

The Usage of Antimicrobials in Pediatric Dentistry- A Narrative Review

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Abstract: Antimicrobials play a crucial role in pediatric dentistry, helping to manage and prevent infectious diseases. However, their indiscriminate use and misuse can have significant consequences, including the development of antimicrobial resistance. This article aims to provide an in-depth exploration of antimicrobials in pediatric dentistry, discussing their appropriate use, common indications, potential adverse effects, and the importance of judicious prescribing. It also highlights the significance of antimicrobial stewardship programs in promoting responsible antimicrobial use and mitigating the emergence of resistance in dental set up.

Keywords: Antibiotics, Pediatric Dentistry, Oral procedures, Prophylaxis.

INTRODUCTION

Pediatric dentistry emphasises on the oral health of infants, children and individuals with special health needs. As a part of comprehensive therapy, antibiotics are prescribed by the Pediatric dentist to manage and prevent infection. Antibiotics also act as an adjunct to the undergoing treatment.

Antibiotics are substances produced by microorganisms, which selectively suppresses the growth of or kills other microorganisms at very low concentrations. This definition excludes other natural substances which also inhibit micro-organisms but are produced by higher forms or even those produced by microbes but are needed in high concentrations [1]. The term "antibiosis" was first coined by Louis Paster in the year 1889 which meant the process of life killing life [2]. The term "Antibiotic" was first coined by Selman Waksman in the year 1942.

Antibiotics are prescribed in dental practice for prophylactic and therapeutic reasons [3]. However, the overuse, misuse, and inappropriate prescribing of antimicrobials pose significant challenges in maintaining their efficacy and preventing the advent of resistance to antibiotics. Prophylactic antibiotics are prescribed to prevent diseases caused by the host microorganisms when the defense mechanism of the host is compromised. Prophylactic antibiotics are most commonly used in diseases like, in infective

endocarditis. Therapeutic antibiotics are prescribed to treat cases of hard and soft tissue infection where the local debridement therapy has failed. Antibiotics is prescribed in infections related to Endodontia, Oral surgery and Periodontia. The dosage of antibiotics in children varies from the adults. There are several formulas depending on the age, weight and body surface area of the child to calculate the dosage of the medication.

From 2000 to 2015, the global antibiotic consumption in terms of defined daily doses has seen an increase of 65%, mainly in low middle income countries [4]. Thus, use of antibiotics in developing countries has been observed to be much higher compared to the developed world [5].

The overuse of antibiotics is most commonly seen in children which is main cause of resistance [6]. Even when used appropriately, the usage of antibiotic can still cause resistance, hence the prescription of antibiotics is very important as the negative outcomes, weighs more than the positive outcome [7]. The American Academy of Pediatric Dentistry (AAPD) has published guidelines for antibiotic use, recognizing the increasing prevalence of antibiotic-resistant microorganisms [8].

Thus, the main aim of this review is to highlight the various antibiotics used in pediatric dentistry, their dosage, their overuse and misuse along with clinical conditions indicated for their use. It also highlights the significance of antimicrobial stewardship programs in promoting responsible antimicrobial use and mitigating the emergence of resistance in dental set up.

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COMMON INDICATIONS FOR ANTIMICROBIAL USE IN PEDIATRIC DENTISTRY

Antimicrobial agents are prescribed in paediatric dentistry to manage and prevent various infectious conditions. However, it is crucial to differentiate between situations that genuinely require antimicrobial therapy and those that can be effectively managed without antibiotics. The appropriate use of antimicrobials in paediatric dentistry is essential to ensure optimal patient care and reduce the risk of adverse effects and antimicrobial resistance. The following are common indications for antimicrobial use in paediatric dental practice:

1. Treatment of Acute and Chronic Dental Infections

Antimicrobials are often prescribed to manage dental infections characterized by symptoms such as pain, swelling, and fever. Dental infections can range from localized infections, such as dental abscesses, to more severe systemic infections, such as cellulitis. In cases where the infection is spreading rapidly, causing systemic symptoms, or compromising the patient's airway, antimicrobials are an essential adjunct to definitive dental treatment. The common dental infections are the irreversible pulpitis, necrotic pulp and acute dental abscess or the dentoalveolar abscess. In the above conditions, depending on the extent of the infection systemic antibiotics are prescribed along with local debridement. For oral wounds, like facial laceration and puncture wounds topical application of antibiotic is recommended. If the infection is non-responsive for the topical application, systemic antibiotics are prescribed. If the infection does not subside with systemic antibiotics, culture and sensitivity swab from the infected area is indicated [9].

