

Children's Dentistry The Impact of Pediatric Medications on Oral Development

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Abstract:

Pediatric medications play a crucial role in managing various childhood illnesses, but they can also significantly impact oral development and dental health. Medications such as antibiotics, antihistamines, and corticosteroids are commonly prescribed for children, yet their side effects may include alterations in oral flora, dry mouth, and changes in taste sensation. These conditions can lead to an increased risk of dental caries and gum disease, highlighting the need for careful consideration by pediatricians and dentists when prescribing and administering these treatments. The timing and method of medication delivery, such as liquid formulations often containing sugar, can also contribute to enamel erosion and cavities if oral hygiene practices are not adequately reinforced. Furthermore, long-term use of certain medications can affect the development of permanent teeth and jaw structure. For instance, some medications may disrupt normal bone growth or alter the eruption patterns of teeth, which can lead to misalignment and the need for orthodontic intervention later on. It's vital for healthcare professionals to collaborate on a child's treatment plan, ensuring that parents are educated about the potential oral health implications of medications. Regular dental check-ups become essential during this time, allowing for early detection and management of any developing issues.

Keywords: Pediatric medications, Oral development, Dental health, Antibiotics, Dental caries, Gum disease, Enamel erosion, Bone growth, Tooth alignment, Orthodontic

Introduction:

Children's dentistry is a specialized field dedicated to the oral health of infants, children, adolescents, and individuals with special healthcare needs. This area of dentistry not only focuses on preventive care and the treatment of dental issues but also encompasses the understanding of how various factors, including medication, can influence oral health and development during critical growth periods. As pediatric healthcare continues to evolve, there is a growing recognition of the significant role that pediatric medications play in shaping oral development, particularly in an age when children are increasingly prescribed a range of medications for various health conditions [1].

The intersection of pediatric medications and oral development is a multifaceted topic that warrants comprehensive examination. Medications used in pediatric care can range from antibiotics and antiepileptics to medications for attention-deficit hyperactivity disorder (ADHD) and asthma. Each category of medication carries its own set of potential side effects, some of which can manifest in the oral cavity, while others may influence overall growth and development. Understanding these impacts is crucial not only for the dental community but also for parents, healthcare providers, and policymakers aiming to ensure optimal healthcare for children [2].

One of the primary ways in which medications can affect oral health is through their influence on salivary function. Saliva plays a vital role in oral health by helping to neutralize acids produced by bacteria, wash away food particles, and provide essential minerals that aid in the remineralization of tooth enamel. Certain medications, particularly antihistamines, antidepressants, and some medications used to manage ADHD, may lead to reduced saliva production, a condition known as xerostomia or dry mouth. This decreased salivary flow can elevate the risk of dental caries, oral infections, and periodontal disease, creating a cascade of consequences for children's oral health that can persist into adulthood [3].

Moreover, the potential impact of medications on the development of dental tissues is an important consideration. Research has shown that some pharmacological agents can affect the formation of enamel and dentin, which may lead to developmental defects in the teeth. For example, certain antibiotics, such as tetracycline, are known to cause discoloration of permanent teeth if administered during critical periods of tooth development. Conversely, medications such as fluoride, when provided in appropriate doses, can strengthen enamel and reduce the incidence of cavities, suggesting that the timing, dosage, and type of medication can have significantly divergent effects on oral development [4].

Additionally, the psychological and behavioral impacts of medications are pertinent to the discussion of children's dentistry. Many children who require regular medication treatment have underlying health issues that may influence their oral hygiene practices and dental visits. Behavioral medications, for instance, may alter a child's attention and engagement level during dental appointments, complicating the delivery of preventive care and treatment. It is essential for dental professionals to approach this demographic with an understanding of their unique needs and to develop strategies that accommodate the challenges posed by both the medication regimens and the underlying health conditions. [5]

As the field of pediatric medications continues to expand, research and clinical practice must keep pace with new developments. Continuous monitoring of drug safety and efficacy is crucial, not only for the primary health conditions they are designed to treat but also for their long-term implications on oral health. This requires a collaborative approach between pediatricians, dentists, pharmacists, and families, ensuring that all aspects of a child's health are considered in treatment planning [6].

Additionally, further research is necessary to establish a clearer understanding of the relationship between pediatric medications and oral health outcomes. Longitudinal studies that track children over time, examining both their medication use and oral health status, could provide valuable insights that inform guidelines and interventions aimed at minimizing adverse oral health effects while maximizing therapeutic efficacy [7].

Overview of Common Pediatric Medications:

Pediatric medications are indispensable in the management of various health conditions in children, providing relief from pain, fighting infections, and managing chronic diseases. While the

therapeutic effects of these medicines are well-documented, there is a growing body of literature suggesting that certain medications can also impact oral development in children. Understanding the interactions between common pediatric medications and oral health is crucial for parents, caregivers, and healthcare professionals in order to mitigate potential side effects and promote optimal oral development [8].

