AMERICA'S PEDIATRIC DENTISTS
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Report of the Council on Clinical Affairs

Proposed changes/additions to oral health policies and clinical recommendations of the American Academy of Pediatric Dentistry

3/27/2019

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NOTICE TO ACTIVE AND LIFE MEMBERS

(1) Reference Committee Hearing and Reports &
(2) General Assembly Meeting

Constitution and Bylaws amendments and proposed changes/additions to oral health policies and clinical recommendations of the American Academy of Pediatric Dentistry will be the subject matter for the Reference Committee hearings at the Annual Session. Recommendations from the Council on Clinical Affairs concerning oral health policies and clinical recommendations were posted as a Members-only document on the AAPD website (*www.aapd.org*) no later than sixty (60) days prior to the General Assembly. All members will be alerted to this availability via *AAPD E-News.*

The Reference Committee hearing will take place on Saturday, May 25, 2019, from 10 to 11 a.m., in the Waldorf Room at the Hilton Chicago. Members are strongly encouraged to attend. Non-members may attend, but will be polled and asked to identify themselves by the chair, and are not allowed to comment. The Reference Committees are intended to be the venue for member discussion on any formal resolutions that will be proposed before the General Assembly. This is an opportunity for members to present testimony on proposed oral health policies and clinical recommendations, and other business to come before the General Assembly.

Reference Committee Reports will be available in the back of the Waldorf Room at the Hilton Chicago beginning at 8:30 a.m., on Sunday morning May 26, 2019, prior to the beginning of the General Assembly and Awards Recognition at 9:30 a.m. If available in time, copies will also be provided at District Caucuses on Saturday, May 25, 2019, from 1 to 2 p.m.

The Awards Recognition and General Assembly will take place on Sunday, May 26, 2019, from 9:30 to 11:30 a.m., in the Waldorf Room of the Hilton Chicago. The General Assembly is a meeting of Active and Life members for the purposes of conducting the business of the AAPD. Final action on recommendations from Reference Committees takes place at the General Assembly. An agenda for the General Assembly meeting will be posted on the AAPD website (*www.aapd.org*) approximately one month prior to the meeting. All members will be alerted to this availability via *AAPD E-News*.

Table of Contents

(Click on a title to go directly to content)

This draft does not constitute an official AAPD health oral policy or clinical recommendation until approval by the General Assembly. Circulation is limited to AAPD members.

Definition of Medically-Necessary Care

Review Council

Council on Clinical Affairs

Latest ~~Revision~~ Reaffirmation

~~2015~~ 2019

Medically-necessary care (**MNC**) is the reasonable and essential diagnostic, preventive, and treatment services (including supplies, appliances, and devices) and follow-up care as determined by qualified health care providers in treating any condition, disease, injury, or congenital or developmental malformation to promote optimal health, growth, and development. MNC includes all supportive health care services that, in the judgment of the attending dentist, are necessary for the provision of optimal quality therapeutic and preventive oral care. These services include, but are not limited to, sedation, general anesthesia, and utilization of surgical facilities. MNC must take into account the patient's age, developmental status, and psychosocial well-being, in addition to the setting appropriate to meet the needs of the patient and family.

Dental care is medically-necessary to prevent and eliminate orofacial disease, infection, and pain, to restore the form and function of the dentition, and to correct facial disfiguration or dysfunction.

This definition was originally developed by the Council on Clinical Affairs and adopted in 1997. This document is ~~an update~~ a reaffirmation of the ~~previous version, revised in 2011~~ 2015 version.

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Policy on a Patient's Bill of Rights and Responsibilities*

Review Council

Council on Clinical Affairs

~~Reaffirmed~~

~~2014~~

Latest Revision

2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that pediatric oral health care should be rendered under conditions ~~that are~~ acceptable to both patient and dentist. The expectation is that oral health care providers, their staff, ~~and~~ patients, and parents of patients will support this policy, thereby enhancing patient care.

Methods

This policy was adopted in 2009. The updated document used electronic database and hand searches of the articles in the medical and the dental literature using the following parameters: Terms:: patient freedoms, patient's Bill of Rights, Bill of Rights, Consumer Bill of Rights; Fields: all; Limits: within the last 10 years and English; birth through age 18. Additionally, when data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced organizations relating to the concept of patient rights and responsibilities.

~~This policy was adopted in 2009, and is based on a systematic literature search of the PubMed /MEDLINE database using the terms: patient freedoms, patient's Bill of Rights, Bill of Rights, Consumer Bill of Rights; fields: all; limits: within the last 10 years and English. Eighty-one articles met these criteria. Papers for review were chosen from this list and from the references within selected articles. Documents of health care and public policy organizations relating to the concept of patient rights and responsibilities also were reviewed.(AAPD Vision, AHA 1992, President's Advisory Commission 1998)~~

* **ABBREVIATION**
AAPD: American Academy Pediatric Dentistry.

Background

The AAPD is the leader in representing the oral health interests of infants, children, adolescents, and persons with special health care needs.[1] Effective oral health care requires collaboration between pediatric dentists, their patients/parents ~~and pediatric dentists~~ and other health care professionals. Optimal patient care requires honest and open communication between provider and patient, mutual respect for personal and professional values, and sensitivity to cultural differences.[2] ~~Open and honest communication, respect for personal and professional values, and sensitivity to differences are integral to optimal patient care.~~

Often, the delivery of contemporary pediatric oral health care ~~many times~~ can be confusing to parents. It is normal for parents to have expectations about their child's proposed care. It is important that parents have realistic expectations in order for them to have a clear understanding of their responsibilities in the delivery of care to their children. ~~whose children have planned oral health care treatment to have a set of expectations about the proposed care. Likewise, it is desirable for these parents to have a clear understanding of their responsibilities in the delivery of care to their children.~~

Patient's Bill of Rights and Responsibilities ~~A Patient's Bill of Rights~~ is a statement of the rights to which patients are entitled as recipients of medical/dental care. These rights can be exercised on the patient's behalf by a parent or legal guardian if the patient is a minor, lacks decision-making capacity, or is legally incompetent. It articulates the positive rights that health care providers and facilities should provide patients, thereby providing information, offering fair treatment, and granting them autonomy over medical decisions.

The collaborative nature of health care requires that patients, or their families/surrogates, participate in their care. The effectiveness of care and patient satisfaction with the course of treatment depend, in part, on the patient's fulfilling certain responsibilities. As such, the AAPD proposes this Policy on a Patient's Bill of Rights and Responsibilities in the planning and delivery of pediatric oral health care. The AAPD encourages oral health care providers to tailor this Bill of Rights and Responsibilities to their patient community by translating and/or simplifying it as ~~may be~~ necessary to ensure that patients and their families understand their rights and responsibilities.[3]

~~Bill of rights~~

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~~these rights can be exercised on the patient's behalf by a parent or legal guardian if the patient is a minor, lacks decision-making capacity, or is legally incompetent.~~ ~~The patient has the right to:~~

Patient's Rights include:

- Receive treatment at a dental home that provides comprehensive, considerate, and respectful care.
- Have oral health diagnoses made by a dentist.
- Know the identity, education, and training of the providers involved in his/her care, as well as when those involved are students, residents, or other trainees.[4]
- Choose an ~~A choice of~~ oral health care provider. The parent has a right to designate a pediatric dentist as a primary oral health care provider for their child.
- Participate fully in all the decisions related to his/her care.
- Receive accurate, relevant, current, and easily-understood information concerning diagnosis, treatment, and prognosis.
- ~~The patient is entitled to the opportunity to~~ Discuss and request information related to ~~the~~ specific procedures and/or treatments, including accompanying risks and benefits, and ~~the risks involved~~, ~~and~~ the medically reasonable. ~~alternatives and their accompanying risks and benefits.~~ Life threatening emergency care could be an exception.
- Make decisions about the plan of care prior to and during the course of treatment, to refuse a recommended treatment or plan of care to the extent permitted by law, and to be informed of the health consequences of this ~~action~~ refusal. In case of ~~such~~ refusal, the patient is entitled to other appropriate care and services that the pediatric dentist offers or to transfer to another dentist.[5]
- Consent ~~to~~ or decline to participate in proposed research studies affecting care and treatment or requiring direct patient involvement
- ~~and to~~ Have ~~those~~ studies explained fully prior to consent. A patient who declines to participate in research is entitled to the most effective care that the pediatric dentist can otherwise provide.
- Expect reasonable continuity of care.
- Receive emergency care as needed for acute dental trauma and odontogenic infections~~, as needed~~.
- ~~Know the identity, education, and training of the providers involved in his/her care, as well as when those involved are students, residents, or other trainees.~~
- Know the immediate and long-term financial implications of treatment choices, insofar as they

are known by the provider. The patient has the right to be informed of the charges for services and available payment methods.

- Be informed of the provider's policies and practices that relate to patient care, treatment, and responsibilities. This includes ~~patient has the right to be informed of~~ available resources for resolving disputes, grievances, and conflicts, such as ethics committees, patient representatives, or other mechanisms available in an organization.
- Have privacy considered in every interaction. ~~Every consideration of privacy.~~ Case discussion, consultation, examination, and treatment should be conducted in such a way that best protects ~~so as to protect~~ each patient's privacy.
- Expect that all communications and records pertaining to his/her care will be treated as confidential, except in cases where reporting is permitted or required by law, such as suspected abuse and public health hazards. ~~when reporting is permitted or required by law.~~ The patient has the right to expect that the provider will emphasize the confidentiality of information released to other parties entitled to review this information.
- Advise staff regarding specific privacy concerns or questions.[3]
- Review the records pertaining to his/her medical care and to have the information explained or interpreted as necessary, except when restricted by law. The patient has the right to request amendments to his/her record.
- Ask and be informed of the existence of business relationships among institutions, other health care providers, or payers that may influence the patient's treatment and care.

Patient's ~~Bill of r~~ Responsibilities:

The responsibilities can be exercised on the patient's behalf by a parent or legal guardian if the patient is a minor, lacks decision-making capacity, or is legally incompetent. The patient is responsible for:

- ~~for p~~Providing, to the best of his/her knowledge, accurate and complete information about past illnesses, hospitalizations, medications, and other health status-related matters. ~~related to his/her health status.~~
- ~~The patient must take responsibility for r~~ Requesting additional information or clarification about ~~his/her~~ health status or treatment when he/she does not fully understand information and instructions.
- ~~The patient is responsible for~~ His/her actions if he/she refuses treatment or does not follow the instructions of the provider.[3] It is the patient's responsibility to inform dentists and other

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caregivers of anticipated problems in following prescribed treatment, including follow-up treatment instructions.

- ~~The patient has a responsibility to~~ ~~k~~ Keeping appointments and when unable to do so, to notify the dental office as soon as possible.
- ~~The patient is responsible for~~ ~~b~~ Being considerate of the rights of other patients and health care workers.[6] This includes not ~~and for not~~ interfering with the ~~general~~ functioning of the facility, nor using profane or derogatory behavior, and minimizing noise.[7]
- ~~The patient is responsible for~~ ~~h~~ His/her conduct with staff. The patient must resolve conflicts using available institutional mechanisms. Verbal and physical abuse of staff is prohibited.[8]
- ~~The patient is responsible for~~ ~~p~~ Providing accurate insurance information and for accepting the financial obligations associated with the services rendered.
- Following HIPAA guidelines including not taking videos/photographs of people and/or protected health information.

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Policy on Infection Control*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes the importance of infection control policies, procedures, and practices in dental health care settings in order to prevent disease transmission from patient to care provider, from care provider to patient, and from patient to patient.

Methods

This policy was originally developed by the Infectious Disease Control Subcommittee and adopted in 1989. This document is a revision of the previous version, revised in 2014. The revision of this policy is based upon a review of current dental and medical literature related to infection control, expert opinion, and best current practices. ~~an update from the last revision in 2009.~~ Literature searches of PubMed® and Google Scholar databases were ~~An electronic database search was~~ conducted using the terms: dentistry infection control AND health care, and infection control AND dental; fields: all; limits: within the last 10 years; English; humans; comparative study, meta-analysis, multi-center study, systematic reviews, and validation study. The search returned 352 ~~34~~ articles that matched the criteria. The articles were evaluated by title and/or abstract and relevance to dental care for children and adolescents. Twenty-five ~~Three~~ articles ~~citations~~ were chosen from this method and from references within selected articles.

Background

The application of standard ~~universal~~ precautions regarding infection control during dental treatment is paramount. The environment in which dental care is delivered impacts both patient and provider safety. Health care professionals should remain knowledgeable in how to reduce exposure and contamination risks to infectious materials. This would include body substances, contaminated

* ABBREVIATION
AAPD: American Academy Pediatric Dentistry.

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supplies, equipment, environmental surfaces, water, and air. Some infection control practices routinely used by healthcare professionals cannot be rigorously evaluated by clinical trials for ethical and logistical reasons.[1] ~~(Kohn et al 2003)~~

Many resources are available to aid dental providers in creating checklists, standard operating procedures or other quality assurance mechanisms for use in daily practice. All patient care, laboratory procedures and equipment management should be carried out in an environment with techniques consistent with guidelines set forth by Center for Disease Control and Prevention (CDC), the Occupational Safety and Health Administration (OSHA), as well as state and local regulatory boards. Providers should consult such organizations as the CDC, the OSHA, state dental boards and other dental organizations for current infection control recommendations.[2-9]

Dental practices should stay abreast of updated infection control requirements issued by official regulatory organizations. Standard precautions includes hand washing, personal protective equipment (PPE) such as gloves, gowns, eyewear with safety side shields, and masks whenever touching or exposure to patients' body fluids is likely.

The possibility of contamination within the internal components of dental handpieces has led to the more recent recommendation that all dental handpieces, including low-speed motors and removable prophylaxis angles, undergo heat sterilization between patients. Providers should verify that the instructions for sterilization provided by the manufacturer of their reusable equipment comply with current standards.[2-4]

Dental practices should be cognizant of potential infections associated with waterlines. It is important to follow manufacturer guidelines to disinfect waterlines, monitor water quality, use point-of-use water filters, and eliminate dead ends in plumbing where stagnant water can enable biofilm formation.[4,5,10] There have been cases of disease transmission from waterlines.[10, 11] In 2015, an outbreak of *Mycobacterium abscessus* odontogenic infections was reported in children receiving pulpotomy treatment from a pediatric dental clinic. The source of the *Mycobacterium* was contaminated water from dental unit waterlines.[5,11] A practitioner may consider use of sterile water or saline when irrigating pulpal tissue.[11]

Although no adverse health effects have been reported with use of saliva ejectors, CDC cautions the

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dental health care providers to be aware of the possibility of a potential backflow, where suctioned fluids in tubing can flow back into patient's mouth. This can happen when: 1) Pressure in patient's mouth, as a result of closing their lips and forming a seal around the tip of the ejector, is lower than the pressure in saliva ejector; 2) Suction tubing attached to the ejector is positioned above patient's mouth; or 3) Saliva ejector is used at same time with other high-volume suctions. Clinicians are recommended to take all necessary precautions to prevent potential backflow associated with use of saliva ejectors.[2]

Policy statement

The AAPD: ~~acknowledges~~

- Acknowledges the Centers for Disease Control and Prevention's Statement on Reprocessing Dental Handpieces- 2018[3], Guidelines for Infection Control in the Dental Health-Care Setting-2003 [1], Guidelines for Disinfection and Sterilization in Healthcare Facilities-2008 [7] and Updated CDC Recommendations for the Management of Hepatitis B Virus-infected Health Care Providers and Students—2012 [6] as in-depth reviews of infection control measures for dental settings and supports the strategies therein.
- ~~Aware that some~~ ~~Some recommendations are based only on suggestive evidence or theoretical rationale, and because many concerns regarding infection control in the dental setting remain unresolved, the AAPD encourages dental practitioners to follow current literature and consider carefully infection control measures in their practices so as to minimize the risk of disease transmission.~~
- Encourages providers to follow CDC recommendations to heat sterilize all dental handpieces, including low-speed motors and removable prophylaxis angles, between patients.[3]
- Encourages providers and their dental teams to be proactive in addressing infection control concerns. Staff may benefit from additional training to better answer questions from parents regarding the infection control practices at their practice.