2. Prevention of Infective Endocarditis

In certain high-risk patients with underlying cardiac conditions, prophylactic antimicrobial therapy may be recommended to prevent infective endocarditis (IE) during invasive dental procedures. Guidelines, such as those provided by the American Heart Association (AHA), specify the specific cardiac conditions and procedures that require antibiotic prophylaxis. It is important to adhere to these guidelines to minimize the risk of Infective Endocarditis while avoiding unnecessary antibiotic exposure. The first AHA guidelines identify those with rheumatic and or congenital heart diseases as being at risk of Infective endocarditis, and dental extractions and other dental manipulations which disturbs the gums are the

procedure which need antibiotic prophylaxis [10, 11]. In the 2015 guideline, antibiotic prophylaxis is to be prescribed only for procedures requiring manipulation of gingival and periapical region of the teeth or perforation of the oral mucosa [10]. The 2021 AHA guideline for the antibiotic prophylaxis of infective endocarditis no longer recommends clindamycin as an alternative for amoxicillin in individual who are allergic to amoxicillin [12].

The recommended antibiotic prophylaxis for those not allergic to penicillin is as follows,

Amoxicillin, 2g orally 30 – 60 mins before the procedure

And for those individuals who are allergic to penicillin,

Azithromycin 500mg orally 30-60 mins before the procedure or Cephalexin 500mg orally for 30- 60 mins before the procedure.

Management of Oral Manifestations of Systemic Conditions

Children with systemic conditions may present with oral manifestations that require antimicrobial therapy. For example, patients with conditions like diabetes mellitus, neutropenia, immunosuppression, or congenital immunodeficiencies may be at increased risk of oral infections. In such cases, antimicrobial agents may be prescribed as part of a comprehensive treatment plan to manage the oral manifestations and prevent complications.

Children with diabetes mellitus are more prone to infections than the non-immune compromised children [9]. The other immunocompromised state in children is the renal dysfunction, leukaemia, sickle cell anaemia to name a few. The dosage of the antibiotics given to individuals with the above condition is usually one to one and half times [11] more than the normal dose depending on the condition and the range of infection.

Adjunctive Therapy for Surgical Procedures

Antibiotics may be used as adjunctive therapy in paediatric dental surgeries to prevent postoperative infections. Procedures, such as surgical tooth extractions, periodontal surgeries, or surgical interventions for oral-facial trauma, may warrant the use of antimicrobials to reduce the risk of surgical site infections. Though, the routine use of antibiotics for every dental procedure is common, it is not

recommended, and their use should be limited to specific cases with a higher risk of infection.

Management of Acute Trauma

In cases of severe dental trauma, such as avulsion (complete displacement) of a permanent tooth, the use of antimicrobials may be considered to reduce the risk of infection associated with open tooth sockets. Prompt treatment with appropriate antimicrobials, along with proper dental management, can help minimize the risk of complications and promote favourable outcomes. In case of avulsion, local application of an antibiotic to the surface of the root of the avulsed tooth, has been recommended, to inhibit external resorption and aid in pulpal revascularization. Systemic antibiotics have been recommended as an adjunctive therapy for avulsed permanent incisors. Tetracycline is the drug of choice, but consideration must be exercised in the systemic use of tetracycline, due to the risk of discoloration in the developing permanent dentition.

It is important to note that antimicrobials should not be routinely prescribed for conditions such as teething discomfort, minor gingival inflammation, or localized dental caries without evidence of systemic involvement or risk of spread. These conditions can typically be managed through non-pharmacological measures, preventive strategies, and appropriate dental interventions.

In all cases, the decision to prescribe antimicrobials should be based on a thorough clinical evaluation, consideration of patient-specific factors (*e.g.*, age, medical history, allergies), and adherence to evidence-based guidelines. Collaboration with paediatricians or infectious disease specialists may be beneficial in complex cases to ensure appropriate antimicrobial selection and dosage. Proper communication with patients and caregivers regarding the rationale and risks of antimicrobial therapy is essential to enhance understanding and promote compliance with the prescribed treatment plan.

APPROPRIATE USE OF ANTIMICROBIALS

Appropriate use of antimicrobials in pediatric dentistry is crucial for the effective treatment and prevention of oral infections while minimizing the risks associated with antimicrobial resistance. Antimicrobials are medications used to control or eliminate microbial infections caused by bacteria, viruses, fungi, or parasites. In pediatric dentistry, antimicrobials are commonly prescribed to manage various oral

infections, such as pulpitis, periodontal diseases, and abscesses. In less known situations, they are also used in treating infections that are not caused by bacteria like, candidiasis is treated by an antifungal medication, herpes labialis which is very common in children is treated by a topical antifungal agent [15]. However, their use should be judicious and based on established guidelines to ensure optimal patient care. Joseph and Rodvold summarized the 4 D's of antimicrobial therapy they are: right Drug, right Dose, De-escalation to pathogen directed therapy, and right Duration of therapy [14].