Common Pediatric Medications

Pediatric medications can be categorized into several groups based on their primary function. Some of the most frequently prescribed medications include:

1. **Antibiotics:** Medications such as amoxicillin, penicillin, and azithromycin are commonly used to treat bacterial infections in children. While they are effective in combating infections, they are also known to have several side effects, including the potential to disrupt the balance of oral microbiota [9].
2. **Analgesics:** Pain relief medications, including acetaminophen and ibuprofen, are often given to manage pain related to teething, ear infections, or post-operative recovery. While generally benign, the dosage and frequency of use can have implications for a child's overall health and dental hygiene.
3. **Asthma Medications:** Children with asthma may be prescribed short-acting beta-agonists (e.g., albuterol) and corticosteroids (e.g., fluticasone). These inhaled medications can have local effects in the oral cavity, leading to complications such as oral candidiasis (thrush) and changes in oral flora.
4. **Antidepressants and Antipsychotics:** Medications such as selective serotonin reuptake inhibitors (SSRIs) or atypical antipsychotics are increasingly being prescribed for behavioral and mood disorders in children. Side effects of these medications can include dry mouth, which is a risk factor for dental cavities and gum disease [9].
5. **Oral Contraceptives and Hormone Treatments:** In rare cases, pediatric patients may require hormone treatments that can influence oral and overall development. The impact of hormone treatment on oral structures, such as gums and jaw alignment, can be significant.
6. **Antihistamines:** Often used to manage allergies, these medications can also cause dry mouth, leading to an increased risk of oral health problems [9].

Effects of Pediatric Medications on Oral Development

The effects of medications on oral development can be both direct and indirect. Here are some of the most notable impacts:

Changes in Oral Microbiota

Antibiotics, while essential for treating infections, can significantly alter the oral microbiome. This disruption may result in an overgrowth of harmful bacteria, subsequently leading to conditions such as thrush or gingivitis. Maintaining a balanced microbiota is crucial for oral health, and parents should be vigilant about the signs of oral infections following antibiotic treatment [10].

Medications such as antihistamines, antidepressants, and asthma inhalers can lead to reduced salivary flow, resulting in dry mouth. Saliva plays a key role in washing away food particles and neutralizing acids produced by oral bacteria. Reduced saliva can create an environment conducive to dental caries and periodontal disease. Maintaining hydration and encouraging regular dental check-ups can help manage this side effect.

Some medications, including certain antibiotics and antihistamines, can alter taste perception, which may affect a child's appetite and dietary choices. A balanced diet is essential for healthy

oral and physical development. Parents should monitor any changes in a child's eating habits and consult with healthcare providers if concerns arise [11].

Long-term use of corticosteroids, often prescribed for chronic conditions such as asthma, can affect the development of oral and facial bones. These medications may lead to difficulties in swallowing or changes in the hardness of oral tissues, which can impact how a child chews and processes food. It is essential for pediatricians to weigh the benefits of such treatments against possible impacts on oral development [12].

Certain medications can influence jaw growth and dental alignment. For instance, prolonged use of certain sedatives and anticonvulsants has been associated with changes in the oral and facial structure. These changes can lead to malocclusion, which might require orthodontic intervention later. Regular dental evaluations are crucial in identifying and addressing these potential issues early [13].

Children taking immunosuppressive drugs for chronic conditions may be at higher risk for oral infections. Managing these health risks requires a comprehensive approach that includes routine dental check-ups, stringent oral hygiene practices, and education about potential oral side effects tied to their medications [13].

Preventative Measures and Recommendations

Given the complexities involved in the relationship between pediatric medications and oral development, a proactive approach is essential. Here are some recommendations for parents, healthcare providers, and caregivers:

1. **Regular Dental Visits:** Children should have dental check-ups every six months, or as recommended by their dentist, to monitor oral health closely [14].
2. **Promote Oral Hygiene:** Educate children on good oral hygiene practices. This includes brushing twice a day with fluoride toothpaste and flossing daily. Parents should supervise young children to ensure proper technique.
3. **Hydration:** Encourage adequate water intake to combat dry mouth and promote salivary flow. Sugar-free gum or lozenges can also stimulate saliva production, especially for children experiencing side effects from medications.
4. **Monitor Dietary Choices:** Be aware of how medications affect taste perception and encourage a balanced diet rich in fruits, vegetables, and whole grains [14].
5. **Communication with Healthcare Providers:** Open dialogue between healthcare providers, parents, and dentists is crucial. Reporting any side effects or concerns regarding medications can help tailor treatment plans that consider oral health.
6. **Education on Side Effects:** Parents should be informed about the possible oral side effects of prescribed medications. When possible, healthcare providers should consider alternatives with fewer dental implications [14].