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Policy on the Use of Dental Bleaching for Child and Adolescent Patients*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ **2019**

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that the desire for dental whitening in pediatric and adolescent patients has increased. This policy is intended to help professionals and patients make informed decisions about the indications, efficacy, and safety of internal and external bleaching of primary and young permanent teeth and incorporate such care into a comprehensive treatment plan.

Methods

This policy was originally developed by the Council on Clinical Affairs and adopted in 2004. This document is an update from the last revision in ~~2009~~.**2014**. This revision included a new literature search of the PubMed®/MEDLINE database using the terms: dental bleaching, dental whitening, and tooth bleaching; fields: all; limits: within the last 10 years, humans, English, and birth through age 18. ~~260 articles matched these criteria. Papers for review were chosen from this list and from the references within selected articles~~. Articles were selected and reviewed. Additional information was obtained from reviewing references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

~~Through news stories and advertisements, the public has become more aware of advances in cosmetic dentistry.~~ The desire for improved dental esthetics has fueled innovations in dental materials and the development of new resources. ~~Increased demand for bleaching materials and services has affected both the variety and availability of dental bleaching products on the market.~~. ~~Both the variety and availability~~

* **ABBREVIATION**
AAPD: American Academy of Pediatric Dentistry

~~of bleaching products on the market. have increased.Consequently~~ Patients, parents and the news media continue to request information on dental whitening for children and adolescents with increasing frequency. In addition, increased demand for bleaching materials and services has affected both the variety and availability of dental bleaching products on the market.

Discoloration of teeth is classified by etiology.[1] Clinical indications for internal or external dental whitening for individual teeth may include discoloration resulting from a traumatic injury (i.e., calcific metamorphosis, darkening with devitalization), irregularities in enamel coloration of a permanent tooth due to trauma or infection of the related primary tooth, or intrinsic discoloration/staining (e.g., enamel hypoplasia, fluorosis, tetracycline staining).[2-7] Teeth staining from metals (e.g., iron supplements) or consumption of tea, coffee, soft drinks, alcohol and certain foods is extrinsic and easier to treat compared to intrinsic factors which are congenital or acquired. Severe discolorations may be best treated with microabrasion and subsequent bleaching to achieve desirable results.[8] ~~A positive self-image due to a discolored tooth or teeth can have serious consequences on adolescents and could be considered an indication for bleaching. (Donly 2003)~~ Due to the difference in the thickness of enamel of primary and permanent teeth, tooth coloration within a dental arch may vary significantly during the mixed dentition. Full arch cosmetic bleaching during this developmental stage, however, would result in mismatched dental appearance once the permanent dentition is reached. As adolescents present with unique dental needs, the impact of tooth discoloration on an adolescent's self-image could be considered an indication for bleaching.[8] Tooth whitening has been successful in adolescent patients using typical bleaching agents,[8] but research is lacking on the effects of bleaching on the primary dentition.

Dental whitening may be accomplished by using either professional or at-home bleaching modalities. Advantages of in-office whitening or whitening products dispensed and monitored by a dental professional include:

- An initial professional examination to help identify causes of discoloration and clinical concerns with treatment (e.g., existing restorations, side effects).
- Professional control and soft-tissue protection.
- Patient compliance.
- Rapid results.
- Immediate attention to teeth sensitivity and other adverse effects

The pretreatment professional assessment helps identify pulp pathology that may be associated with a single discolored tooth. This examination also identifies restorations that are faulty or could be affected by the bleaching process, and the associated costs for replacing such restorations to maximize esthetic results.[8-12] By using photographs and/or a shade guide, the dentist can document the effectiveness of treatment. In addition to providing in-office bleaching procedures, a dentist may fabricate custom trays for at-home use of a bleaching product. Custom trays ensure intimate fit and fewer adverse gingival effects.[13] Over-the-counter products for at-home use include bleaching gels, whitening strips, brush-on agents, pens, toothpastes, mints, chewing gum, and mouth rinses. Their main advantages include patient convenience and lower associated costs.

Peroxide-containing whiteners or bleaching agents improve the appearance of a tooth by changing its intrinsic color. The professional-use products usually range from 10 percent carbamide peroxide (equivalent to about 3.5 percent hydrogen peroxide) to 38 percent carbamide peroxide (equivalent to approximately 13 percent hydrogen peroxide). In-office bleaching products require isolation with a rubber dam or a protective gel to shield the gingival soft tissues. Home-use bleaching products contain lower concentrations of hydrogen peroxide or carbamide peroxide.[2-4,14] Efficacy and long-term outcomes of home whitening products will vary according the concentration of peroxide used and the severity of the initial tooth discoloration.[15-18] Many whitening toothpastes contain polishing or chemical agents to improve tooth appearance by removing extrinsic stains through gentle polishing, chemical chelation, or other non-bleaching action.[10,19]

Side effects from bleaching vital and non-vital teeth have been documented. It should be noted that most of the research on bleaching has been performed on adult patients, with only a limited number of published research studies using child or adolescent patients.[2,4,8,14,17,20-23] The more common side effects associated with bleaching vital teeth are tooth sensitivity and tissue irritation. Tooth sensitivity associated with vital teeth bleaching may be due to permeation of enamel and dentin by hydrogen peroxide and a subsequent mild, transient inflammatory response.[24-26] Sensitivity will be affected by the concentration of whitening agent and the amount of time that the teeth are exposed to the bleaching product[27] Between 8 and 66 percent of patients experience post-bleaching sensitivity, most often during the early stages of treatment.[7,10,14,17,20,23] Over-treatment has been shown to harm tooth structure, which is of particular concern when bleaching products are used excessively by overzealous teens and young adults.[28-30]

In most cases, tissue irritation results from an ill-fitting tray rather than the bleaching agents and resolves once a more accurately fitted tray is used. Both sensitivity and tissue irritation are usually temporary and

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cease with discontinuation of treatment.[6,7,14,17,19,20,23, 32] Additional risks may include erosion, mineral degradation, pulpal damage and increased marginal leakage of existing restorations.[14,33] When used correctly, however, teeth bleaching has been proven to be safe and causes no irreversible tooth structure damage.[28]

Internal bleaching for non-vital endodontically treated teeth in young patients can be performed in the same way as for adults.[28] The more common side effects from internal bleaching of nonvital teeth are external root resorption[34-37] and ankylosis. With external bleaching of nonvital teeth, the most common side effect is increased marginal leakage of an existing restoration.[3,38-42] One of the degradation byproducts of hydrogen peroxide or carbamide peroxide is a hydroxyl-free radical. This byproduct has been associated with periodontal tissue damage and root resorption. Due to concern for hydroxyl free radical damage[43-45] and the potential side effects of dental bleaching, minimizing exposure to the lowest effective concentration of hydrogen peroxide or carbamide peroxide is recommended. Providers should use caution when bleaching primary anterior teeth, as the underlying permanent teeth are in jeopardy of developmental disturbance from intramedullary inflammatory changes.[28,46]

Of growing concern is the preponderance of non-dental professionals offering teeth whitening services to the public.[47] Tooth whitening is defined as any process to whiten, lighten, or bleach teeth.[47] Teeth whitening kiosks, retail and beauty salons are providing whitening services and dispensing teeth whitening agents.[19,48] Dental organizations throughout the nation have supported state regulations that restrict the practice of providing bleaching services to only dentists or other qualified dental staff under the direct supervision of a dentist. The use of over-the-counter whitening products remain exempt from this regulation. Legislation defining the scope of practice by non-dentists offering whitening treatment vary from state to state and should be examined when these services are being provided.[48-50]
~~For Current literature and clinical studies support the use of sodium perborate mixed with water for bleaching nonvital teeth.28,29 Studies have shown higher incidences of root resorption when hydrogen peroxide is mixed with sodium perborate21-24 or any mixture of sodium perborate is heated.29 Therefore, the use of hydrogen peroxide and heating any mixture of sodium perborate are not recommended.~~

Policy statement

Teeth whitening procedures have been shown to be safe and may be beneficial for children and adolescents. Their use should follow the safety and efficacy standards as defined by clinical research and

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best practice. Young patients undergoing dental bleaching should be supervised by an adult and under the guidance of a dentist. Although the use of whitening agents can successfully improve teeth esthetics and enhance a person's self-esteem, proper treatment planning with objectives should be conducted prior to engaging in any bleaching protocol.

The AAPD encourages:

- The judicious use of bleaching for vital and non-vital teeth.
- Patients to consult their dentists to determine appropriate methods for and the timing of dental whitening within the context of an individualized, comprehensive, and sequenced treatment plan.
- Dental professionals and consumers to consider side effects when contemplating dental bleaching for child and adolescent patients.
- Further research of dental whitening agents in children.

The AAPD discourages full-arch cosmetic bleaching for patients in the mixed and primary dentition.

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Policy on Third-Party Payor Audits, Abuse, and Fraud*

~~Originating~~ Review Council

Council on Clinical Affairs

~~Adopted~~

~~2014~~

Latest Revision

2019

Purpose

One of the aims of the Deficit Reduction Act,[1] approved by the U.S. Congress in 2005, was to prevent Medicaid fraud and abuse through an audit process. Despite the good intentions of this law, experts predicted health care providers ~~will~~ would see more investigations, enforcement actions, and whistleblower cases, and ~~will~~ would need to devote more resources toward compliance.[2] Pediatric dentists play a critical role in the Medicaid program, and there will be negative impact on access to care if ~~honest~~ providers are burdened with excessive regulations and unfounded audits. The American Academy of Pediatric Dentistry (**AAPD**) supports efforts to eliminate Medicaid abuse. The AAPD cautions, however, against ill-informed or misguided investigations that may discourage dental provider participation in the program.[2] The AAPD is opposed to any of its dentist members committing abuse and fraud as it relates to their relationship with third party payors. Such behavior is unprofessional conduct and could result in loss of membership status in AAPD.[3] This policy is intended to help AAPD members understand the audit process, both internal and external audits.

Methods

This policy is based upon a review of current dental and medical literature, including a literature search of the PubMed® electronic database using the terms: dental audits, dental abuse and fraud, peer review, provider profiling, practice management, EPSDT; field: all; limits: within the last 10 years; human; English. Nineteen articles match these criteria. Papers for review were chosen from this list as well as references within the selected articles. ~~When data did not appear sufficient or were inconclusive,~~

* **ABBREVIATIONS**
AAPD: American Academy Pediatric Dentistry. **CMS:** Centers for Medicare and Medicaid Services. **EPSDT**: Early and periodic screening, diagnosis, and treatment. **MNC**: Medically Necessary care. **RAC**: Recovery audit contractor.

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~~recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.~~

Background

External audits are increasingly common for a full range of health care providers. ~~AAPD members~~ Dentists are no exception, as some ~~of our members~~ pediatric dentists have experienced. If a provider requests payment from third-party payors, the claims may be subject to review by a recovery audit contractor (**RAC**), a private entity that reviews paid claims and, in some cases, earns contingency fees for improper payments it retrieves. Private and public third-party payors use audits as a mechanism to recoup over-payments, inspect for potential improper behavior, and possibly guide health care providers to control utilization and costs.[4] Notably, there can be serious financial and even criminal penalties associated with billing errors.[5]

In ~~2012~~ 2017, an estimated $~~19~~ 37 billion, or ~~seven~~ ten percent, of the federal Medicaid funds were absorbed by improper payments, which include fraud and abuse as well as unintentional mistakes such as paper errors.[6] ~~Improper payments totaled an estimated $11 billion, or nine percent of states' Medicaid budgets in 2010, the most recent year for which data is available.(CMS Medicaid Improper Payment)~~ Improper payments can occur when funds go to the wrong recipient, the recipient receives the incorrect amount of funds (either an underpayment or overpayment), documentation is not available to support a payment, or the recipient uses the funds in an improper manner.[6]

The AAPD recognizes the concern its members have regarding these external audits. The AAPD encourages its members to develop internal self-audit programs to address these challenges. Internal audits are used in order to preemptively detect discrepancies before the external authorities can discover them and impose penalties.[4] Given the heightened concern for compliance to avoid an external audit, internal audits have taken on importance. A compliance program generally will incorporate a credible internal audit system, which means that it must be prepared to respond to an external audit by various authorities. In addition, some pediatric dentists have discovered that an internal audit system can be developed so that it not only addresses the external audit, but also serves other quality of care and performance improvement purposes.[4]

Definitions

Abuse: "provider practices that are inconsistent with sound fiscal, business, or medical practices, and result in an unnecessary cost to the Medicaid program, or reimbursement for services that are not medically necessary or that fail to meet the professionally recognized standards for healthcare. It also includes recipient practices that result in unnecessary cost to the Medicaid program."[7] The AAPD supports medically necessary care (**MNC**) and recognizes that dental care is medically necessary for the purpose of preventing and eliminating orofacial disease, infection, and pain, restoring the form and function of the dentition, and correcting facial disfiguration or dysfunction.[8]

Audit: "planned and documented activity performed by qualified personnel to determine by investigation, examination, or evaluation of objective evidence, the adequacy and compliance with established procedures, or applicable documents, and the effectiveness of implementation".[9] After receiving a notice of an impending audit from a third-party payor, the dentist should ascertain the type and scope of audit to be conducted in writing.[10,11]

Fraud: "an intentional deception or misrepresentation made by a person with the knowledge that the deception could result in some unauthorized benefit to him or some other person."[7]

Third party payor: "~~an organization other than the patient (which would be the first party) or health care provider (also known as the second party) involved in the financing of health care services."(Oberman 2010)~~ "An organization other than the patient (first party) or health care provider (second party) involved in financing of personal health services."[12]

Recovery audit contractor: RAC's review claims on a post-payment basis. The RACs detect and correct past improper payments so that CMS and Carriers, FIs, and MACs can implement actions that will prevent future improper payments.[13]

Credentials of auditors. The Affordable Care Act required that each state Medicaid program use at least one RAC beginning in 2011.[14] Some states have started employing the RACs to aid in recovery of improper payments.[15] The AAPD strongly believes that, while audits are a part of third-party payment contracts and are necessary to protect the integrity of these programs, such audits must be completed by those who have credentials on par with the dental provider being audited. For example, pediatric dentists must be audited by a dentist who specializes in pediatric dentistry and who understands the clinical guidelines and standards of care which have been adopted and followed by their specialty. The AAPD is

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adamantly opposed to auditors receiving financial incentives for any money recuperated through these audits. This represents a conflict of interest.

Provider profiling. The AAPD is opposed to "provider profiling," a strategy that may be used by health plans to assess efficiency among providers and believes that dentist providers selected for audits should be chosen randomly or with compelling evidence that makes them an outlier compared to peers practicing in similar geographic areas, on similar populations of patients, and within the same specialty. Claims-based data used for provider profiling are not collected exclusively for performance assessment and, as a result, may be irrelevant or inadequate for profiling.[16] ~~Claims data may be unable to properly and fully characterize an episode of care and may fail to reveal a patient's baseline status.14 In addition, codes contained in claims data do not articulate "patients' compliance, their desire for care, or their socioeconomic status~~". Furthermore, the procedure codes included in claims-based data cannot fully characterize the nature of a particular episode of care, and may fail to account for variations in baseline status, socioeconomic considerations, compliance with treatment and access to care.[16]

Peer review as part of audit outcomes. The AAPD supports peer review as a way to offer information and support to dentists who need to review best practices regarding chart documentation, coding, and billing practices related to third party payors. This should be offered in lieu of financial penalties when an audit shows that no intent to fraud was present, but that the dentists need education to improve their practice systems. It provides practicing dentists a means to preserve their reputation and good standing in the community, and fosters risk management, accountability and self-regulation among dental professionals.[17] This model would be consistent with the peer review practices that occur when clinical decision making is in question. The intent of peer review is to resolve discrepancies between the dentists and third-party payors expeditiously, fairly, and in a confidential manner.[17]

Best practices for chart documenting, coding, and billing. The AAPD supports the education of pediatric dentistry residents, pediatric dentists, and their staff to ensure good understanding of appropriate coding and billing practices. The AAPD, therefore, supports the creation of educational resources and programs that promote best practices, which may include:

- ~~Programming~~ Programs offered at the AAPD's Annual Session or other AAPD-sponsored continuing education course.
- Programs offered ~~to~~ by the pediatric dentistry state unit and district organizations.
- The creation of a web-based tutorial for dentists and their staff, including the states' Dental Medicaid

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Provider Manuals and frequently asked questions regarding Medicaid.

