veterinarians, food producers, and governments. It is high time for us all to become part of the solution and not the problem.

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