Mechanisms of Action: How Medications Affect Oral Health:

The relationship between medication and oral health is an intricate one, deeply rooted in biochemical interactions and physiological implications. Understanding how various medications affect oral health is paramount for both healthcare providers and patients alike [15].

Pharmacological Effects on Oral Health

Medications can have a broad range of pharmacological effects that can directly or indirectly influence oral health. These effects can be classified into several categories, including changes in saliva production, alteration of microbial flora, mucosal effects, and systemic effects that manifest in the oral cavity [16].

1. **Salivary Changes:** Saliva plays a crucial role in maintaining oral health by providing lubrication, aiding in digestion, neutralizing acids, and serving as a barrier against pathogens. Medications can influence salivary flow either by stimulating or inhibiting secretion. For instance, common antihypertensives, such as diuretics, can lead to dry mouth (xerostomia) by reducing saliva production. The implications of xerostomia are profound, as it can lead to an increased risk of dental caries, periodontal disease, and oral infections. Conversely, medications such as pilocarpine, which is used to treat dry mouth, enhance salivary flow, thus alleviating symptoms associated with xerostomia [17].
2. **Alteration of Microbial Flora:** Antibiotics, antifungals, and certain other medications can profoundly change the oral microbiome. A disrupted microbial balance can establish conditions conducive to the proliferation of pathogenic bacteria, leading to infections such as oral thrush or antibiotic-associated diarrhea. For instance, broad-spectrum antibiotics may eliminate beneficial bacteria, allowing overgrowth of *Candida* species, thereby causing oral candidiasis. Understanding the impact of antibiotics on the oral microbiome is essential as it highlights the need for judicious use of such medications to maintain oral health [18].
3. **Mucosal Effects:** Many medications can directly affect the oral mucosa. The use of nonsteroidal anti-inflammatory drugs (NSAIDs), for example, may lead to oral mucosal lesions, ulcers, or even anaphylactic reactions in susceptible individuals. Chemotherapy agents, used in cancer treatment, often provoke mucositis, characterized by inflammation and ulceration of the oral mucosa. This can lead to significant complications, including pain, difficulty in eating, and increased risk of infection, all of which necessitate proactive dental management during and after cancer treatment [19].

Systemic Medications and Oral Health

Certain systemic medications are particularly noteworthy for their multifaceted impacts on oral health. Calcium channel blockers and bisphosphonates, used for managing hypertension and osteoporosis, respectively, can have side effects involving soft and hard oral tissues. For instance, one of the well-documented side effects of calcium channel blockers is gum hyperplasia, a condition marked by the overgrowth of gum tissue that can complicate oral hygiene and increase the risk for periodontal diseases [20].

Similarly, bisphosphonates, while critical in the management of osteoporosis, have been associated with osteonecrosis of the jaw (ONJ). This condition is characterized by the death of bone tissue in the jaw and is particularly concerning for individuals undergoing dental procedures. Patients on bisphosphonates should be informed about their potential oral health risks, especially if they are considering tooth extractions or other invasive dental work [20].

Polypharmacy, or the concurrent use of multiple medications, is a common issue in geriatric populations and others with chronic health conditions. This practice increases the risk of drug interactions that can have harmful implications for oral health. For example, the combination of anticoagulant medications and anti-inflammatory agents can enhance the risk of bleeding in oral tissues, complicating dental procedures and increasing the potential for hemorrhage during treatment [21].

Moreover, certain medications can exacerbate the side effects of others. For instance, combination therapy often seen in the treatment of diabetes can lead to compounded effects on salivary flow, increasing the risk of caries and periodontal diseases. Dentists must be aware of a patient's complete medication profile to effectively manage and anticipate potential complications [21].

With the understanding of how medications affect oral health, dental care providers must adopt a vigilant and holistic approach to patient management. Comprehensive medical history taking is critical, helping to identify patients' medications and the potential implications on their oral health. This includes assessing the need for preemptive measures, such as fluoride treatments, routine follow-ups for patients using medications that induce xerostomia, or careful management of patients on bisphosphonate therapy [21].

Additionally, counseling patients about the oral health implications of their medications is crucial. Patients should be informed about the importance of maintaining proper oral hygiene, utilizing salivary substitutes, and monitoring for signs of changes in oral health. Dental professionals can play an essential role in educating patients on the importance of dental check-ups and collaborating with their healthcare providers to optimize both systemic and oral health outcomes [22].