- Partnering with other public/private organizations and agencies to distribute 'Medicaid Updates' that can be received via e-mail, and building open *Medicaid Compliance for the Dental Professional* webinars offered jointly by AAPD and Centers for Medicare and Medicaid Services (**CMS**)[18]
- The development of a third party payor submission compliance program.

Medicaid policies that conflict with AAPD ~~clinical practice guidelines~~ clinical recommendations.

The AAPD is opposed to Medicaid programs that have policies which are in direct conflict with AAPD clinical practice ~~guidelines~~ recommendations and are of detriment to patient care. For example, i~~I~~n several states, children are not receiving appropriate dental treatment covered by Early and Periodic Screening, Diagnosis, and Treatment (**EPSDT**) because there is a refusal to reimburse providers for EPSDT-covered dental services.[19] ~~It is in the best interest of the public to have EPSDT dental periodicity schedules readily available on the Internet. Such availability would also improve compliance by health care professionals and EPSDT staff members with federal EPDST requirements.(Hom et al 2013) In addition, a~~According to CMS, "federal law also requires that states inform all families about EPSDT coverage"[20] ~~The~~ and AAPD ~~recommends that~~ supports this requirement ~~be followed~~ to enable caregivers to seek necessary dental treatment for their children.

Policy statement

Dental care is medically necessary to prevent and eliminate orofacial disease, infection, and pain, to restore the form and function of the dentition, and to correct facial disfiguration or dysfunction. MNC is based upon current preventive and therapeutic practice guidelines formulated by professional organizations with recognized clinical expertise. Expected benefits of MNC outweigh potential risks of treatment or no treatment. Early detection and management of oral conditions can improve a child's oral health, general health and well-being, school readiness, and self-esteem. Early recognition, prevention, and intervention could result in savings of health care dollars for individuals, community health care programs, and third party payors. Because a child's risk for developing dental disease can change over time, continual professional reevaluation and preventive maintenance are essential for good oral health. Value of services is an important consideration, and all stakeholders should recognize that cost-effective care is not necessarily the least expensive treatment.[8]

The AAPD:

- Encourages it members and all third-party payors to support efforts to eliminate Medicaid abuse.

- Opposes any of its dentist members committing abuse and fraud as it relates to their relationship with third-party payors.
- Recognizes the concern its members have regarding these external audits.
- Encourages its members to develop internal self-audit programs to address these challenges.
- Strongly believes that, while audits are a part of third-party payment contracts and are necessary to protect the integrity of these programs, such audits must be completed by those who have credentials on par with the dental provider being audited.
- Adamantly opposes auditors receiving financial incentives for any money recuperated through audits.
- Opposes provider profiling and believes that dentist providers selected for audits should be chosen randomly or with compelling evidence that makes them an outlier as compared to their peers who practice in similar geographic areas, on similar populations of patients, and within the same specialty.
- Supports peer review in lieu of financial penalties when an audit shows that no intent to fraud was present, as a way to offer information and support to dentists who need to re-acquaint themselves on best practices regarding chart documentation, coding, and billing practices relating to third-party payors.
- Supports the education of pediatric dentistry residents, pediatric dentists, and their staff to ensure a good understanding of appropriate coding and billing practices.
- Supports the creation of educational resources and programs that promote appropriate coding and billing practices.
- Opposes Medicaid programs that have policies in direct conflict with AAPD clinical practice ~~guidelines~~ recommendations and are of detriment to patient care.
- Endorses the enforcement of the "federal law that requires that states inform all families about EPSDT coverage"[20] to enable caregivers to seek necessary dental treatment for their children.

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Policy on Medically-Necessary Care[*]

Review Council

Council on Clinical Affairs

Latest Revision

~~2015~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that dental care is medically-necessary for the purpose of preventing and eliminating orofacial disease, infection, and pain, restoring the form and function of the dentition, and correcting facial disfiguration or dysfunction.

Methods

This document was originally developed by the Council on Clinical Affairs and adopted in 2007. This document is an update from the last revision in 201~~4~~5. It includes an electronic search with Scopus and PubMed /MEDLINE® using the terms: medically-necessary care, systemic disease and oral disease, dentistry as medically-necessary care, periodontal disease and cardiovascular disease, oral health and pregnancy, oral health and respiratory illness, oral health and quality of life, pediatric dentistry general anesthesia, and nutritional deficiency cognitive development; fields: all; limits: within the last 15 years, human, English. The reviewers agreed upon the inclusion of ~~59~~ 78 articles that met the defined criteria. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

The AAPD defines medically-necessary care (**MNC**) as "the reasonable and essential diagnostic, preventive, and treatment services (including supplies, appliances, and devices) and follow-up care as determined by qualified health care providers in treating any condition, disease, injury, or congenital or developmental malformation to promote optimal health, growth, and development. MNC includes all supportive health care services that, in the judgment of the attending dentist, are necessary for the provision of optimal quality therapeutic and preventive oral care. These services include, but are not

[*] ABBREVIATIONS
AAPD: American Academy of Pediatric Dentistry. CC: Chronic condition. ECC: Early childhood caries. MNC: Medically-necessary care

limited to, sedation, general anesthesia, and utilization of surgical facilities. MNC must take into account the patient's age, developmental status, and psychosocial well-being, in addition to the clinical setting appropriate to meet the needs of the patient and family."[1]

MNC is based upon current preventive and therapeutic practice guidelines formulated by professional organizations with recognized clinical expertise. Such recommendations ideally are evidence based but, in the absence of conclusive evidence, may rely on expert opinion and clinical observations. Expected benefits of care should outweigh potential risks. MNC increases the probability of good health and well-being and decreases the likelihood of an unfavorable outcome. Value of services is an important consideration, and all stakeholders should recognize that cost-effective care is not necessarily the least expensive treatment.[2]

Dental care is medically-necessary to prevent and eliminate orofacial disease, infection, and pain, to restore the form and function of the dentition, and to correct facial disfiguration or dysfunction. Following the U.S. Surgeon General's report[3] emphasizing that oral health is integral to general health, the U.S. Department of Health and Human Services recommended changing perceptions of the public, policy makers, and healthcare providers so that oral health becomes an accepted component of general health.[4,5] Oral diseases can have a direct and devastating impact on overall health, especially for those with certain systemic health problems or conditions.

Caries is the most common chronic disease of childhood.[3,6] Approximately 60 percent of children experience caries in their primary teeth by age five.[7] Between 1988-1994 and 1999-2004, prevalence of caries in primary teeth increased for youths aged two to 11 years, with a significant increase noted for those in the two to five year age range.[6] By 17 years of age, 78 percent of children in the U.S. have experienced caries.[5] As much as 90 percent of all caries in school-aged children occurs in pits and fissures. Caries, periodontal diseases, and other oral conditions, if left untreated, can lead to pain, infection, and loss of function. These undesirable outcomes can adversely affect learning, communication, nutrition, and other activities necessary for normal growth and development.[8] Rampant caries is associated with insufficient development in children who have no other medical problems.[9](~~Acs et al 1992~~) Children with early childhood caries (**ECC**) may be severely underweight because of the associated pain and disinclination to eat. Nutritional deficiencies during childhood can impact cognitive development.[10,11]

Other oral conditions also can impact general health and well-being. Gingivitis is nearly universal in children and adolescents, and children can develop severe forms of periodontitis.[12](~~AAPerio 2003~~) There ~~exists~~ may exist a relationship between periodontal disease and cardiovascular disease[13-15] as well as periodontal disease and adverse pregnancy outcomes~~.~~,[16,17]including pregnancy hypertension.[18] An association between oral health and respiratory diseases has been recognized.[18,19] Oral health, oral microflora, and bacterial pneumonia, especially in populations at high risk for respiratory disease, have been linked. The mouth can harbor respiratory pathogens that may be aspirated, resulting in airway infections.[20]) Furthermore, dental plaque may serve as a reservoir for respiratory pathogens in patients who are undergoing mechanical ventilation.[21]. Problems of esthetics, form, and function can affect the developing psyche of children, with life-long consequences in social, educational, and occupational environments.[22,23] Self-image, self-esteem, and self-confidence are unavoidable issues in society, and an acceptable orofacial presentation is a necessary component of these psychological concepts.[24,25]

Congenital or acquired orofacial anomalies (e.g., ectodermal dysplasia, cleft defects, cysts, tumors) and malformed or missing teeth can have significant negative functional, esthetic, and psychological effects on individuals and their families.[26,27] Patients with craniofacial anomalies often require specialized oral health care as a direct result of their craniofacial condition. These services are an integral part of the rehabilitative process.[26] Young children benefit from esthetic and functional restorative or surgical techniques and readily adapt to appliances that replace missing teeth and improve function, appearance, and self-image. During the period of facial and oral growth, appliances require frequent adjustment and have to be remade as the individual grows.

Professional care is necessary to maintain oral health,[3,4] and risk assessment is an integral element of contemporary preventive care for infants, children, adolescents, and persons with special health care needs.[28] The goal of caries risk assessment is to prevent disease by identifying and minimizing causative factors (e.g., microbial burden, dietary habits, dental morphology) and optimizing protective factors (e.g., fluoride exposure, personal oral hygiene, sealants).[29,30] Ideally, risk assessment and implementation of preventive strategies would occur before the disease process has been initiated.

Infants and young children have unique caries-risk factors such as ongoing establishment of oral flora and host defense systems, susceptibility of newly erupted teeth, and development of dietary habits and childhood food preferences. Children are most likely to develop caries if mutans streptococci is acquired at an early age.[31-33] High-risk dietary practices are multi-factorial[34] and food preferences appear to be

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established early, probably by 12 months of age, and are maintained throughout early childhood.[35,36] Adolescence can be a time of heightened caries activity and periodontal disease due to an increased intake of cariogenic substances and inattention to oral hygiene procedures.[37-39]

An analysis of caries risk includes determination of protective factors, such as fluoride exposure. More than one-third of the U.S. population does not benefit from community water fluoridation.[3] Fluoride contributes to the prevention, inhibition, and reversal of caries.[40] Therefore, early determination of a child's systemic and topical fluoride exposure is important. Children experiencing caries as infants and toddlers have a much greater probability of subsequent caries in both the primary and permanent dentitions.[10] An individualized preventive plan based on a caries risk assessment is the key component of caries prevention. Because any risk assessment tool may fail to identify all infants at risk for developing ECC, early establishment of the dental home is the ideal approach for disease prevention.[41] Early diagnosis and timely intervention, including necessary referrals, can prevent the need for more extensive and expensive care often required when problems have gone unrecognized and/or untreated.[42-44]

When very young children have not been the beneficiaries of adequate preventive care and subsequently develop ECC, therapeutic intervention should be provided by a practitioner with the training, experience, and expertise to manage both the child and the disease process. Because of the aggressive nature of ECC, restorative treatment should be definitive yet specific for each individual patient. Conventional restorative approaches may not arrest the disease.[45] Areas of demineralization and hypoplasia can cavitate rapidly. The placement of stainless steel crowns may be necessary to decrease the number of tooth surfaces at risk for new or secondary caries. Stainless steel crowns are less likely than other restorations to require retreatment.[45,46] Low levels of compliance with follow-up care and a high recidivism rate of children requiring additional treatment also can influence a practitioner's decisions for management of ECC~~.~~[47] and may decrease success of a disease management approach to ECC.[48]

Sealants are particularly effective in preventing pit and fissure caries and providing cost savings if placed on the teeth of patients during periods of greatest risk.[49] Children with multiple risk factors and tooth morphology predisposed to plaque retention (i.e., developmental defects, pits and fissures) benefit from having such teeth sealed prophylactically. A child who receives sealants is 72 percent less likely to receive restorative services over the next three years than children who do not.[50] Sealant~~s~~ placement on primary molars in young children is a cost-effective strategy for children at risk for caries, including those insured by state Medicaid programs.[51,52] Although sealant retention rates initially are high, sealant loss

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does occur.[53] It is in the patient's interest to receive periodic evaluation of sealants. With follow-up care, the success rate of sealants may be 80 to 90 percent, even after a decade.[53]

Sealants are safe and effective, yet their use continues to be low.[53-55] Initial insurance coverage for sealants often is denied, and insurance coverage for repair and/or replacement may be limited.[55,56] While all Medicaid programs reimburse dentists for placement of sealants on permanent teeth, only one in three reimburses for primary molar sealants.[57] While some third party carriers restrict reimbursement for sealants to patients of certain ages, it is important to consider that timing of dental eruption can vary widely. Furthermore, caries risk may increase at any time during a patient's life due to changes in habits (e.g., dietary, home care), oral microflora, or physical condition, and previously unsealed teeth subsequently might benefit from sealant application.[53,58]

The extent of the disease process, as well as the patient's developmental level and comprehension skills, affect the practitioner's behavior guidance approaches. The success of restorations may be influenced by the child's response to the chosen behavior guidance technique. To perform treatment safely, effectively, and efficiently, the practitioner caring for a pediatric patient may employ advanced behavior guidance techniques such as protective stabilization and/or sedation or general anesthesia.[59,60] The patient's age, dental needs, disabilities, medical conditions, and/or acute situational anxiety may preclude the patient's being treated safely in a traditional outpatient setting.[61,62] For some infants, children, adolescents, and persons with special health care needs, treatment under sedation or general anesthesia in a hospital, outpatient facility, or dental office or clinic represents the only appropriate method to deliver necessary oral health care.[59,63] Failure by insurance companies to cover general anesthesia costs, hospital fees, and/or sedation costs can expose the patient to multiple ineffective, potentially unsafe and/or psychologically traumatic in-office experiences. The impact of chronic conditions (**CC**) status and CC severity increases the odds of receiving dental treatment under general anesthesia.[64] Although general anesthesia may provide optimal conditions to perform restorative procedures, it can add significantly to the cost of care.[65] General anesthesia may be required in the hospital setting due to the extent of treatment, the need to deliver timely care, or the patient's medical history/CC (such as cardiac defects, severe bleeding disorders, limited opening due to orofacial anomalies). General anesthesia, under certain circumstances, may offer a cost-saving alternative to sedation for children with ECC.[66,67]

Reimbursement issues defined by the concept of MNC have been a complicated topic for dentistry. Pediatric dental patients may be denied access to oral health care when insurance companies refuse to provide reimbursement for sedation/ general anesthesia and related facility services. Most denials cite the procedure as “not medically-necessary”.[68] This determination appears to be based on arbitrary and inconsistent criteria.[69-74] For instance, medical policies often provide reimbursement for sedation/general anesthesia or facility fees related to myringotomy for a three-year-old child, but deny these benefits when related to treatment of dental disease and/ or dental infection for the same patient. American Dental Association Resolution 1989-546 states that insurance companies should not deny benefits that would otherwise be payable “solely on the basis of the professional degree and licensure of the dentist or physician providing treatment, if that treatment is provided by a legally qualified dentist or physician operating within the scope of his or her training and licensure.”[74]

Patients with craniofacial anomalies often are denied third party coverage for initial appliance construction and, more frequently, replacement of appliances as the child grows. The distinction between congenital anomalies involving the orofacial complex and those involving other parts of the body is often arbitrary and unfair. Often medical insurance companies interpret dental appliance construction to be solely esthetic, without taking into consideration the restorative function. For instance, health care policies may provide reimbursement for the prosthesis required for a congenitally missing extremity and its replacement as the individual grows, but deny benefits for the initial prosthesis and necessary periodic replacement for congenitally missing teeth. Third-party payers frequently will refuse to pay for oral health care services even when they clearly are associated with the complete rehabilitation of the craniofacial condition.[75,76]

Policy statement

Dental care is medically-necessary to prevent and eliminate orofacial disease, infection, and pain, to restore the form and function of the dentition, and to correct facial disfiguration or dysfunction. MNC is based upon current preventive and therapeutic practice guidelines formulated by professional organizations with recognized clinical expertise. Expected benefits of MNC outweigh potential risks of treatment or no treatment. Early detection and management of oral conditions can improve a child’s oral health, general health and well-being, school readiness, and self-esteem. Early recognition, prevention, and intervention could result in savings of health care dollars for individuals, community health care programs, and third party payors. Because a child’s risk for developing dental disease can change over time, continual professional reevaluation and preventive maintenance are essential for good oral health. Value of services is an important consideration, and all stakeholders should recognize that cost-effective care is not necessarily the least expensive treatment.