Here are some key considerations for the appropriate use of antimicrobials in pediatric dentistry:

Accurate Diagnosis

Accurate diagnosis is fundamental before initiating antimicrobial therapy. Dentists should thoroughly assess the patient's condition, taking into account their medical history, clinical presentation, and diagnostic tests, such as radiographs and laboratory investigations. An accurate diagnosis helps identify the specific microbial aetiology, which is essential for selecting the appropriate antimicrobial agent. When the broad-spectrum antibiotic fail to eliminate the infection, culture sensitivity is done by taking a sample from the infected area and more specific narrow spectrum antibiotic is prescribed.

Indication for Antimicrobial Therapy

Antimicrobials should be prescribed only when there is a clear indication for their use. In recent times, there has been a surge of overuse of antibiotics in children [7]. In pediatric dentistry, the common indications for antimicrobial therapy include severe dental infections, cellulitis, facial swelling, spreading infections, systemic involvement, and immunocompromised patients [17]. In mild to moderate infections, antimicrobials may not be necessary and can be managed by local measures, such as dental treatment, drainage, and oral hygiene practices.

Antibiotic Prophylaxis

Antibiotic prophylaxis may be recommended for certain pediatric patients at high risk of developing infective endocarditis or other systemic infections due to dental procedures. The American Heart Association (AHA) and other professional organizations provide guidelines for antibiotic prophylaxis in pediatric dentistry [16]. Dentists should be familiar with these

guidelines and use them to determine the appropriate use of antimicrobials in high-risk patients. Prophylactic antibiotics are prescribed in condition where the immunity of the child is compromised and the dental procedure done can lead to infection. Prophylactic antibiotics are prescribed in condition such as infective endocarditis, patients with valvular or cardiac prosthesis and patients with diabetes mellitus.

The prophylactic antibiotics that are commonly used are amoxicillin (20–40 mg/kg/day), erythromycin (30mg/kg/day), ampicillin (50mg/kg/dose), cefaxolin (30mg/kg/dose), cefotetan (40mg/kg/dose) [18].

Selection of Antimicrobial Agent

The choice of antimicrobial agent should be based on several factors, including the suspected or confirmed pathogen, its susceptibility profile, pharmacokinetics, safety, and the patient's age, weight, and medical history [19, 20]. It is essential to select antibiotics with a narrow spectrum of activity whenever possible to minimize the risk of antimicrobial resistance. Dentists should also consider any known allergies or contraindications to specific antimicrobials. Universally used antibiotics in case of a aerobic infections are amoxicillin (Penicillin) and cephalosporins. Amoxicillin is one of the most commonly prescribed antibiotics in the field of dentistry. About 17.5% of dentists preferred amoxicillin as antibiotic to their pediatric patients [3]. Erythromycin and Clindamycin are an alternative drug that can be prescribed to patients who are allergic to penicillins. Amoxicillin with clavulanic acid (clavulanate) is used in certain cases, as it has the advantage of preserving the activity against the betalactamases enzyme commonly produced by microorganisms associated with odontogenic infections. In case of anaerobic infections, along with amoxicillin and cephalosporin and combination of amoxicillin and clavulanic acid, metronidazole can be prescribed. Oral fungal lesions like candidiasis oral dose of clotrimazole or topical fluconazole are prescribed. The commonly seen viral infection in children are herpetic stomatitis which is treated by a topical application of acyclovir. Generally, the lesions are treated with topical medications but, when they do not result in resolution of the lesion, systemic medications are prescribed.

Appropriate Dose and Duration

Dentists should prescribe the appropriate dose and duration of antimicrobial therapy for pediatric patients. The dose should be adjusted according to the child's

weight, age, and renal function. The duration of therapy should be sufficient to treat the infection adequately but should be as short as possible to reduce the risk of developing resistance. Patients should be educated about the importance of completing the full course of antibiotics. There are various ways to calculate the dose of the drugs for the children depending on their weight, age and body surface area. The Young's rule uses the age of the child and the Clark's rule is calculated with the weight of the child. Amoxicillin dosage is as follows, Children > 3 months and < 40 kg: 20–40 mg/kg/day in divided doses 8 hourly and children > 40 kg: 250–500 mg 8 hourly or Phenoxyethyl penicillin is prescribed for 2–3 days and a maximum of 5 days: children <12 years: 25–50 mg/kg/day in divided doses 6 hourly and children ≥12 years: 250–500 mg 6 hourly. Recommended antibiotic regimen for penicillin-allergic patient is azithromycin: children > 6 months up to 16 years: 5–12 mg/kg daily for 3 days, or clarithromycin (7 days):7.5 mg/kg 12 hourly or erythromycin 30mg/kg/day for 3 days. In case of an anaerobic infection, metronidazole (3 days): children 30/mg/kg/day in divided doses 6 hourly is prescribed [21].