Short-Term Effects of Pediatric Medications on Dental Development:

The dental development of children is a complex process influenced by a myriad of factors, including genetics, nutrition, and environmental conditions. Among the myriad factors impacting dental health, pediatric medications stand out as a significant but often overlooked aspect. The use of pharmacological treatments in children is essential for managing a wide range of health conditions, from infections and chronic diseases to behavioral disorders. However, the short-term effects of these medications can have implications for dental development during the crucial years of growth [22].

Pediatric medications are categorized into various classes based on their therapeutic purpose, and each class presents potential dental implications. Common medications include antibiotics, corticosteroids, anticonvulsants, and medications for attention-deficit hyperactivity disorder (ADHD). These drugs are essential for treating conditions such as ear infections, asthma, epilepsy, and behavioral disorders. While the primary focus is often on the systemic benefits, the implications for dental development require equal attention, particularly since dental health plays a critical role in overall well-being [23].

One of the most commonly prescribed classes of medications, antibiotics, can have varied effects on dental development. For instance, tetracycline, a specific antibiotic used to treat bacterial infections, is particularly notorious for its adverse effects on developing teeth. When administered to children, especially during the critical periods of enamel formation—usually between the ages of 4 months and 8 years—tetracycline can lead to intrinsic staining of the teeth. This is a condition known as dental fluorosis, characterized by discoloration, while enamel hypoplasia, or insufficient enamel formation, is another critical concern. The observation of dark staining or bands on teeth can affect not only the aesthetic appearance but also the structural integrity of the teeth, raising the risk for further dental complications [23].

On the other hand, while most antibiotics do not carry the same risk as tetracycline, they can disrupt the balance of oral flora—the naturally occurring bacteria in the mouth. Disruption of this balance can lead to oral health issues such as oral thrush or an overgrowth of pathogenic bacteria, which may contribute to gingivitis and other periodontal diseases, indirectly influencing the health of developing teeth.

Corticosteroids are often prescribed for conditions such as asthma or autoimmune disorders. While they serve essential roles in managing inflammation, their short-term use can result in side effects that influence dental development and health. Systemic corticosteroid treatments can lead to altered metabolism and fluctuations in blood sugar levels, potentially resulting in increased

susceptibility to oral infections, such as candidiasis, which can affect the mucosal surfaces of the mouth and even impede proper tooth eruption [23].

Moreover, corticosteroids can also affect salivary production. A decrease in saliva flow, resulting from reduced corticosteroid-induced gland function, can increase the risk for dental caries and support the growth of harmful bacteria, effectively creating an oral environment that is not conducive to healthy tooth development. Saliva plays a crucial role in neutralizing acids produced by bacteria, washing away food particles, and providing minerals necessary for the remineralization processes of enamel [24].

Children with epilepsy often rely on anticonvulsant medications to control seizures. However, medications such as phenytoin and valproate have been documented to affect gum tissue, leading to a phenomenon known as drug-induced gingival enlargement. This can result in swollen, compromised gingiva that obstructs optimal oral hygiene practices, making it more challenging to maintain health during periods of dental development.

Moreover, these medications can alter taste perception and reduce the desire to consume nutritional foods, leading to an unhealthy diet that lacks the necessary minerals for dental health. As children undergo critical growth phases, these disruptions can contribute to delayed tooth eruption and misalignment, ultimately affecting their occlusion, or bite, which can necessitate orthodontic intervention later in life [24].

Medications used to treat ADHD, such as methylphenidate, may also present short-term consequences for dental health. One notable side effect is dry mouth (xerostomia), which can severely impact saliva's protective role. Reduced saliva flow increases acid levels in the mouth, heightening the risk of dental caries and enamel erosion. Furthermore, behavioral aspects tied to ADHD, including impulsivity and concentration difficulties, could exacerbate issues related to oral hygiene, leading to plaque accumulation and an increased risk of periodontal disease [25].

Long-Term Consequences of Medication Use on Oral Structures:

The utilization of medication is a cornerstone of modern medicine and healthcare, significantly improving the quality of life for millions across the globe. However, while pharmaceutical interventions can offer significant benefits, they also come with potential side effects that can affect oral health in various ways. Over the years, comprehensive studies have shed light on the long-term consequences of medication use on oral structures [26].

Types of Medications and Their Uses

Medications can be classified into several categories based on their therapeutic uses: analgesics, antihypertensives, antidepressants, antibiotics, and medications for chronic diseases. Analgesics, commonly used for pain management, can be over-the-counter remedies such as acetaminophen or prescription opioids. Antihypertensives are prescribed for the management of high blood pressure, whereas antidepressants can address various mood disorders. Antibiotics are essential for treating bacterial infections, while chronic disease medications, such as those for diabetes or asthma, help manage symptoms over the long term [26].

Each of these categories carries a unique set of potential side effects that can significantly impact oral health. Understanding these potential effects is crucial for both healthcare providers and patients [26].