The AAPD encourages:

1. Oral health care to be included in the design and provision of individual and community-based health care programs to achieve comprehensive health care.
2. Establishment of a dental home for all children by 12 months of age in order to institute an individualized preventive oral health program based upon each patient's unique caries risk assessment.
3. Healthcare providers who diagnose oral disease to either provide therapy or refer the patient to a primary care dentist or dental/medical specialist as dictated by the nature and complexity of the condition. Immediate intervention is necessary to prevent further dental destruction, as well as more widespread health problems.
4. Evaluation and care provided for an infant, child, or adolescent by a cleft lip/palate, orofacial, or craniofacial deformities team as the optimal way to coordinate and deliver such complex services.
5. The dentist providing oral health care for a patient to determine the medical indication and justification for treatment. The dental care provider must assess the patient's developmental level and comprehension skills, as well as the extent of the disease process, to determine the need for advanced behavior guidance techniques such as sedation or general anesthesia.

Furthermore, the AAPD encourages third party payors to:

1. Recognize malformed and missing teeth are resultant anomalies of facial development seen in orofacial anomalies and may be from congenital defects. Just as the congenital absence of other body parts requires care over the lifetime of the patient, so will these.
2. Include oral health care services related to these facial and dental anomalies as benefits of health insurance without discrimination between the medical and dental nature of the congenital defect. These services, optimally provided by the craniofacial team, include, but are not limited to, initial appliance construction, periodic examinations, and replacement of appliances.
3. End arbitrary and unfair refusal of compensation for oral health care services related to orofacial and dental anomalies.
4. Recognize the oral health benefits of dental sealants and not base coverage for sealants on permanent and primary teeth on a patient's age.
5. Ensure that all children have access to the full range of oral health delivery systems. If sedation or general anesthesia and related facility fees are payable benefits of a health care plan, these same benefits shall apply for the delivery of oral health services.

6. Regularly consult the AAPD with respect to the development of benefit plans that best serve the oral health interests of infants, children, adolescents, and persons with special health care needs, especially those with craniofacial or acquired orofacial anomalies.

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Policy on Workforce Issues and Delivery of Oral Health Care Services in a Dental Home

~~Originating Council~~

~~Council on Clinical Affairs~~

Review Council

Council on Clinical Affairs

~~Adopted~~

~~2011~~

Revised

~~2014,~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) advocates optimal oral health and health care services for all children, including those with special health care needs. Strategies for improving access to dental care, the most prevalent unmet health care need for disadvantaged U.S. children, and increasing utilization of available services should include, but not be limited to, workforce considerations. This policy will address workforce issues with an emphasis on the benefits of oral health care services delivered within a dentist-directed dental home.

Methods

In 2008, the AAPD created a Task Force on Workforce Issues (**TFWI**) which was charged, in part, with investigating the problem of access to oral health care services by children in the U.S. and analyzing the different auxiliary delivery systems available. The TFWI's findings and recommendations were summarized in a report[1] presented to the AAPD Board of Trustees in 2009. That report served~~s~~ as the basis for the original version of this policy,~~.~~ ~~This document was originally~~ developed by the Council on Clinical Affairs and adopted in 2011. This document is an update of the previous version, revised in 2014.

Background

Access to oral health care for children is an important concern that has received considerable attention since publication of Oral Health in America: A Report of the Surgeon General in 2000.[2] The report

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identified "profound and consequential disparities in the oral health of our citizens" and that dental disease "restricts activities in school, work, and home, and often significantly diminishes the quality of life." It concluded that for certain large groups of disadvantaged children there is a "silent epidemic" of dental disease. This report identified dental caries as the most common chronic disease of children in the U.S., noting that 80 percent of tooth decay is found in 20 to 25 percent of children, large portions of whom live in poverty or low-income households and lack access to an on-going source of quality dental care. ~~The latest~~ ~~r~~Research on the topic has shown that the distribution of these disparities may vary by age group.[3]

The mission of the AAPD~~, the membership organization representing the specialty of pediatric dentistry, is "to advocate policies, guidelines, and programs that promote optimal oral health and oral health care for infants and children through adolescence, including those with special health care needs."(AAPD Mission Statement)~~ is "to advance optimal oral health for all children by delivering outstanding service that meets and exceeds the needs and expectations of our members, partners, and stakeholders."[4] AAPD has long focused its efforts on addressing the disparities between children who are at risk of having high rates of dental caries and the millions of U.S. children who enjoy access to quality oral health care and unprecedented levels of oral health. AAPD's advocacy activities take place within the broader health care community and with the public at local, regional, and national levels. Access to care issues extend beyond a shortage or maldistribution of dentists or, more specifically, dentists who treat Medicaid or State Children's Health Insurance Program (**CHIP**) recipients. Health care professionals often elect to not participate as providers in these programs due to low reimbursement rates, administrative burdens, and the frequency of failed appointments by patients whose treatment is publicly funded.[5-8] Nevertheless, American Dental Association (**ADA**) survey data reveals that pediatric dentists report the highest percentage of patients insured through public assistance among all dentists.[9] Medicaid-enrolled children living in areas with more pediatric dentists are more likely to utilize preventive dental care.[10] However, ~~Especially~~ when considering the disincentives of participating as Medicaid/CHIP providers, more dentists and/or non-dentist oral health care providers cannot be considered the panacea for oral health disparities.

Inequities in oral health can result from underutilization of services. Lack of health literacy, limited English proficiency, and cultural and societal barriers can lead to difficulties in utilizing available services. Financial circumstances ~~and~~ as well as geographic~~al~~ and ~~/~~transportation~~al~~ considerations also can impede

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access to care. Eliminating such barriers will require a collaborative, multi-faceted approach.[11,12] Systematic policy and environmental changes that improve living conditions and alleviate poverty are needed to directly address the social determinants of health.[13] All the while, stakeholders must promote education and primary prevention so that disease levels and the need for therapeutic services decrease.

All AAPD advocacy efforts are based upon the organization's ~~core values (AAPD Core Values)~~ strategic objectives.[4] ~~which include:~~

1. ~~Health and health care equity.~~
2. ~~An effective dental workforce.~~
3. ~~Effective public programs.~~
4. ~~Oral health promotion.~~
5. ~~Child and adolescent welfare.~~
6. ~~Science, education, research, and evidence-based care.~~

A major component of AAPD's advocacy efforts is development of oral health policies, ~~and evidence-based~~ clinical practice guidelines, and best practices that promote access to and delivery of safe, high quality comprehensive oral health care for all children, including those with special health care needs, within a dental home. A dental home is the ongoing relationship between the dentist and the patient, inclusive of all aspects of oral health care delivery, in a comprehensive, continuously accessible, coordinated, and family-centered way.[14] Such care takes into consideration the patient's age, developmental status, and psychosocial well-being and is appropriate to the needs of the child and family. This concept of a dental home was detailed in a 2001 AAPD oral health policy[15] and is derived from the American Academy of Pediatrics' (**AAP**) model of a medical home.[16,17] ~~Children who have a dental home are more likely to receive appropriate preventive and therapeutic oral health care.~~ The AAPD, AAP, ADA, and Academy of General Dentistry support the establishment of a dental home as early as six months of age and no later than 12 months of age.[15,17-19] This provides time-critical opportunities to provide education on preventive health practices and reduce a child's risk of preventable dental/oral disease when delivered within the context of an ongoing relationship. Prevention can be customized to an individual child's and/or family's risk factors. Growing evidence supports the effectiveness of early ~~establishment of a~~ dental ~~home~~ visits in reducing ~~early childhood~~ caries.[21-22] Each child's dental home should include the capacity to refer to other dentists or medical

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care providers when all medically necessary care cannot be provided within the dental home. The AAPD strongly believes a dental home is essential for ensuring optimal oral health for all children.[23]

Central to the dental home model is dentist-directed care. The dentist performs the examination, diagnoses oral conditions, and establishes a treatment plan that includes preventive services, and all services are carried out under the dentist's supervision. The dental home delivery model implies direct supervision (i.e., physical presence during the provision of care) of allied dental personnel by the dentist. The allied dental personnel [e.g., dental hygienist, expanded function dental assistant/auxiliary (**EFDA**), dental assistant] work under direct supervision of the dentist to increase productivity and efficiency while preserving quality of care. This model also allows for provision of preventive oral health education ~~by EFDAs~~ and preventive oral health services by ~~a dental hygienist~~ allied dental personnel under general supervision (i.e., without the presence of the supervising dentist in the treatment facility) following the examination, diagnosis, and treatment plan by the licensed, supervising dentist. Furthermore, the dental team can be expanded to include auxiliaries who go into the community to provide education and coordination of oral health services. Utilizing allied personnel to improve oral health literacy could decrease individuals' risk for oral diseases and mitigate a later need for more extensive and expensive therapeutic services.

In addition to ~~promoting quality~~ advancing optimal oral health ~~care~~ for all children ~~through its~~ by developing policies and guidelines, AAPD advocacy efforts, in part, include:

1. ~~Improving perinatal and infant oral health by training pediatric and general dentists to perform infant oral health examinations.~~ Working closely with legislators, professional associations and health care professionals to implement research opportunities in pediatric oral health and educate pediatric dentists, health care providers and the public regarding pediatric oral health.
2. ~~Representing pediatric dentists on an advisory committee to the Bureau of Health Professions, promoting~~ Convening an annual Advocacy Conference in Washington, D.C. to advocate for funding for pediatric and general dentistry residency programs and faculty loan repayment.

~~3. Conducting annual workshops which train pediatric dentists from across the country to educate legislators on strategies to improve access to pediatric dental care.~~

~~4.~~3. Working with the ADA to identify non-financial barriers to oral health care and develop recommendations to improve access to care for Medicaid recipients.[24,25]

~~5.~~4. Partnering with federally funded agencies to develop strategies to improve children's oral health.[26]

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~~6.~~5. ~~Utilizing a Task Force on Workforce Issues (2008-2009) to examine the~~ Investigating various non-dentist (also known as mid-level) provider models that exist and/or are being proposed to address the access to care issues.[27]

The AAPD ~~Task Force~~ TFWI reported that a number of provider models to improve access to care for disadvantaged children have been proposed and, in some cases, implemented following the Surgeon General's report.[1] At the heart of the issue with each non-dentist provider proposal is ensuring ongoing access to dental care for the underserved. Therefore, practice location and retention of independent non-dentist providers are important considerations. When providers are government employees (e.g, Indian Health Services, National Health Services Corps), they are assigned to high-need areas. ~~assignment to areas of greatest need is possible~~. The dental therapy model has been shown to improve use of dental care services in Alaska.[28,29] However, the current U.S. proposed models are private practice/non-government employee models, providing no assurances that independent providers will locate in underserved areas. Recent case studies of private practices in Minnesota describe the impact of dental therapists on production. Their findings suggest that while a therapist joining a dentist in a located practice may increase the dentist's efficiency, it does not expand geographic access to dental care characteristic of the Alaska initiative or of the international model of therapists.[30-32] Moreover, evidence from several developed countries that have initiated mid-level provider programs suggests that, when afforded an opportunity, those practitioners often gravitate toward private practice settings ~~in less-remote areas,~~ thereby diminishing the impact on care for the underserved.[33]

In all existing and proposed non-dentist provider models, the clinician receives abbreviated levels of education compared to the educational requirements of a dentist. For example, the dental health aid therapist model in Alaska is a two-year certificate program with a pre-requisite high school education,[34,35] ~~the educational requirement for licensure as a dental therapist in Minnesota is a baccalaureate from a dental therapy program (Minnesota 2008), and proposed legislation for dental therapists in Vermont requires a two year curriculum including at least 100 hours of dental therapy clinical practice under the general supervision of a licensed dentist (Vermont 2011).~~ The level of educational training varies from state to state,[36-38] and none of the current programs are approved by CODA. In contrast, b~~B~~uilding on their college education, dental students generally spend four years learning the biological principles, diagnostic skills, and clinical techniques to distinguish between health and disease and to manage oral conditions while taking into consideration a patient's general health and well-being. The clinical care they provide during their doctoral education is under direct supervision. Those who specialize in pediatric dentistry must spend an additional 24 or more months in a full time post-doctoral program that provides advanced didactic and clinical experiences.[39] The skills that pediatric dentists develop are applied to the needs of children through their ever-changing stages of dental, physical, and psychosocial development, treating conditions and diseases unique to growing individuals.

While most pediatric dental patients can be managed effectively using communicative behavioral guidance techniques, many of the disadvantaged children who exhibit the greatest levels of dental disease require advanced techniques (e.g., sedation, general anesthesia).[40,41] Successful behavior guidance enables the oral health team to perform quality treatment safely and efficiently and to nurture a positive dental attitude in the pediatric patient.[42] Accurate diagnosis of behavior and safe and effective implementation of advanced behavior guidance techniques necessitate specialized knowledge and experience.

Studies addressing the technical quality of restorative procedures performed by non-dentist providers have found, in general, that within the scope of services and circumstances to which their practices are limited, the technical quality is comparable to that produced by dentists.[43,44] There is, however, no evidence to suggest that they deliver any expertise comparable to a dentist in the fields of diagnosis, pathology, trauma care, pharmacology, behavioral guidance, treatment plan development, and care of patients with special health care needs ~~patients~~. It is essential that policy makers recognize that evaluations which demonstrate comparable levels of technical quality merely indicate that individuals know how to provide certain limited services, not that those providers have the knowledge and experience necessary to determine whether and when various procedures should be performed or to manage individuals' comprehensive oral health care, especially with concurrent conditions that may complicate treatment or have implications for overall health. Technical competence cannot be equated with long-term outcomes.

The AAPD continues to work diligently to ensure that the dental home is recognized as the foundation for delivering oral health care of the highest quality to infants, children, and adolescents, including those with special health care needs. The AAPD envisions that many new and varied delivery models will be proposed to meet increasing demands on the infrastructure of existing oral health care services in the U.S.. New Zealand, known for utilizing dental therapists since the 1920s

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and frequently referenced as a workforce model for consideration in the U.S., ~~recently completed its first nationwide oral health status survey in over 20 years.~~ makes ~~D~~dental care ~~is~~ available at no cost for children up to 18 years of age, with most public primary schools having a dental clinic and many regions operating mobile clinics.[45] In New Zealand's most recent nationwide oral health status survey, ~~O~~overall, one in two children ~~in New Zealand~~ aged two–17 years was caries-free. The caries rate for five-year-olds and eight-year-olds in 2009 was 44.4 percent and 47.9 percent respectively.[46] These caries rates, which are higher than the U.S., United Kingdom, and Australia, help refute a presumption that utilization of non-dentist providers will overcome the disparities.