Follow-up and Reassessment

Pediatric patients receiving antimicrobial therapy should be closely monitored for treatment response and any adverse effects, which can range from a simple rash to a fatal anaphylactic shock.

Regular follow-up appointments allow the dentist to assess the patient's condition, evaluate the need for continuing or modifying the antimicrobial regimen, and provide additional dental treatment as required.

Patient Education and Oral Hygiene

Emphasizing the importance of oral hygiene practices, such as regular brushing, flossing, and maintaining a healthy diet, can help prevent oral infections and reduce the need for antimicrobial therapy. Educating parents and caregivers about the appropriate use of antimicrobials, including dosage, administration, and potential side effects, is also crucial.

Interprofessional Collaboration

Collaboration between dentists, pediatricians, and other healthcare providers is essential to ensure appropriate antimicrobial use in pediatric dentistry. Interprofessional communication allows for coordinated

care, the sharing of information, and the prevention of unnecessary duplication of antimicrobial therapy.

The appropriate use of antimicrobials in pediatric dentistry requires accurate diagnosis, clear indications, proper selection of antimicrobial agents, appropriate dosing, and duration. Dentists should follow established guidelines and consider the principles of antimicrobial stewardship to optimize patient care, minimize the development of antimicrobial resistance, and preserve the efficacy of antimicrobials for future generations.

POTENTIAL ADVERSE EFFECTS AND RISKS

While antimicrobials are essential for treating and preventing oral infections in pediatric dentistry, they come with certain risks and potential adverse effects. Dentists and healthcare providers need to be aware of these risks and carefully weigh the benefits against the potential harms. Here are some common adverse effects and risks associated with antimicrobial use in pediatric dentistry:

Allergic Reactions

Allergic reactions to antimicrobials can range from mild skin rashes to severe systemic reactions such as anaphylaxis. Children may be more susceptible to allergic reactions than adults. Dentists should inquire about any known drug allergies before prescribing antimicrobials and be vigilant for signs of allergic reactions during treatment [22].

Gastrointestinal Disturbances

Antimicrobials can disrupt the natural balance of the gut microbiota, leading to gastrointestinal disturbances such as diarrhoea, nausea, vomiting, and abdominal pain. These effects can be more common with broad-spectrum antibiotics and may range from mild to severe. Appropriate probiotic supplementation may help mitigate these effects in some cases.

Superinfections

Prolonged or inappropriate use of antimicrobials can lead to the development of superinfections. These are infections caused by resistant microorganisms or opportunistic pathogens that proliferate when the normal microbial flora is disrupted. Common superinfections include oral thrush (*Candida* overgrowth) and *Clostridium difficile*-associated diarrhoea [23, 24].

Development of Antimicrobial Resistance

The overuse or misuse of antimicrobials contributes to the development and spread of antimicrobial resistance. When bacteria are exposed to antimicrobials, they can develop mechanisms to resist their effects, making future infections more difficult to treat. This can have serious implications for both the individual patient and public health as a whole [25].

Impact on Oral Microbiota

Antimicrobials can alter the balance of the oral microbiota, which plays a vital role in maintaining oral health. Disruption of the oral microbiota can increase the risk of oral infections and other oral health problems, such as dental caries and periodontal diseases. Dentists should carefully consider the potential impact on the oral microbiota when prescribing antimicrobials.

Drug Interactions

Some antimicrobials may interact with other medications the child is taking, potentially affecting their efficacy or causing adverse effects. Dentists should review the patient's medication history and consider potential drug interactions before prescribing antimicrobials.

Long-Term Effects

Limited data exists on the long-term effects of antimicrobial use in pediatric dentistry. Some studies suggest that early exposure to certain antimicrobials may have long-lasting effects on the developing microbiota and immune system. Further research is needed to better understand these potential long-term effects.

To minimize these risks and adverse effects, dentists should adhere to established guidelines for antimicrobial use, prescribe the appropriate agent at the correct dosage and duration, and educate patients and parents about the importance of compliance and potential side effects. Dentists should also emphasize the importance of non-pharmacological approaches, such as proper oral hygiene practices and preventive measures, to reduce the need for antimicrobials whenever possible.