The Impact of Medications on Oral Structures

1. **Xerostomia (Dry Mouth):** One of the most common oral side effects associated with various medications, including antidepressants, antihypertensives, and certain pain relievers, is xerostomia or dry mouth. Saliva plays a crucial role in oral health; it helps in

digestion, protects oral tissues, facilitates taste, and acts as an antimicrobial agent. A reduction in salivary flow can lead to several oral health issues, including difficulty in swallowing, a burning sensation in the mouth, altered taste perception, and an increased risk of dental caries and periodontal disease. Long-term xerostomia can contribute to the deterioration of oral structures, including the enamel and soft tissues of the mouth [27].

2. **Gingival Overgrowth:** Certain medications, particularly anticonvulsants (like phenytoin), immunosuppressants (such as cyclosporine), and some calcium channel blockers, are known to cause gingival overgrowth or hyperplasia. This condition is characterized by swollen and enlarged gum tissue, which can make oral hygiene practices challenging. As plaque accumulation increases due to difficult cleaning, there can be a subsequent rise in gum disease and tooth decay. Long-term gingival overgrowth may require surgical intervention and can lead to significant discomfort, impacting overall oral aesthetics and function [27].
3. **Taste Alteration:** Medications can also influence taste perception. Certain antibiotics, angiotensin-converting enzyme (ACE) inhibitors, and some chemotherapy drugs are known to induce taste changes, leading to a condition known as dysgeusia. This alteration in taste can affect nutritional intake, leading to broader health issues stemming from insufficient dietary variety [28].
4. **Erosion of Tooth Enamel:** Long-term medication use, especially those that induce reflux or vomiting (like certain antidepressants or chemotherapy agents), can contribute to dental erosion. The acidic environment created can wear down tooth enamel, exposing the dentin and increasing the risk of decay and sensitivity. Loss of enamel integrity not only affects the aesthetics of teeth but can also compromise their structural integrity over time [28] [29].
5. **Oral Mucosal Changes:** Some medications, particularly those used in chemotherapy, can lead to mucositis, characterized by inflammation and ulceration of the oral mucosa. Chronic use of certain drugs can also lead to leukoplakia or other potentially malignant lesions. Continuous inflammation or changes in the oral lining can have long-standing implications, increasing the risk of secondary infections or malignancies.

The Role of Dental Care in Medication Management

Given the significant impact medications can have on oral structures, integrating dental care into the overall management plan for patients on long-term medication is essential. The following strategies can help mitigate the adverse effects associated with medication use:

1. **Patient Education:** Healthcare providers should educate patients about the potential oral side effects of their medications. Understanding the relationship between their medication and oral health can motivate patients to adopt better oral hygiene practices [30].
2. **Regular Dental Check-Ups:** Patients taking long-term medications should be encouraged to have regular dental check-ups. Dental professionals can monitor for early signs of medication-related side effects, allowing for preventive measures or timely interventions.
3. **Saliva Substitutes:** For patients experiencing xerostomia, the use of saliva substitutes or stimulants can be beneficial. Patients should be informed about products specifically designed to alleviate dry mouth symptoms, including mouth rinses, gels, or lozenges [31].
4. **Customized Oral Hygiene Regimens:** Dental professionals can develop individualized oral hygiene plans to address specific risks associated with particular medications. This may include fluoride treatments, antimicrobial mouthwashes, and professional cleanings tailored to the patient's needs [32].

5. **Interdisciplinary Communication:** Effective communication between healthcare providers and dental professionals is vital. Prescribing doctors should be informed of their patients' dental health, and vice versa, ensuring that all aspects of a patient's healthcare are interconnected [32].

The Role of Sugar and Flavoring Agents in Liquid Medications:

Liquid medicines have become an essential part of pediatric healthcare, serving as a fundamental means of delivering therapeutics to infants and young children who may struggle to swallow solid forms of medication. In an effort to enhance the palatability of these medications and ensure compliance among the pediatric population, manufacturers often incorporate sugar and various flavorings into liquid formulations. While these additives play a critical role in improving taste and acceptance, it is equally important to investigate their implications for children's oral development and overall oral health [33].

Pediatric patients frequently exhibit aversive reactions to the taste of certain medications, which can lead to non-compliance and subsequent health complications. To mitigate this issue, pharmaceutical companies have devised strategies to mask unpleasant tastes and odors, primarily through the addition of sugars and flavoring agents. The sweetness of sugar serves as an effective means of masking bitterness, while flavors such as fruit or candy provide a sense of familiarity and enjoyment. This enhanced palatability encourages children to accept the medication willingly, thus increasing the likelihood of effective treatment and adherence to prescribed regimens [34].