As technology continues to improve, proposed models may suggest dentist supervision of services outside the primary practice location via electronic communicative means to be comparable in safety and effectiveness to services provided under direct supervision by a dentist. Health care already has witnessed benefits of electronic communications in diagnostic radiology and other consultative services. The AAPD encourages exploration of new models of dentist-directed health care services that will increase access to care for underserved populations. But as witnessed through the New Zealand oral health survey, a multi-faceted approach will be necessary to improve the oral health status of our nation's children.

Policy statement

The American Academy of Pediatric Dentistry remains committed in its ~~core values~~ vision and mission to address the disparities between children who lack access to quality oral health care and those who benefit from such services. AAPD believes that all infants, children, and adolescents, including those with special health care needs, deserve access to high quality comprehensive preventive and therapeutic oral health care services provided through a dentist-directed dental home. In the delivery of all dental care, patient safety must be of paramount concern.

AAPD encourages the greater use of expanded function dental assistants/auxiliaries and dental hygienists under direct supervision by a dentist to help increase volume of services provided within a dental home, based upon their proven effectiveness and efficiency in a wide range of settings.[44-50] The AAPD also supports provision of preventive oral health services by a dental hygienist under general supervision (i.e., without the presence of the supervising dentist in the treatment facility) following the examination, diagnosis, and treatment plan by the licensed, supervising dentist. Similarly, partnering with other health providers, especially those who most often see children during

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the first years of life (e.g., pediatricians, family physicians, pediatric nurses), will expand efforts for improving children's oral health.

The AAPD strongly believes there should not be a two-tiered standard of care, with our nation's most vulnerable children receiving services by providers with less education and experience~~, especially when evidence-based research to support the safety, efficiency, effectiveness, and sustainability of such delivery models is not available~~.

AAPD will continue its efforts to:

1. Educate families, health care providers, academicians, community leaders, and partnered governmental agencies on the benefits of early establishment of a dental home.
2. Forge alliances with legislative leaders that will advance the dental home concept and improve funding for delivery of oral health care services and dental education.
3. Expand public-private partnerships to improve the oral health of children who suffer disproportionately from oral diseases.
4. Encourage recruitment of qualified students from rural areas and underrepresented minorities into the dental profession.
5. Partner with other dental and medical organizations to study barriers to care and underutilization of available services.
6. Support scientific research on safe, efficacious, and sustainable models of delivery of dentist-directed pediatric oral health care that is consistent with AAPD's oral health policies and ~~clinical~~ practice ~~guidelines~~ <u>recommendations</u>.

Furthermore, AAPD encourages researchers and policy makers to consult with AAPD and its state units in the development of pilot programs and policies that have potential for significant impact in the delivery of oral health care services for our nation's children.

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Policy on School Absences for Dental Appointments*

Review Council

Council on Clinical Affairs

Latest ~~Revision~~ Reaffirmation

~~2015~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes dental care is medically necessary and that poor oral health can negatively affect a child's ability to learn. This policy is intended to assist public health and school education administrators in developing enlightened policies on school absence for dental appointments and support parents in seeking medically necessary care for their children.

Methods

This policy was originally developed by the Council on Clinical Affairs and adopted in 2010. This document is a reaffirmation of the previous version, revised in 2015. An electronic database search was conducted using the terms: school absences for dental appointments, excused school absences, and department of education. Papers for review were chosen from this list and from references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based on expert and/or consensus opinion by experienced researchers and clinicians. It is beyond the scope of this document to review every state statute and regulation on absences from school for dental appointments.

Background

Oral health is integral to general health. Many systemic diseases and conditions have oral manifestations. These oral manifestations may be the initial sign of clinical disease and indicate the need for further assessment.[1] Oral conditions can interfere with eating and adequate nutritional intake, speaking, self-esteem, daily activities, and quality of life.[2] Dental care is medically necessary to prevent and eliminate orofacial disease, infection, and pain. It is also important to restore the form and function of the dentition and correct facial disfiguration or dysfunction.[3] The public's lack of awareness of the importance of oral health is a major barrier to dental care.[1] Unrecognized disease and postponed care result in exacerbated

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* ABBREVIATION
AAPD: American Academy Pediatric Dentistry.

problems, which lead to more extensive and costly treatment needs.[3]

The National Association of State Boards of Education recognizes, "Health and success in schools are interrelated. Schools cannot achieve their primary mission of education if students and staff are not healthy and fit physically, mentally, and socially".[4] Children and adolescents with poorer oral health status are more likely to experience oral pain, miss school, and perform poorly in school compared with their counterparts with better oral health status.[5] Children with dental pain may be irritable, withdrawn, or unable to concentrate. Pain can affect test performance as well as school attendance.[1,6] Left untreated, the pain and infection caused by tooth decay can lead to problems in eating, speaking, and learning.[7]

The social impact of oral disease in children is substantial. More than 51 million school hours are lost each year to dental related illness.[1] On average, children and adolescents with oral health problems are absent one school day per year more than other children or adolescents.[8] When these problems are treated and children no longer are experiencing pain, their learning and school attendance improve.[2]

According to the U.S. Surgeon General, "a national public health plan for oral health does not exist".[1] This corresponds with the fact that there is no national policy on excused absences from school for dental appointments. Some states (e.g., California, Texas) have very specific laws excusing students for dental appointments.[9,10] Other state laws are more general and recognize absences due to doctor's appointments or illness.[11,12]

Policy statement

Dental care is medically necessary and oral health is integral to general health. Undiagnosed and untreated oral conditions may interfere with a child's ability to eat, sleep, or function well at home or at school due to discomfort or pain. The unaesthetic nature of caries and dental malocclusion may compromise a child's self-esteem and social development. Schools' policies that prevent or discourage legitimate school absence for the purpose of delivery of vital health care services may cause harm to their students.

Children who have their dental conditions corrected improve learning and attendance in school. State laws and local school district policies are not uniform on absences from school for dental appointments. A uniform policy that recognizes the negative effect of chronic truancy on academic performance would be useful. Such policies should not restrict necessary health care delivery.

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The AAPD supports state law or school policy that allows the absence for legitimate health care delivery, including that of oral health services, and encourages parents, school administrators, and dentists to work together to ensure that children receive dental care while minimizing school absences.

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[Best Practices]

Antibiotic Prophylaxis for Dental Patients at Risk for Infection*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that numerous medical conditions predispose patients to bacteremia-induced infections. Because it is not possible to predict when a susceptible patient will develop an infection, prophylactic antibiotics are recommended when these patients undergo procedures that are at risk for producing bacteremia. This guideline is intended to help practitioners make decisions regarding antibiotic prophylaxis for dental patients at risk.

Methods

This guideline was originally developed by the Council on Clinical Affairs and adopted in 1990. This document is a revision of the previous version, last revised in ~~2011~~2014, and based on a review of current dental and medical literature pertaining to post procedural bacteremia-induced infections. This document included database searches using key terms: infective endocarditis (**IE**), bacteremia, antibiotic prophylaxis, and dental infection. Articles were evaluated by title and/or abs~~-~~tract and relevance to dental care for children, adolescents, and those with special health care needs. Thirty-one citations were chosen from this method and from references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians. In addition, "Prevention of infective endocarditis: Guidelines from the American Heart Association,"[1,2] "Infective Endocarditis in Childhood: 2015 Update: A Scientific Statement From the American Heart Association,"[3] and the ADA report on "The use of prophylactic antibiotics prior to dental procedures in patients with

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* **ABBREVIATIONS**
~~**AAOS**: American Academy of Orthopedic Surgeons~~. **AAPD**: American Academy Pediatric Dentistry. **ADA**: American Dental Association. **AHA**: American Heart Association. **CHD**: Congenital heart disease. **CIED**: Cardiovascular implantable electronic device. **IE**: Infective endocarditis.

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prosthetic joints"[4] ~~"Prevention of orthopedic implant infection in patients undergoing dental procedures: Guidelines from the American Academy of Orthopedic Surgeons (**AAOS**) and American Dental Association (**ADA**)"(Watters et al 2013, AAOS 2013)~~ were reviewed.

Background

Bacteremia, bacteria in the bloodstream, is anticipated following invasive dental procedures and can lead to complications in an immunodeficient patient.[5,6] Patients with high risk cardiac disease, immunosuppression and immunodeficiencies may compromise one's ability to fight simple infection. The rationale for antibiotic prophylaxis was to reduce or eliminate transient bacteremia caused by invasive dental procedures.[7] ~~Infective endocarditis is an uncommon but life-threatening complication resulting from bacteremia. The incidence of infections such as IE ranges from 5.0 to 7.9 per 100,000 person-years with a significant increasing trend among women.(de Sa et al 2010) Only a limited number of bacterial species have been implicated in resultant postoperative infections. Viridans group streptococci, *Staphylococcus aureus*, enterococcus, pseudomonas, serratia, and candida are some of the microorganisms implicated with IE.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation) The vast majority of cases of IE caused by oral microflora can result from bacteremia associated with routine daily activities such as toothbrushing, flossing, and chewing.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation) However, antibiotic~~ Antibiotic ~~prophylaxis is recommended with certain dental procedures.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation, Lockhart et al 2004, Roberts et al 2006) An effective antibiotic regimen should be directed against the most likely infecting organism, with antibiotics administered shortly before the procedure. When procedures involve infected tissues or are performed on a patient with a compromised host response, additional doses or a prescribed postoperative regimen of antibiotics may be necessary.~~

Antibiotic usage may result in the development of resistant organisms.[1,2,5,6,8-10] Utilization of antibiotic prophylaxis for patients at risk does not provide absolute prevention of infection. Post-procedural symptoms of acute infection (e.g., fever, malaise, weakness, lethargy) may indicate antibiotic failure and need for further medical evaluation.

The decision to use antibiotic prophylaxis should be made on an individual basis. Some medical conditions that may predispose patients to post-procedural infections are discussed below. This is not intended to be an exhaustive list; rather, the categorization should help practitioners identify children who may be at increased risk. If a patient reports a syndrome or medical condition with which the practitioner is not familiar, it is appropriate to contact the child's physician to determine susceptibility to bacteremia-induced infections.

~~In 2007, the American Heart Association (**AHA**) released its newly revised guidelines for the prevention of IE and reducing the risk for producing resistant strains of bacteria.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation) The AAPD, acknowledging the AHA's expertise and efforts to produce evidenced-based recommendations, continues to endorse the AHA guideline for antibiotic prophylaxis, entitled "Prevention of Infective Endocarditis".~~

~~The significant reasons for the revision include (Wilson et al 2007-JADA, Wilson et al 2007-Circulation):~~

- ~~"IE is much more likely to result from frequent exposure to random bacteremias associated with daily activities than from bacteremia caused by a dental, GI tract, or GU tract procedure." (Wilson et al 2007-JADA) (Daily activities would include toothbrushing, flossing, chewing, using toothpicks, using water irrigation devices, and other activities.)~~
- ~~"Prophylaxis may prevent an exceedingly small number of cases of IE if any, in individuals who undergo a dental, GI tract, or GU tract procedure.~~
- ~~The risk of antibiotic-associated adverse events exceeds the benefit, if any, from prophylactic antibiotic therapy.~~
- ~~Maintenance of optimal oral health and hygiene may reduce the incidence of bacteremia from daily activities and is more important than prophylactic antibiotics for a dental procedure to reduce the risk of IE." (Wilson et al 2007-JADA)~~

~~The 2007 AHA revision was intended to clarify when antibiotic prophylaxis is/is not recommended and to provide more uniform global recommendations. Major changes from the 1997 version (Wilson et al 2007-JADA, Wilson et al 2007-Circulation, Dajani et al 1997) include:~~

- ~~"The Committee concluded that only an extremely small number of cases of infective endocarditis might be prevented by antibiotic prophylaxis for dental procedures even if such prophylactic therapy were 100 percent effective.~~
- ~~Infective endocarditis prophylaxis for dental procedures is reasonable only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from infective endocarditis.~~

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- ~~For patients with these underlying cardiac conditions, prophylaxis is reasonable for all dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa.~~
- ~~Prophylaxis is not recommended based solely on an increased lifetime risk of acquisition of infective endocarditis." (Wilson et al 2007 JADA)~~

~~Recommendations~~

To date, the evidence base supporting the efficacy and use of antibiotic prophylaxis is limited, especially in the pediatric population. Many of the indications are based on consensus.[3,11-13] The conservative use of antibiotics is indicated to minimize the risk of developing resistance to current antibiotic regimens.[1,2,8,14,15] Given the increasing number of organisms that have developed resistance to current antibiotic regimens, as well as the potential for an adverse anaphylactic reaction to the drug administered, it is best to be judicious in the use of antibiotics for the prevention of IE[1,2] ~~and~~ or other distant-site infections.[8.,10,16]

Recommendations

Antibiotic prophylaxis is recommended with certain dental procedures[1-3,5,7,17] but this should be directed against the most likely infecting organism. When procedures involve infected tissues or are performed on a patient with a compromised host response, additional doses or a prescribed pre- and postoperative regimen of antibiotics may be necessary. Emphasis should be placed on the prevention of disease, establishment of good oral health care habits and routine oral health assessments through a dental home. ~~to~~ This may prevent the frequent need for the use of antibiotic therapy and, thus, decrease the risks of resistance and adverse events relation to its use.[7,18,19]

Patients with cardiac conditions

Infective endocarditis is an example of an uncommon but life-threatening complication resulting from bacteremia. The incidence pediatric admissions due to infective endocarditis was between 0.5 and 0.12 cases per 1000 admissions from 2003-2010.[3] Only a limited number of bacterial species have been implicated in resultant postoperative infections. Viridans group streptococci, *Staphylococcus aureus*, *Enterococcus* species are the main microorganisms implicated in IE.[1-3] Enterococcal and other organisms such as *Haemophilus* species, Aggregatibacter species, *Cardiobacterium hominis,*

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Eikenella corrodens and *Kingella* species are less common.[3] Routine daily activities such as toothbrushing, flossing, and chewing contribute more to the incidence of bacteremia when compared to dental procedures.[1,2] There has been a shift of focus from antibiotic prophylaxis to an emphasis on oral hygiene and the prevention of oral diseases.[3,7,12,13,17,19]

In 2007, the American Heart Association (**AHA**) revised its guidelines for the prevention of IE and reducing the risk for producing resistant strains of bacteria.[1,2] The significant reasons for the revision include:[1,2]

- "IE is much more likely to result from frequent exposure to random bacteremias associated with daily activities than from bacteremia caused by a dental, GI tract, or GU tract procedure."[1] (Daily activities would include toothbrushing, flossing, chewing, using toothpicks, using water irrigation devices, and other activities.)
- Prophylaxis may prevent an exceedingly small number of cases of IE if any, in individuals who undergo a dental, GI tract, or GU tract procedure.
- The risk of antibiotic-associated adverse events exceeds the benefit, if any, from prophylactic antibiotic therapy.
- Maintenance of optimal oral health and hygiene may reduce the incidence of bacteremia from daily activities and is more important than prophylactic antibiotics for a dental procedure to reduce the risk of IE."[1]

The AHA guidelines focus on antibiotic prophylaxis prior to certain dental procedures for patients in the highest risk group (See Table 1).[1-3,5] Globally, there is still a lack of consensus with regards to the benefit of antibiotic prophylaxis for prevention of infective endocarditis. Since the change in recommendations, the rate and incidence of IE has been low.[3]

The AHA recommends that children with cyanosis with specific periodontal concerns may have an increased risk of IE, which makes optimum oral hygiene very important. ~~Dental practitioners should consider prophylactic measures to minimize the risk of IE in patients with underlying cardiac conditions. The risk of developing IE can arise from a combination of high-risk patients and dental procedures. However, at~~At-risk patients with poor oral hygiene and gingival bleeding after routine activities (e.g., toothbrushing) also have shown an increased incidence of bacteremia as a measure for risk ~~potential for developing complications~~ of IE.[1,2, 21,22]The focus should be on maintaining good oral hygiene, routine dental ~~reviews~~ examinations, infection control to reduce bacteremia and

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discouraging tattooing or piercing rather than relying on antibiotic prophylaxis for patients at risk.[12,13,17-19,22] ~~It, therefore, is recommended to encourage daily good oral hygiene practices to reduce gingivitis as part of the prophylactic regimen.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation, Lockhart et al 2009, Lockhart et al 2008)~~ These patients and~~/or~~ their parents need to be educated and motivated to maintain personal oral hygiene through daily plaque removal, including flossing.[1,2] ~~Greater~~ There is a shift in the emphasis ~~should be placed~~ on improved access to dental care and oral health in patients with underlying cardiac conditions at high risk for IE and less of a focus on a dental procedure and antibiotic coverage.[3] Professional prevention strategies should be based upon the individual's assessed risk for caries and periodontal disease.