It is crucial for dentists to stay informed about current research and guidelines on antimicrobial use in pediatric dentistry to ensure the best possible care while minimizing risks to their young patients.

ANTIMICROBIAL STEWARDSHIP IN PEDIATRIC DENTISTRY

Refers to a comprehensive approach aimed at optimizing the use of antimicrobials to ensure effective treatment while minimizing the development of antimicrobial resistance and reducing the risk of adverse effects [16, 26]. It involves implementing strategies, guidelines, and practices that promote judicious and appropriate use of antimicrobials [27]. Here are some key aspects of antimicrobial stewardship in pediatric dentistry:

- Education and Awareness: Dentists, dental staff, parents, and caregivers should receive education and training on the principles of antimicrobial stewardship. This includes understanding the appropriate use of antimicrobials, the risks associated with their misuse, and the importance of minimizing unnecessary prescriptions.
- Adherence to Guidelines: Dental professionals should follow established guidelines and recommendations for antimicrobial use in pediatric dentistry. These guidelines provide evidence-based recommendations for specific conditions, appropriate choice of antimicrobial agents, dosage, and duration of therapy.
- Accurate Diagnosis: Accurate diagnosis is crucial for appropriate antimicrobial prescribing. Dentists should perform a thorough evaluation and diagnostic tests to identify the microbial etiology and determine if antimicrobials are necessary. This helps to avoid unnecessary prescriptions and ensure targeted therapy.
- Prescription Practices: Dentists should prescribe antimicrobials only when they are indicated and necessary. The selection of antimicrobial agents should be based on the suspected or confirmed pathogen, its susceptibility profile, and patient factors. Dentists should choose antibiotics with a narrow spectrum of activity whenever possible to minimize the impact on the normal flora and reduce the risk of resistance.
- Dose Optimization: The dose of antimicrobial agents should be optimized based on the child's age, weight, and renal function. Dentists should follow appropriate dosing guidelines to ensure therapeutic efficacy while avoiding under-dosing or over-dosing.
- Treatment Duration: The duration of antimicrobial therapy should be appropriate to treat the infection effectively but as short as possible to minimize the risk of developing resistance. Dentists should avoid prescribing unnecessarily long courses of antimicrobials and regularly reassess the need for continued therapy.
- Regular Follow-up: Regular follow-up visits allow dentists to evaluate treatment response, monitor adverse effects, and make adjustments to the antimicrobial regimen if needed. Dentists should encourage patients and parents to report any concerns or changes in symptoms during the course of treatment.
- Interprofessional Collaboration: Collaboration among dental professionals, paediatricians, pharmacists, and other healthcare providers is crucial for effective antimicrobial stewardship. Interprofessional communication facilitates shared decision-making, coordination of care, and the exchange of information to ensure appropriate antimicrobial use.
- Patient and Parent Education: Patient and parent education play a vital role in antimicrobial stewardship. Dentists should provide clear instructions on proper antimicrobial use, including dosage, administration, compliance, and the importance of completing the full course of treatment. Emphasizing the role of oral hygiene practices, preventive measures, and the limitations of antimicrobials in preventing infections can also help reduce the need for antimicrobial therapy.
- Monitoring and Surveillance: Dentists should actively monitor and evaluate antimicrobial prescribing patterns and resistance rates in their practice. Surveillance of local antimicrobial resistance patterns helps inform treatment decisions and allows for appropriate adjustments in prescribing practices when necessary.

Antimicrobial stewardship in pediatric dentistry is essential to preserve the effectiveness of antimicrobial agents, prevent the emergence of resistant microorganisms, and protect the health of pediatric patients. By implementing appropriate guidelines, promoting education, and fostering interprofessional

collaboration, dental professionals can contribute to responsible antimicrobial use and ensure the best possible outcomes for their young patients.

EDUCATION AND COMMUNICATION

Education plays a vital role in promoting responsible antimicrobial use in pediatric dentistry. Dental professionals should stay updated with current guidelines, antimicrobial resistance trends, and best practices. Effective communication with parents and caregivers regarding the rationale, risks, and benefits of antimicrobial therapy is crucial to enhance understanding and foster compliance.

CONCLUSIONS

Antimicrobials have a significant role in managing infectious diseases in pediatric dentistry. However, their use must be judicious and based on evidence-based guidelines. It is essential to recognize the potential risks associated with their misuse, including the emergence of antimicrobial resistance. By implementing antimicrobial stewardship programs, promoting education, and fostering responsible prescribing practices, dental professionals can contribute to preserving the effectiveness of antimicrobials and ensuring optimal oral health outcomes for pediatric patients.

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