Sugars, particularly sucrose and high fructose corn syrup, are commonly included as sweetening agents in liquid medications. While their primary function is to improve the taste, it is essential to consider the potential ramifications of sugar consumption on children's oral health. The relationship between sugar intake and dental caries (tooth decay) is well established; sugars are metabolized by bacteria in the oral cavity, producing acids that can erode tooth enamel, leading to cavities. For children, who are particularly susceptible to carious lesions due to developing dentition, the presence of sugar in medicines can pose a significant risk [35].

The prevalence of liquid formulations containing sugar puts children at a higher risk for dental issues, especially if these medications are administered frequently or in large quantities. Concern is further heightened by the fact that many liquid medications are often taken at bedtime or when oral hygiene practices may be less rigorously maintained. Consequently, residual sugars may remain on the teeth overnight, prolonging the exposure of teeth to cariogenic effects [35].

Flavorings, whether they are natural or artificial, can also play a pivotal role in the appeal of liquid medicines. Natural flavorings derived from fruit extracts may seem benign, but they are often paired with sugars to achieve desired sweetness levels. Artificial flavorings, while sometimes sugar-free, can still mask unpleasant tastes effectively. However, the nutritional content and implications of these additives remain critical considerations for oral health [36].

While flavorings are essential for enhancing acceptance of medications, the combination of flavored, sugar-sweetened liquids may contribute to the development of preferences for sweet flavors. Such preferences can perpetuate a cycle of sugar consumption, leading to a higher risk of developing poor dietary habits. Recent studies have suggested that early exposure to sweet flavors, particularly through consumption of sweetened medicines, could influence future dietary choices, potentially resulting in increased cravings for sugar-laden foods and beverages [37].

The consequences of sugar and flavoring additives in liquid medications extend beyond immediate dental concerns. Oral health is integral to overall child development, impacting nutrition, growth, and even psychosocial aspects such as self-esteem. Dental decay, if left untreated, can lead to pain,

infection, or, in severe cases, necessitate tooth extraction. Lost teeth during formative years can disrupt normal speech and hinder proper eating habits, ultimately affecting a child's quality of life [37].

Moreover, the oral cavity serves as a crucial site for the growth and development of the jaw and facial structure. Chronic dental issues, often exacerbated by sugary and flavored medications, can influence the alignment of teeth and lead to malocclusion. In certain cases, this misalignment necessitates orthodontic intervention, adding to the overall burden of dental care required as children grow [38].

Best Practices and Recommendations

In light of these considerations, it is essential for healthcare providers, caregivers, and pharmaceutical manufacturers to adopt practices that minimize the oral health risks associated with liquid medications. These could include:

1. **Consideration of Sugar-Free Formulations:** Whenever possible, the development and prescription of sugar-free alternatives should be prioritized, particularly for long-term therapies or medications that are taken frequently [39].
2. **Educating Caregivers on Proper Oral Hygiene:** Caregivers should be educated on the importance of maintaining proper oral hygiene before and after administering liquid medications. Brushing the child's teeth after medication intake can help mitigate the risk of sugar-induced cavities.
3. **Limiting Frequency of Sugar-Sweetened Medicines:** Healthcare providers should consider the necessity of flavorings and sugars in liquid medications and, when feasible, prescribe them only when absolutely necessary.
4. **Regular Dental Check-Ups:** Routine dental examinations are crucial for early detection of potential oral health issues, allowing for timely intervention by dental professionals [40].
5. **Encouraging Healthy Dietary Habits:** Parents and caregivers should promote a balanced diet, limiting the intake of candies and sugary foods, while complementing the child's nutrition with fibrous fruits and vegetables, which naturally aid in oral health.

Oral Hygiene Practices for Children on Medication:

Maintaining optimal oral hygiene is a universal necessity; however, special considerations must be taken when it comes to children who are on medication. Medication can have varying effects on a child's oral health, including changes in their saliva production, susceptibility to cavities, and potential for gum disease. Therefore, establishing an effective oral hygiene routine tailored to these young patients is crucial [41].

The Importance of Oral Hygiene

Oral hygiene is a cornerstone of overall health. For children, poor oral hygiene can lead to numerous health issues, including cavities, gum disease, and infections. The significance of instilling good oral hygiene practices at a young age cannot be overstated, as these habits often carry into adulthood. With children who are on medication, the importance is amplified, given the potential side effects that might exacerbate oral health problems. Parents and caregivers should recognize that these medications can create an environment conducive to dental issues, making awareness and preventive measures essential [41].