~~Specific recommendations from the 2007 AHA guideline on prevention of IE are included in the following tables. The AHA recommends antibiotic prophylaxis only for those whose underlying cardiac conditions are associated with the highest risk of adverse outcome (Wilson et al 2007-JADA, Wilson et al 2007-Circulation) (see Table 1). Such conditions include prosthetic heart valves or prosthetic material used for cardiac valve repair, a previous history of IE unrepaired or incompletely repaired cyanotic congenital heart disease (**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 six months after the procedure, and repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or device, and cardiac transplantation recipients who develop cardiac valvulopathy such as valve regurgitation due to a structurally abnormal valve.(Wilson et al 2007-JADA, Wilson et al 2007-Circulation, Nishimura et al 2008)~~

~~After the 2007 AHA revised guidelines were published, there were concerns by healthcare providers that there may be an increase in cases of viridans group streptococci IE due to the decrease in the numbers of patients requiring antibiotic prophylactic coverage for dental procedures.(DeSimone et al 2012) A population based review of definitive and possible cases of IE demonstrated no observed increase in viridans group streptococci IE after publication of the 2007 AHA endocarditis prevention guidelines.(DeSimone et al 2012)~~ In addition to those diagnoses listed in the AHA guidelines, patients with a reported history of injection drug use may be considered at risk for developing IE in the absence of cardiac anomalies.[21] Patients should also be discouraged from tattooing and piercing.[12,13,23] ~~Although quite rare, complications from intraoral tongue piercing can include IE among patients with a pre-existing cardiac valvular condition and/or history of injection drug use.(Lick et al 2005, Akhondi and Rahimi 2002, Tronel et al 2001)~~ Consultation with the patient's physician may be necessary to determine susceptibility to bacteremia-induced infections. *Antibiotics are recommended for all dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa for cardiac patients with the highest risk[1,2] (see Table 1 and 2). Specific antibiotic regimens can be found in Table 3. Practitioners and patients/ parents can review the entire AHA guidelines in the AHA Circulation Journal archives, “http://circ.ahajournals.org/cgi/ content/full/116/15/1736” for additional background information as well as discussion of special circumstances (e.g., patients already receiving antibiotic therapy, patients on anti-coagulant therapy).

Patients with compromised immunity

~~Patients with a compromised immune system may not be able to tolerate a transient bacteremia following invasive dental procedures.(Lockhart et al 2007) These non-cardiac factors can place a patient with compromised immunity at risk for distant-site infection from a dental procedure.(Lockhart et al 2007)~~ Non-cardiac patients with a compromised immune system may be at risk for complications of bacteremia and distant site infection following invasive dental procedures). Existing evidence does not support the extensive use of antibiotic prophylaxis and should only be limited to immunocompromised patients or those at high risk.[18] Consultation with the patient’s physician is recommended for management of patients with a compromised immune system. ~~This category~~ Although there is not enough data to support its use, high risk patients who should be considered for use of prophylaxis includes, but is not limited to, patients with the following medical conditions:[12,13,24]

1. Immunosuppression secondary to:
    a. human immunodeficiency virus (HIV);
    b. severe combined immunodeficiency (SCIDS);
    c. neutropenia;
    d. cancer chemotherapy; and
    e. hematopoietic stem cell or solid organ transplantation.
2. Head and neck radiotherapy.
3. Autoimmune disease (e.g., juvenile arthritis, systemic lupus erythematosus).
4. Sickle cell anemia.[25]
5. Asplenism or status post splenectomy.
6. Chronic high dose steroid usage.
7. Diabetes mellitus.

8. Bisphosphenate therapy.[26,27]
9. <u>Hemodialysis</u>

~~Consultation with the child's physician is recommended for management of patients with a compromised immune system.~~ Discussion of antibiotic prophylaxis for patients undergoing chemotherapy, irradiation, and hematopoietic cell transplantation appears in a separate AAPD guideline.[28]

Patients with shunts, indwelling vascular catheters, or medical devices

The AHA recommends that antibiotic prophylaxis for non-valvular devices, including indwelling vascular catheters (e.g., central lines) and cardiovascular implantable electronic devices (**CIED**), is indicated only at the time of placement of these devices in order to prevent surgical site infection.[22,24,29] The AHA found no convincing evidence that microorganisms associated with dental procedures cause infection of CIED and nonvalvular devices at any time after implantation.[22,24,29] The infections occurring after device implantation most often are caused by *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.[22,29,30] ~~The AHA further states that immunosuppression is not an independent risk factor for nonvalvular device infections; immunocompromised hosts who have those devices should receive antibiotic prophylaxis as advocated for immunocompetent hosts.(Lockhart et al 2007, Baddour et al 2003, Baddour et al 2010, Baddour et al 2011)~~Consultation with the child's physician is recommended for management of patients with nonvalvular devices.

Ventriculoatrial (VA), ventriculocardiac (VC), or ventriculovenus (VV) shunts for hydrocephalus are at risk of bacteremia-induced infections due to their vascular access.[24,31] In contrast, ventriculoperitoneal (VP) shunts do not involve any vascular structures and, consequently, do not require antibiotic prophylaxis.[24,31] Consultation with the child's physician is recommended for management of patients with vascular shunts.

Patients with prosthetic joints

For patients with a history of total joint arthroplasty, deep hematogenous infections can lead to life threatening complications such as a loss of the prosthetic joint or even increased morbidity and mortality.[32,33] <u>There is not enough evidence to demonstrate an association between dental procedures and prosthetic joint infection. Antibiotic prophylaxis has not shown a significant reduction in the risk</u>

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of developing joint infections subsequent to dental procedures.[32,34] Given the increasing risk in antibiotic resistance and adverse reactions, antibiotic prophylaxis prior to dental procedures is not recommended in the prevention of prosthetic joint infections.[4,7] ~~A 2012 information statement published by the AAOS recommends that dentists consider antibiotic prophylaxis for at-risk joint replacement patients who are undergoing an invasive procedure.(AAOS-Guideline on prevention of orthopaedic implant infection) Patients with an increased risk of hematogenous total joint infection are all patients with a prosthetic joint replacement, previous prosthetic joint infection, inflammatory arthropathies (e.g., rheumatoid arthritis, systemic lupus erythematosus), megaprosthesis, hemophilia, malnourishment, and compromised immunity (see examples in previous section).(AAOS-Guideline on prevention of orthopaedic implant infection) However, AAOS states that clinical judgment must consider the potential benefit of antibiotic prophylaxis versus the risks of adverse reactions for each patient.(Watters et al 2013, AAOS 2013, AAOS-Guideline on prevention of orthopaedic implant infection) The AAPD recognizes recommendations from AAOS and the ADA with regards to antibiotic prophylaxis for patients with joint replacement. A joint collaboration of the AAOS and the ADA developed evidence based recommendations on antibiotic prophylaxis for patients at a high risk for implant infection undergoing dental procedures (Table 4). (Watters et al 2013, AAOS 2013, AAOS-Guideline on prevention of orthopaedic implant infection)~~

~~Currently, the AAPD endorses the 2012 recommendations of the ADA and the AAOS for management of patients with prosthetic joints.(Watters et al 2013, AAOS 2013, AAOS-Guideline on prevention of orthopaedic implant infection) Antibiotic prophylaxis has not shown a significant reduction in the risk of developing joint infections subsequent to dental procedures.(Aminoshariae and Kulild 2010, Berbari et al 2010) Therefore, antibiotic prophylaxis is not indicated for dental patients with pins, plates, screws, or other hardware that is not within a synovial joint nor is it indicated routinely for most dental patients with total joint replacements.(AAOS-Guideline on prevention of orthopaedic implant infection, Little et al 2010)~~

Consultation with the child's physician may be necessary for management of at-risk patients as well as patients with other implanted devices (e.g., Harrington rods, external fixation devices).[24,32-35]

~~**Acceptance by dental practitioners of AHA guidelines for antibiotic prophylaxis**~~

~~The revised 2007 AHA guidelines provided a significant reduction in patients requiring antibiotic prophylaxis prior to invasive dental procedures. In a survey sent to US dentists, 71 percent of the~~

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~~respondents reported they were satisfied with the current guidelines.(Lockhart et al 2013) The survey also demonstrated that 70 percent of the dentists reported a majority of patients previously receiving antibiotic prophylaxis no longer required prophylaxis.(Lockhart et al 2013) However, the same percentage of respondents also indicated that a significant number of these patients were still receiving antibiotic prophylaxis regardless of the AHA revised guidelines.(Lockhart et al 2013)~~

Table 1. CARDIAC CONDITIONS ASSOCIATED WITH THE HIGHEST RISK OF ADVERSE OUTCOME FROM ENDOCARDITIS FOR WHICH PROPHYLAXIS WITH DENTAL PROCEDURES IS REASONABLE
Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
Previous infective endocarditis
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 six 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

* Except for the conditions listed above, antibiotic prophylaxis is no longer recommended for any other form of CHD.
† Prophylaxis is reasonable because endothelialization of prosthetic material occurs within six months after the procedure.

Reprinted with permission. Circulation. 2007;116:1736-1754. ©2007, American Heart Association, Inc.[2]

Table 2. DENTAL PROCEDURES FOR WHICH ENDOCARDITIS PROPHYLAXIS IS REASONABLE FOR PATIENTS IN TABLE 1
All dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa**
** The following procedures and events do not need prophylaxis: routine anesthetic injections through non-infected tissue, taking dental radiographs, placement of removable prosthodontic or orthodontic appliances, adjustment of orthodontic appliances, placement of orthodontic brackets, shedding of deciduous teeth, and bleeding from trauma to the lips or oral mucosa.

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Table 3. REGIMENS FOR A DENTAL PROCEDURE

	Regimen: Single Dose 30 to 60 min Before Procedure		
Situation	**Agent**	**Adults**	**Children**
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin OR Cefazolin or ceftriaxone	2 g IM or IV 1 g IM or IV	50 mg/kg IM or IV 50 mg/kg IM or IV
Allergic to penicillins or amipicillin—oral	Cephalexin*† OR Clindamycin OR Azithromycin or clarithromycin	2 g 600 mg 500 mg	50 mg/kg 20 mg/kg 15 mg/kg
Allergic to penicillin or amipicillin and unable to take oral medication	Cefazolin or ceftriaxone† OR Clindamycin	1 g IM or IV 600 mg IM or IV	50 mg/kg IM or IV 20 mg/kg IM or IV

IM indicates intramuscular; **IV**, intravenous.

* Or other first-or second-generation oral cephalosporin in equivalent adult or pediatric dosage.

† Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticaria with penicillins or ampicillin.

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~~**Table 4. AAOS/ADA PREVENTION OF ORTHOPAEDIC IMPLANT INFECTION CLINICAL PRACTICE GUIDELINE PROTOCOL RECOMMENDATIONS (Watters et al 2013, AAOS 2013).**~~
~~***Recommendation 1***~~ ~~The practitioner might consider discontinuing the practice of routinely prescribing prophylactic antibiotics for patients with hip and knee prosthetic joint implants undergoing dental procedures.~~ ~~**Grade of Recommendation: Limited**~~ ~~A Limited recommendation means the quality of the supporting evidence that exists is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another. Practitioners should be cautious in deciding whether to follow a recommendation classified as Limited, and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.~~
~~***Recommendation 2***~~ ~~We are unable to recommend for or against the use of topical oral antimicrobials in patients with prosthetic joint implants or other orthopaedic implants undergoing dental procedures.~~ ~~**Grade of Recommendation: Inconclusive**~~ ~~An Inconclusive recommendation means that there is a lack of compelling evidence resulting in an unclear balance between potential benefits and potential harm. Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as Inconclusive and should exercise judgment and be alert to future publications that clarify existing evidence for determining balance of benefits versus potential harm. Patient preference should have a substantial influencing role.~~
~~***Recommendation 3***~~ ~~In the absence of reliable evidence linking poor oral health to prosthetic joint infection, it is the opinion of the work group that patients with prosthetic joint implants or other orthopaedic implants maintain appropriate oral hygiene.~~ ~~**Grade of Recommendation: Consensus**~~ ~~A Consensus recommendation means that expert opinion supports the guideline recommendation even though there is no available evidence that meets inclusion criteria. Practitioners should be flexible in deciding whether to follow a recommendation classified as Consensus, although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.~~

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(NE Comment: Recommend new table "Management of patients with prosthetic joints undergoing dental procedures" – request table from ADA. See sample below)

Management of patients with prosthetic joints undergoing dental procedures

Clinical Recommendation:

In general, for patients with prosthetic joint implants, prophylactic antibiotics are *not* recommended prior to dental procedures to prevent prosthetic joint infection.

For patients with a history of complications associated with their joint replacement surgery who are undergoing dental procedures that include gingival manipulation or mucosal incision, prophylactic antibiotics should only be considered after consultation with the patient and orthopedic surgeon.* To assess a patient's medical status, a complete health history is always recommended when making final decisions regarding the need for antibiotic prophylaxis.

Clinical Reasoning for the Recommendation:

- There is evidence that dental procedures are not associated with prosthetic joint implant infections.
- There is evidence that antibiotics provided before oral care do not prevent prosthetic joint implant infections.
- There are potential harms of antibiotics including risk for anaphylaxis, antibiotic resistance, and opportunistic infections like *Clostridium difficile*.
- The benefits of antibiotic prophylaxis may not exceed the harms for most patients.
- The individual patient's circumstances and preferences should be considered when deciding whether to prescribe prophylactic antibiotics prior to dental procedures.

ADA. Center for Evidence-Based Dentistry™

* In cases where antibiotics are deemed necessary, it is most appropriate that the orthopedic surgeon recommend the appropriate antibiotic regimen and when reasonable write the prescription.

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[Best Practices]

Caries-risk Assessment and Management for Infants, Children, and Adolescents*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ 2019

Key words: Dental caries, risk assessment; practice guidelines

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that caries-risk assessment and management protocols, also called care pathways, can assist clinicians with decisions regarding treatment based on child's age, caries risk and patient compliance; and are essential elements of contemporary clinical care for infants, children, and adolescents. This guideline is intended to educate health care providers and other interested parties on the assessment of caries risk in contemporary pediatric dentistry and aid in clinical decision making regarding evidence- and risk-based diagnostic, fluoride, dietary, and restorative protocols.