Challenges Faced by Medicated Children

Children may be prescribed a variety of medications for chronic conditions, allergies, or infections, each with its potential side effects that can impact oral health. Some common types of medications and their effects include:

1. **Antibiotics:** While antibiotics are crucial for treating bacterial infections, they can disrupt the natural balance of oral flora, which may lead to yeast infections in the mouth (oral thrush). This situation can make maintaining oral hygiene more complicated [42].
2. **Antihistamines:** Often prescribed for allergies, these medications can lead to dry mouth (xerostomia), significantly reducing saliva production. Saliva plays a vital role in washing away food particles and neutralizing acids produced by bacteria in the mouth, so a lack of saliva increases the risk of cavities and gum disease.
3. **Asthma Medications:** Inhalers, particularly those containing corticosteroids, can lead to oral thrush and dental caries if oral hygiene is not meticulously managed. Children may also be at risk of developing other oral complications due to the components in asthma medications.
4. **Psychiatric Medications:** Some medications for ADHD or depression can result in dry mouth, changes in taste, and other disruptions to oral health. These impacts necessitate attention to a child's daily oral hygiene practices [42].

Establishing a Comprehensive Oral Hygiene Routine

Ensuring that children on medication have an effective oral hygiene routine requires a thoughtful and proactive approach. Some best practices include:

1. **Regular Dental Visits:** Establish a routine of regular dental check-ups, ideally every six months. Dentists can keep track of the child's oral health and provide professional cleanings, fluoride treatments, and tailored advice based on their medication [43].
2. **Brushing Techniques:** Encourage children to brush their teeth twice daily with a fluoride toothpaste to help combat tooth decay. Parents should supervise young children to ensure they are using proper brushing techniques, which include brushing for at least two minutes, covering all tooth surfaces, and using a gentle circular motion to protect the gums.
3. **Flossing:** Flossing should be introduced as soon as two teeth are in contact with each other. It's an essential step to remove plaque and food particles that brushing may miss, particularly in children with crowded teeth or braces [44].
4. **Stay Hydrated:** Encourage children to drink plenty of water, especially if they are taking medications that cause dry mouth. Water helps to stimulate saliva production and rinses away food particles, further protecting against cavities.
5. **Limit Sugary Snacks:** Parents should be vigilant about the child's diet, particularly regarding sugar intake. Sugary snacks and drinks can exacerbate the risk of tooth decay, especially when combined with medications that influence saliva production [45].
6. **Saliva Substitutes and Mouth Rinses:** For children suffering from dry mouth due to medications, saliva substitutes or oral moisturizers may be beneficial. There are also specialized mouth rinses that can help alleviate dry mouth and maintain oral health.
7. **Educating the Child:** Teaching children the significance of oral hygiene and how medication can impact their mouth is vital. Understanding the relationship between medication and oral health can empower them to take ownership of their dental care routines [46].
8. **Consultation with Healthcare Providers:** Parents should maintain open communication with healthcare providers regarding any concerns about medication's side effects on oral health. In some cases, alternative medications or adjustments in dosage may be advisable [46].

The Role of Parents and Caregivers

Parents and caregivers play an instrumental role in establishing, maintaining, and reinforcing good oral hygiene practices for children on medication. They must be engaged in monitoring their children's compliance with oral health routines, providing encouragement, and emphasizing the importance of consistent care. By creating a positive environment around oral hygiene, parents can help alleviate any apprehension children may feel towards dental care, especially if they are already coping with the challenges of medication [47].

Collaborative Approaches Between Pediatricians and Dentists:

In the realm of healthcare, the importance of interdisciplinary collaboration cannot be overstated, particularly in the context of pediatric care. Pediatricians and dentists, though trained in distinct medical fields, share a common goal: safeguarding the health and well-being of children. Their collaboration enables them to address not only physical health but also the psychological and social components that accompany pediatric care [48].

Pediatricians are medical doctors specializing in the health care of infants, children, and adolescents. They focus on the broad spectrum of growth and development, preventive care, and the management of various pediatric diseases. In contrast, pediatric dentists are dental specialists focusing on the oral health of children, ranging from infancy through young adulthood. They are adept in managing dental practices, preventing dental diseases, and addressing dental trauma in young patients. Together, they form an essential partnership that addresses children's comprehensive healthcare needs [49].

The Importance of Collaboration

The mouth and body are interconnected; therefore, the holistic management of a child's health often requires insights from both pediatricians and dentists. There are several aspects that underscore the importance of their collaboration:

1. **Preventive Health Strategies:** Collaboration can amplify preventive care measures. For instance, pediatricians can counsel parents about the significance of maintaining good oral hygiene and scheduling regular dental check-ups. On the other hand, dentists can advocate for the role of good nutrition in maintaining both general and oral health. Coordinated efforts in educating parents can lead to healthier behaviors that benefit children's overall well-being [50].
2. **Early Identification of Conditions:** Pediatricians are typically the first healthcare providers a child encounters, giving them a crucial role in early identification of potential dental issues, such as malocclusion or tooth decay. Through a collaborative approach, pediatricians can refer children to dentists for further assessment and intervention, thus ensuring early treatment and better long-term outcomes.
3. **Management of Systemic Conditions:** Certain systemic health conditions in children, such as diabetes or congenital heart defects, necessitate profound dental considerations. Joint management of these conditions can ensure that pediatricians communicate vital health information to dentists, allowing for tailored dental care that takes into account the child's unique health profile [51].
4. **Promotion of Mental and Emotional Health:** Collaboration extends beyond physical health. Both pediatricians and dentists can play crucial roles in addressing the psychological aspects of child health. Dentists can observe signs of anxiety or fear in children during dental visits and communicate these to pediatricians, who can provide appropriate support or referrals to mental health professionals. This cross-disciplinary

approach helps mitigate fear of dental procedures, leading to a more positive health care experience [52].

5. **Education and Training:** The collaboration between pediatricians and dentists extends to education. By participating in joint training sessions, both groups can broaden their understanding of each other's disciplines. This exchange of knowledge can foster respect, enhance clinical practices, and lead to improved patient care [53].

Methods of Collaborative Practice

To effectively implement a collaborative approach, several methods can be adopted:

1. **Interdisciplinary Clinics:** Establishing clinics where both pediatricians and dentists work together can streamline processes and create a unified care system. Child patients could receive comprehensive assessments in a single visit, reducing the need for multiple appointments and increasing the likelihood of early intervention [54].
2. **Shared Protocols and Guidelines:** Developing shared protocols that outline best practices for the management of certain conditions can serve as an effective tool for ensuring consistent care. These guidelines should address referral processes, communication channels, and follow-up strategies [55].
3. **Community Outreach Programs:** Joint community programs aimed at educating families about the importance of medical and dental health can foster a culture of preventive care. Health fairs, workshops, and school initiatives can effectively disseminate information while building rapport between the two fields.
4. **Open Communication Channels:** Establishing clear lines of communication between pediatricians and dentists is vital. This can include collaborative electronic health records, shared notes on patient care, or regular meetings to discuss patient cases and strategies [55].

Challenges to Collaboration

Despite the evident benefits of collaborative approaches between pediatricians and dentists, certain challenges must be addressed:

1. **Professional Silos:** Pediatricians and dentists often operate in separate spheres, leading to a lack of awareness about each other's practices. Breaking down these silos requires cultural shifts within healthcare systems and efforts toward fostering collaboration [56].
2. **Time Constraints:** The demanding schedules of pediatricians and dentists can make collaborative practices logistically challenging. Finding mutually agreeable times for meetings or patient consultations may require additional planning and flexibility from both sides.
3. **Funding and Resources:** In many instances, collaborative care may not receive adequate funding or institutional support, leading to a lack of resources for initiatives aimed at integration. Both fields need to advocate for policy changes and funding that supports collaborative efforts [56].
4. **Education and Training Gaps:** The educational paths of pediatricians and dentists diverge significantly. Incorporating interdisciplinary training into their respective curricula could be beneficial, but it requires curricular adjustments and alignment of educational goals across disciplines [56].

Future Directions

The future of collaborative care between pediatricians and dentists lies in continued efforts to enhance partnership models. As awareness of the integral relationship between oral and systemic

health grows, it is anticipated that collaborative initiatives will become more prevalent. Potential future directions include:

1. **Policy Advocacy:** Advocating for policies that recognize the importance of collaboration in pediatric health can enhance funding and support for joint initiatives. Policymakers should be made aware of the positive impacts of multidisciplinary approaches [57].
2. **Research into Outcomes:** Engaging in research that assesses the outcomes of collaborative care will provide evidence of its effectiveness. Data demonstrating improved health outcomes and patient satisfaction can bolster support for collaborative models [58].
3. **Technological Integration:** Leveraging technology to facilitate communication between pediatricians and dentists can overcome some logistical barriers. Telehealth options, shared electronic records, and digital collaboration tools can streamline shared care practices [59].

Conclusion:

In conclusion, the impact of pediatric medications on oral development is a critical concern in children's dentistry that warrants careful attention from both healthcare providers and parents. While these medications are often essential for managing various health conditions in children, their potential side effects on oral health cannot be overlooked. Issues such as altered oral flora, dry mouth, and changes in taste can create an environment conducive to dental caries and gum disease, as well as lead to long-term complications affecting dental alignment and jaw development.

To mitigate these risks, it is crucial to promote effective communication between pediatricians and dentists, ensuring that the oral health implications of prescribed medications are clearly understood and monitored. Additionally, educating parents about the importance of maintaining good oral hygiene practices and regular dental check-ups while their children are on medication can significantly help in preserving oral health. By fostering a collaborative approach, we can better safeguard the dental development of children, ultimately supporting their overall health and well-being.

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