Methods

This ~~guideline~~ best practices document was originally developed by the Council on Clinical Affairs and adopted in 2002 and last revised in 2014. ~~This document is an update of AAPD's Policy on Use of a Caries-risk Assessment Tool (CAT) for Infants, Children, and Adolescents, revised in 2006 that includes the additional concepts of dental caries management protocols. The update used electronic and hand searches of English written articles in the medical and dental literature within the last 10 years using the search terms caries risk assessment, caries management, and caries clinical protocols. From this search, 1,909 articles were evaluated by title or by abstract. Information from 75 articles was used to update this document.~~ To update this best practices, an electronic search of systematic reviews/meta-analyses or

* **ABBREVIATIONS**
AAPD: American Academy Pediatric Dentistry. **ADA**: American Dental Association. **CDC**: Centers for Disease Control and Prevention. **MS**: Mutans streptococci.

expert panels was conducted from 2012 to 2018 using the terms: caries risk assessment, diet, sealants, fluoride, radiology, non-restorative treatment, caries risk assessment, active surveillance, caries prevention. There were four systematic reviews that informed this update on caries risk assessment[1-4]. There were 10 systematic reviews and clinical practice guidelines that inform this update on care pathways for caries[5-14]. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Caries-risk assessment

Risk assessment procedures used in medical practice ~~normally~~ generally have sufficient data to accurately quantitate a person's disease susceptibility and allow for preventive measures.~~(Lauer and Fontanarosa 2001~~) However, in dentistry ~~Even though caries risk tools~~ ~~data~~ ~~in dentistry~~ there still is a lack of ~~are no~~ sufficiently validated multivariate screen tools to determine which children are at higher risk for dental caries [3-4]. ~~sufficient to validity predict individuals caries risk such procedures have value in that they: there is quantitate the models, the process of determining risk should be a component in the clinical decision-making process.~~ Nevertheless, caries risk assessment:

1. Fosters the treatment of the disease process instead of treating the outcome of the disease.
2. Gives an understanding of the disease factors for a specific patient and aids in individualizing preventive discussions.
3. Individualizes, selects, and determines frequency of preventive and restorative treatment for a patient.
4. Anticipates caries progression or stabilization.

Caries-risk assessment models currently involve a combination of factors including diet, fluoride exposure, a susceptible host, and microflora that interplay with a variety of social, cultural, and behavioral factors. Caries risk assessment is the determination of the likelihood of the increased incidence of caries (i.e., the number of new cavitated or incipient lesions) during a certain time period, or the likelihood that there will be a change in the size or activity of lesions already present. With the ability to detect caries in its earliest stages (i.e., non-cavitated or white spot lesions), health care providers can help prevent cavitation [1].

Caries risk indicators are variables that are thought to cause the disease directly (e.g., microflora) or have been shown useful in predicting it (e.g., life-time poverty, low health literacy ~~socioeconomic status~~) and

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include those variables that may be considered protective factors. The most commonly used caries risk indicators include presence of caries lesions, low salivary flow, visible plaque on teeth, high frequency sugar consumption, presence of appliance in the mouth, health challenges, socio-demographic factors, access to care, cariogenic microflora[1]. Protective factors in caries risk factors include a child receiving optimally-fluoridated water, having teeth brushed daily with fluoridated toothpaste, receiving topical fluoride from a health professional, and a child having regular dental care[1].

~~Currently, there are no caries-risk factors or combinations of factors that have achieved high levels of both positive and negative predictive values.~~ Some issues with the current risk indicators include: ~~Although the best tool to predict future caries is~~ Past caries experience is not particularly useful in young children, and ~~due to the importance of determining caries risk before the disease is manifest.~~ activity of lesions may be more important than number of lesions. Low salivary flow is difficult to measure and may not be relevant in young children[15]. Frequent sugar consumption is hard to quantitate. Socio-demographic factors are just a proxy for various exposures/behaviors which may affect caries risk. Predictive ability of various risk factors across the life-span and how risk changes with age has not been determined[1]. Furthermore, genome-level risks factors may account for substantial variation in caries risk [1]. ~~Children with white spot lesions should be considered at high risk for caries since these are precavitated lesions that are indicative of caries activity. Plaque accumulation also is strongly associated with caries development in young children. As a corollary to the presence of plaque, a child's Mutans Streptococci (**MS**) levels and the age at which a child becomes colonized with cariogenic flora are valuable in assessing risk, especially in preschool children.~~

~~While there is no question that fermentable carbohydrates are a necessary link in the causal chain for dental caries, a systematic study of sugar consumption and caries risk has concluded that the relationship between sugar consumption and caries is much weaker in the modern age of fluoride exposure than previously thought. However, there is evidence that night-time use of the bottle, especially when it is prolonged, may be associated with early childhood caries. Despite the fact that normal salivary flow is an extremely important intrinsic host factor providing protection against caries, there is little data about the prevalence of low salivary flow in children.~~

~~Sociodemographic factors have been studied extensively to determine their effect on caries risk. Children with immigrant backgrounds have three times higher caries rates than non-immigrants. Most consistently, an inverse relationship between socioeconomic status and caries prevalence is found in studies of children~~

~~less than six years of age. Perhaps another type of sociodemographic variable is the parents' history of cavities and abscessed teeth; this has been found to be a predictor of treatment for early childhood caries.~~

~~Teeth of children who reside in a fluoridated community have been shown to have higher fluoride content than those of children who reside in suboptimally fluoridated communities. Additionally, both pre- and post-eruption fluoride exposure maximize the caries-preventive effects. For individuals residing in non-fluoridated communities, fluoride supplements have shown a significant caries reduction in primary and permanent teeth. With regard to fluoridated toothpaste, studies have shown consistent reduction in caries experience. Professional topical fluoride applications performed semiannually also reduce caries, and fluoride varnishes generally are equal to that of other professional topical fluoride vehicles.~~

~~The effect of sugar substitutes on caries rates have been evaluated in several populations with high caries prevalence. Studies indicate that xylitol can decrease MS levels in plaque and saliva and can reduce dental caries in young children and adults, including children via their mothers. With regard to toothbrushing, there only is a weak relationship between frequency of brushing and decreased dental caries, which is confounded because it is difficult to distinguish whether the effect is actually a measure of fluoride application or whether it is a result of mechanical removal of plaque. The dental home or regular periodic care by the same practitioner is included in many caries-risk assessment models because of its known benefit for dental health.~~

Risk assessment tools can aid in the identification of reliable predictors and allow dental practitioners, physicians, and other nondental health care providers to become more actively involved in identifying and referring high-risk children. Tables 1 and 2~~, and 3~~ incorporate available evidence into practical tools to assist dental practitioners, physicians, and other non-dental health care providers in assessing levels of risk for caries development in infants, children, and adolescents. As new evidence emergences, these tools can be refined to provide greater predictably of caries in children prior to disease initiation. Furthermore, the evolution of caries-risk assessment tools and care pathways ~~protocols~~ can assist in providing evidence for and justifying periodicity of services, modification of third-party involvement in the delivery of dental services, and quality of care with outcomes assessment to address limited resources and work-force issues.

Care pathways for caries management ~~**Caries management protocols**~~

~~Clinical management~~ Care pathways ~~protocols~~ are documents designed to assist in clinical decision-

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making. They provide criteria regarding diagnosis and treatment and lead to recommended courses of action[6]. The pathways ~~protocols~~ are based on evidence from current peer-reviewed literature and the considered judgment of expert panels, as well as clinical experience of practitioners. Care pathways for caries management in children 0-2 and 3-5 years-old were first introduced in 2011[16]. ~~The protocols should be~~ Care pathways are updated frequently as new technologies and evidence develop.

Historically, the management of dental caries was based on the notion that it was a progressive disease that eventually destroyed the tooth unless there was surgical/restorative intervention. Decisions for intervention often were learned from unstandardized dental school instruction, and then refined by clinicians over years of practice. ~~Little is known about the criteria dentists use when making decisions involving restoration of carious caries lesions.~~

It is now known that surgical intervention of dental caries alone does not stop the disease process. Additionally, many lesions do not progress, and tooth restorations have a finite longevity. Therefore, modern management of dental caries should be more conservative and includes early detection of non-cavitated lesions, identification of an individual's risk for caries progression, understanding of the disease process for that individual, and active surveillance to apply preventive measures and monitor carefully for signs of arrestment or progression.

~~Caries management protocols~~ Care pathways for children further refine the decisions concerning individualized treatment and treatment thresholds based on a specific patient's risk levels, age, and compliance with preventive strategies (Tables 3 and 4, ~~5, 6~~). Such clinical pathways ~~protocols should~~ yield ~~greater probability of success and better cost effectiveness of treatment~~ greater probability of success, fewer complications and more efficient use of resources than less standardized treatment [6]. ~~Additionally, caries management protocols free practitioners of the necessity for repetitive high level treatment decisions, standardize decision making and treatment strategies, eliminate treatment uncertainties, and guarantee more correct strategies.~~

Content of the present caries management protocol is based on results ~~of clinical trials, and~~ of systematic reviews and expert panel recommendations that give better understanding of and recommendations for diagnostic, preventive, and restorative treatments. ~~Systemic fluoride protocols are based on the Centers for Disease Control and Prevention's (**CDC**) recommendations for using fluoride.(CDC 2001);~~ Guidelines for the use of fluoridated toothpaste ~~topical fluoride treatment~~ are based on the three ~~two~~

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systematic reviews[7,9,10]; and dietary fluoride supplements are based on the CDC's fluoride guidelines[17]; professionally applied and prescription strength home-use topical fluoride are based on two systematic reviews[8,10]; the use of silver diamine fluoride to arrest caries lesions also is based on two systematic reviews[11,12].

Radiographic diagnostic guidelines are based on the ~~latest~~ uniform guidelines of three national organizations[5]. Guidelines for pit and fissure sealants, especially regarding primary teeth, are based on the ADA's Council on Scientific Affairs' systematic review of ~~recommendations for~~ the use of pit-and-fissure sealants[13]. Dietary interventions are based on a systematic review of strategies to reduce sugar sweetened beverages[14]. Caries risk is assessed at both the individual level and tooth level. Treatment of caries with interim therapeutic restorations is based on AAPD Best Practices[18.19]. ~~Guidelines for the use of xylitol are based on the AAPD's oral health policy on use of xylitol in caries prevention, as well-executed clinical trial on high caries-risk infants and toddlers, and two evidence-based reviews.~~ Active surveillance (prevention therapies and close monitoring) of enamel lesions is based on the concept that treatment of disease may only be necessary if there is disease progression[20], and that caries can arrest without treatment[21]~~, and that caries progression has diminished over recent decades~~ ~~and that the majority of proximal lesions, even in dentin, are not cavitated~~.

Other approaches to the assessment and treatment of dental caries will emerge with time and, with evidence of effectiveness, may be included in future guidelines on caries-risk assessment and ~~management~~ care pathways. ~~protocols~~. ~~For example, there are emerging trends to use calcium and phosphate remineralizing solution to reverse dental caries. Other fluoride compounds, such as silver diamine fluoride and stannous fluoride, may be more effective than sodium fluoride for topical applications. There has been interest in antimicrobials to affect the caries rates, but evidence from caries trials is still inconclusive. However, some other proven methods, such as prescription fluoride drops and tablets, may be removed from this protocol in the future due to attitudes, risks, or compliance.~~

Recommendations

1. Dental caries-risk assessment, based on a child's age, social/biological factors, protective factors, and clinical findings, should be a routine component of new and periodic examinations by oral health and medical providers.
2. While there is not enough information at present to have quantitative caries-risk assessment analyses, estimating children at low, moderate, and high caries risk by a preponderance of risk and

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protective factors will enable a more evidence-based approach to medical provider referrals, as well as establish periodicity and intensity of diagnostic, preventive, and restorative services.

3. ~~Clinical management~~ Care pathways ~~protocols~~, based on a child's age and caries risk, ~~and level of patient/parent cooperation,~~ provide health providers with criteria and protocols for determining the types and frequency of diagnostic, preventive, and restorative care for patient-specific management of dental caries.

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~~Table 1. Caries-risk Assessment Form for 0-3 Year Olds~~

~~(adapted from Ramos-Gomez et al 2007, ADA 2008)~~

~~(For Physicians and Other Non-Dental Health Care Providers)~~

~~Factors~~	**~~High Risk~~**	**~~Low Risk~~**
~~Risk Factors, Social/Biological~~		
~~Mother/primary caregiver has active cavities~~	~~Yes~~	
~~Parent/caregiver has life-time of poverty, low health literacy has low socioeconomic status~~	~~Yes~~	
~~Child has frequent exposure (>3 times/day) between meal sugar-containing snacks or beverages~~	~~Yes~~	
~~Continued bottle use Child is put to bed with a bottle containing natural or added sugar~~	~~Yes~~	
~~Child has special health care needs~~	~~Yes~~	
~~Child is a recent immigrant~~	~~Yes~~	
~~Protective Factors~~		
~~Child receives optimally-fluoridated drinking water or fluoride supplements~~		~~Yes~~
~~Child has teeth brushed daily with fluoridated toothpaste~~		~~Yes~~
~~Child receives topical fluoride from health professional~~		~~Yes~~
~~Child has dental home/regular dental care~~		~~Yes~~
~~Clinical Findings~~		
~~Child has white spot lesions or enamel defects~~	~~Yes~~	
~~Child has visible cavities or fillings~~	~~Yes~~	
~~Child has plaque on teeth~~	~~Yes~~	
~~Arrested lesions~~		~~Yes~~

~~Circling those conditions that apply to a specific patient helps the health care worker and parent understand the factors that contribute to or protect from caries. Risk assessment categorization of low or high is based on preponderance of factors for the individual. However, clinical judgment may justify the use of one factor (e.g., frequent exposure to sugar containing snacks or beverages, visible cavities) in determining overall risk.~~

~~Overall assessment of the child's dental caries risk: High~~ ☐ ~~Low~~ ☐

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Table 1 ~~2~~. Caries-risk Assessment Form for 0-6 ~~<6 Year-Olds~~ *

~~(For Dental Providers)~~

Factors	High Risk	Moderate Risk	Low Risk
Risk Factors, Social/Biological			
Mother/primary caregiver has active dental caries ~~cavities~~	Yes		
Parent/caregiver has life-time of poverty, low health literacy ~~has low socioeconomic status~~	Yes		
Child has frequent exposure (>3 times/day) between meal sugar-containing snacks or beverages	Yes		
Bottle or non-spill cup ~~Child is put to bed with a bottle~~ containing natural or added sugar used frequently, between meals and/or at bedtime	Yes		
Child has special health care needs	Yes*	Yes	
~~Child is a recent immigrant~~		Yes	
Protective Factors			
Child receives optimally-fluoridated drinking water or fluoride supplements			Yes
Child has teeth brushed daily with fluoridated toothpaste			Yes
Child receives topical fluoride from health professional			Yes
Child has dental home/regular dental care			Yes
~~Clinical Findings~~ Risk Factors, Clinical			
~~Child has >1 decayed/missing/filled surfaces~~	~~Yes~~		
Child has non-cavitated (incipient/white spot) ~~lesions~~ caries or enamel defects	Yes		
Child has visible cavities or fillings or missing teeth due to caries	Yes		
Child has visible plaque on teeth	Yes	Yes	

* Adapted from [22,23]

Circling those conditions that apply to a specific patient helps the practitioner and parent understand the factors that contribute to or protect from caries. Risk assessment categorization of low, moderate, or high is based on preponderance of factors for the individual. However, clinical judgment may justify the use of one factor (e.g., frequent exposure to sugar-containing snacks or beverages, more than one dmfs) in determining overall risk.

Overall assessment of the child's dental caries risk: High ☐ Moderate ☐ Low ☐

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Table 2 ~~3~~. Caries-risk Assessment Form for 6 and Greater Year-Olds *

~~**(For Dental Providers)**~~

Factors	**High Risk**	**Moderate Risk**	**Low Risk**
Risk Factors, Social/Biological			
Patient has life-time of poverty, low health literacy ~~is of low socioeconomic status~~	Yes		
Child has frequent exposure (>3 times/day) between meal sugar-containing snacks or beverages	Yes		
Patient has special health care needs	Yes*	Yes	
~~Patient is a recent immigrant~~		Yes	
Protective Factors			
Patient receives optimally-fluoridated drinking water			Yes
Patient brushes teeth daily with fluoridated toothpaste			Yes
Patient receives topical fluoride from health professional			Yes
~~Additional home measures (eg xylitol, MI paste, antimicrobial)~~			~~Yes~~
Patient has dental home/regular dental care			Yes
Clinical Findings			
Patient has ≥1 interproximal lesions	Yes		
Patient has active non-cavitated (white spot) ~~lesions~~ caries or enamel defects	Yes		
Patient has low salivary flow	Yes		
Patient has defective restorations	Yes	Yes	
Patient wearing an intraoral appliance	Yes	Yes	

*Adapted from [23,24].

Circling those conditions that apply to a specific patient helps the practitioner and patient/parent understand the factors that contribute to or protect from caries. Risk assessment categorization of low, moderate, or high is based on preponderance of factors for the individual. However, clinical judgment may justify the use of one factor (e.g., ≥1 interproximal lesions, low salivary flow) in determining overall risk.

Overall assessment of the dental caries risk: **High** ☐ **Moderate** ☐ **Low** ☐

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~~Table 4. Example of a Caries Management~~ Pathways ~~Protocol for 1-2 Year Olds~~				
~~**Risk Category**~~	~~**Diagnostics**~~	~~**Interventions**~~ ~~**Fluoride**~~	~~**Diet**~~	~~**Restorative**~~
~~**Low Risk**~~	- ~~Recall every six to12 months~~ - ~~Baseline MS~~$^{\alpha}$	- ~~Twice daily brushing with fluoridated toothpaste~~$^{\beta}$	~~Counseling~~	- ~~Surveillance~~$^{\chi}$
~~**Moderate risk**~~ ~~Parent engaged~~	- ~~Recall every six months~~ - ~~Baseline MS~~$^{\alpha}$	- ~~Twice daily brushing with fluoridated toothpaste~~$^{\beta}$ - ~~Fluoride supplements~~$^{\delta}$ - ~~Professional topical treatment every six months~~	~~Counseling~~	- ~~Active surveillance~~$^{\epsilon}$ ~~of incipient lesions~~
~~**Moderate risk**~~ ~~Parent not engaged~~	- ~~Recall every six months~~ - ~~Baseline MS~~$^{\alpha}$	- ~~Twice daily brushing with fluoridated toothpaste~~$^{\beta}$ - ~~Professional topical treatment every six months~~	~~Counseling, with limited expectations~~	- ~~Active surveillance~~$^{\epsilon}$ ~~of incipient lesions~~
~~**High risk**~~ ~~Parent engaged~~	- ~~Recall every three months~~ - ~~Baseline and follow up MS~~$^{\alpha}$	- ~~Twice daily brushing with fluoridated toothpaste~~$^{\beta}$ - ~~Fluoride supplements~~$^{\delta}$~~Optimize dietary F levels~~ - ~~Professional topical treatment every three months~~ - ~~SDF on cavitated lesions~~	~~Counseling~~	- ~~Active surveillance~~$^{\epsilon}$ ~~of incipient lesions~~ - ~~Restore cavitated lesions with ITR~~$^{\phi}$ ~~or definitive restorations~~
~~**High risk**~~ ~~Parent not engaged~~	- ~~Recall every three months~~ - ~~Baseline and follow up MS~~$^{\alpha}$	- ~~Twice daily brushing with fluoridated toothpaste~~$^{\beta}$ - ~~Professional topical treatment every three months~~	~~Counseling, with limited expectations~~	- ~~Active surveillance~~$^{\epsilon}$ ~~of incipient lesions~~ - ~~Restore cavitated lesions with ITR~~$^{\phi}$ ~~or definitive restorations~~

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Table 3 ~~5~~. Example of a Caries Management Pathways ~~Protocol~~ for 0 to 6 ~~<6 3-5~~-Year-Olds

Risk Category	Diagnostics	Interventions			Restorative
		Fluoride	Diet	Sealants$^{\lambda}$	
Low Risk	- Recall every six to12 months - Radiographs every 12 to 24 months - ~~Baseline MS$^{\alpha}$~~	- Drink optimally fluoridated water - Twice daily brushing with fluoridated toothpaste$^{\gamma}$	~~No~~ Yes	~~Yes~~ No	- Surveillance$^{\chi}$
Moderate risk ~~Patient/Parent engaged~~	- Recall every six months - Radiographs every six to 12 months - Baseline MS$^{\alpha}$	- Drink optimally fluoridated water - Twice daily brushing with fluoridated toothpaste$^{\gamma}$ - Fluoride supplements$^{\delta}$ - Professional topical treatment every six months	Counseling	Yes	- Active surveillance$^{\epsilon}$ of non-cavitated (white spot) incipient lesions - Restoration of cavitated or enlarging lesions
~~**Moderate risk** Parent not engaged~~	- ~~Recall every six months~~ - ~~Radiographs every six to 12 months~~ - ~~Baseline MS$^{\alpha}$~~	- ~~Twice daily brushing with fluoridated toothpaste$^{\gamma}$~~ - ~~Professional topical treatment every six months~~	~~Counseling, with limited expectations~~	~~Yes~~	- ~~Active surveillance$^{\epsilon}$ of incipient lesions~~ - ~~Restoration of cavitated or enlarging lesions~~
High risk ~~Parent engaged~~	- Recall every three months - Radiographs every six months - ~~Baseline and follow up MS$^{\alpha}$~~	- ~~Brushing with 0.5 percent fluoride (with caution)~~ - Twice daily brushing with fluoridated toothpaste - Drink optimally fluoridated water - Optimize dietary F levels - Professional topical treatment every three months	Counseling	Yes	- Active surveillance$^{\epsilon}$ of non-cavitated (white spot) ~~incipient lesions~~ caries - SDF on cavitated lesions - Restoration of cavitated or enlarging lesions
~~**High risk** Parent not engaged~~	- ~~Recall every three months~~ - ~~Radiographs every six months~~ - ~~Baseline and follow up MS$^{\alpha}$~~	- ~~Brushing with 0.5 percent fluoride (with caution)~~ - ~~Professional topical treatment every three months~~	~~Counseling, with limited expectations~~	~~Yes~~	- ~~Restore incipient, cavitated, or enlarging lesions~~

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Table 4 ~~6~~. Example of a Caries Management Pathways ~~Protocol~~ for 6 and Greater Year-Olds

Risk Category	Diagnostics	Interventions			Restorative
		Fluoride	Diet	Sealants	
Low Risk	- Recall every six to12 months - Radiographs every 12 to 24 months	- Drink optimally fluoridated water - Twice daily brushing with fluoridated toothpaste[ɣ]	~~No~~ Yes	Yes	- Surveillance[χ]
Moderate risk ~~Patient/Parent engaged~~	- Recall every six months - Radiographs every six to 12 months	- Drink optimally fluoridated water - Twice daily brushing with fluoridated toothpaste[μ] - Fluoride supplements[δ] - Professional topical treatment every six months	Counseling	Yes	- Active surveillance[ε] of non-cavitated (white spot) incipient lesions caries - Restoration of cavitated or enlarging lesions caries
~~**Moderate risk** Patient/Parent not engaged~~	~~- Recall every six months~~ ~~- Radiographs every six to 12 months~~	~~- Twice daily brushing with fluoridated toothpaste[μ]~~ ~~- Professional topical treatment every six months~~	~~Counseling, with limited expectations~~	~~Yes~~	~~- Active surveillance[ε] of incipient lesions~~ ~~- Restoration of cavitated or enlarging lesions~~
High risk ~~Patient/Parent engaged~~	- Recall every three months - Radiographs every six months	- Drink optimally fluoridated water - Brushing with 0.5 percent fluoride - Professional topical treatment every three months - SDF on cavitated lesions	- Counseling, ~~with limited expectations~~ - ~~Xylitol~~	Yes	- Active surveillance[ε] of non-cavitated (white spot) ~~incipient~~ lesions - Restoration of cavitated or enlarging lesions
~~**High risk** Patient/Parent not engaged~~	~~- Recall every three months~~ ~~- Radiographs every six months~~	~~- Brushing with 0.5 percent fluoride~~ ~~- Professional topical treatment every three months~~	~~- Counseling, with limited expectations~~ ~~- Xylitol~~	~~Yes~~	~~- Restore incipient, cavitated, or enlarging lesions~~

Notes for caries management pathways tables:

Twice daily brushing: Parental supervision of a "smear" amount of fluoridated toothpaste twice daily for children under age 3; "pea size" amount for children, ages 3-6.

Optimize dietary fluoride levels: Ideally by consuming optimally fluoridated water; alternatively by dietary fluoride supplements for children at high caries risk.

Surveillance and active surveillance: Periodic monitoring for signs of caries progression, and active measures by parents and oral health professionals to reduce cariogenic environment and monitor possible caries progression.

SDF: Use of 38% silver diamine fluoride to assist in arresting caries lesions. Parental consent because of staining of lesions.

ITR: Interim therapeutic restorations, (also may be called "protective restorations" (Policy of ITR, 2017).

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Sealants: Although studies report unfavorable cost/benefit ratio for sealant placement in low caries risk children, expert opinion favors sealants in permanent teeth of low risk children based on possible changes in risk over time and differences in tooth anatomy. The decision to seal primary and permanent molars should account for both the individual level and tooth level risk.

~~**Legends for Tables 4-6**~~

~~α Salivary mutans streptococci bacterial levels.~~
~~χ Periodic monitoring for signs of caries progression.~~
~~β Parental supervision of a "smear" amount of toothpaste.~~
~~δ Need to consider fluoride levels in drinking water.~~
~~ε Careful monitoring of caries progression and prevention program.~~
~~φ Interim therapeutic restoration. (AAPD P_ITR)~~
~~γ Parental supervision of a "pea sized" amount of toothpaste.~~
~~λ Indicated for teeth with deep fissure anatomy or developmental defects.~~
~~μ Less concern about the quantity of toothpaste.~~

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[Best Practices]

Management of the Developing Dentition and Occlusion in Pediatric Dentistry*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes the importance of managing the developing dentition and occlusion and its effect on the well-being of infants, children, and adolescents. Management includes the recognition, diagnosis, and appropriate treatment of dentofacial abnormalities. These recommendations are intended to set forth objectives for management of the developing dentition and occlusion in pediatric dentistry.

Methods

Recommendations on management of the developing dentition and occlusion were developed by the Clinical Affairs Committee–Developing Dentition Subcommittee and adopted in 1990. This document is a revision of the previous version, last revised in 2014. This revision is based upon a new PubMed®/MEDLINE search using the terms: tooth ankylosis, Class II malocclusion, Class III malocclusion, interceptive orthodontic treatment, evidence-based, dental crowding, ectopic eruption, dental impaction, obstruction sleep apnea syndrome (**OSAS**), occlusal development, craniofacial development, craniofacial growth, airway, facial growth, oligodontia, oral habits, occlusal wear and dental erosion, anterior crossbite, posterior crossbite, space maintenance, third molar development, and tooth size/arch length discrepancy; fields: all; limits: within the last 10 years, humans, English, and birth through age 18. Papers for review were chosen from these searches and from references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based upon

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* **ABBREVIATIONS**
AAPD: American Academy Pediatric Dentistry. **AP**: Anteroposterior. **CBCT**: Cone-beam computed tomography. **EE**: Ectopic eruption. **OSAS**: Obstruction sleep apnea syndrome.

expert and/or consensus opinion by experienced researchers and clinicians.

Background

Guidance of eruption and development of the primary, mixed, and permanent dentitions is an integral component of comprehensive oral health care for all pediatric dental patients. Such guidance should contribute to the development of a permanent dentition that is in a stable, functional, and esthetically acceptable occlusion and normal subsequent dentofacial development. Early diagnosis and successful treatment of developing malocclusions can have both short-term and long- term benefits while achieving the goals of occlusal harmony and function and dentofacial esthetics.[1-4] Dentists have the responsibility to recognize, diagnose, and manage or refer abnormalities in the developing dentition as dictated by the complexity of the problem and the individual clinician's training, knowledge, and experience.[5]

Many factors can affect the management of the developing dental arches and minimize the overall success of any treatment. The variables associated with the treatment of the developing dentition that will affect the degree to which treatment is successful include, but are not limited to:

1. chronological/mental/emotional age of the patient and the patient's ability to understand and cooperate in the treatment.
2. intensity, frequency, and duration of an oral habit.
3. parental support for the treatment.
4. compliance with clinician's instructions.
5. craniofacial configuration.
6. craniofacial growth.
7. concomitant systemic disease or condition.
8. accuracy of diagnosis.
9. appropriateness of treatment.
10. timing of treatment.

A thorough clinical examination, appropriate pretreatment records, differential diagnosis, sequential treatment plan, and progress records are necessary to manage any condition affecting the developing dentition.

Clinical examination should include:

1. Facial analysis to:

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a. identify adverse transverse growth patterns including asymmetries (maxillary and mandibular);
b. identify adverse vertical growth patterns;
c. identify adverse sagittal (anteroposterior) growth patterns and dental anteroposterior (**AP**) occlusal disharmonies; and
d. assess esthetics and identify orthopedic and orthodontic interventions that may improve esthetics and resultant self-image and emotional development.

2. Intraoral examination to:
   a. assess overall oral health status; and
   b. determine the functional status of the patient's occlusion.
3. Functional analysis to:
   a. determine functional factors associated with the malocclusion;
   b. detect deleterious habits; and
   c. detect temporomandibular joint dysfunction, which may require additional diagnostic procedures.

Diagnostic records may be needed to assist in the evaluation of the patient's condition and for documentation purposes. Prudent judgment is exercised to decide the appropriate records required for diagnosis of the clinical condition.[6]

Diagnostic orthodontic evaluations ~~records~~ fall into three major categories ~~of evaluation~~: (1) health of the teeth and oral structures, (2) alignment and occlusal relationships of the teeth, and (3) facial and jaw proportions.[6] ~~which includes both cephalometric radiographs and facial photographs. Digital images, including cone-beam computed tomographic images (**CBCT**), are supplementing and/or replacing film as records, especially in cases of impacted teeth~~.

Diagnostic records may include:

1. Extraoral and intraoral photographs to:
   a. supplement clinical findings with oriented facial and intraoral photographs; and
   b. establish a database for documenting facial changes during treatment.
2. Diagnostic dental casts to:
   a. assess the occlusal relationship;
   b. determine arch length requirements for intraarch tooth size relationships;
   c. determine arch length requirements for interarch tooth size relationships; and

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   d. determine location and extent of arch asymmetry.
3. Intraoral and panoramic radiographs to:
   a. establish dental age;
   b. assess eruption problems;
   c. estimate the size and presence of unerupted teeth; and
   d. identify dental anomalies/pathology.
4. Lateral and AP cephalograms to:
   a. produce a comprehensive cephalometric analysis of the relative dental and skeletal components in the anteroposterior, vertical, and transverse dimensions;
   b. establish a baseline growth record for longitudinal assessment of growth and displacement of the jaws; and
   c. determine dental maturity relative to skeletal maturity and chronological age.
5. Other diagnostic views (e.g., magnetic resonance imaging, CBCT) for hard and soft tissue imaging as indicated by history and clinical examination.

A differential diagnosis and diagnostic summary are completed to:
1. Establish the relative contributions of the soft tissue and dental and skeletal structures to the patient's malocclusion.
2. Prioritize problems in terms of relative severity.
3. Detect favorable and unfavorable interactions that may result from treatment options for each problem area.
4. Establish short-term and long-term objectives.
5. Summarize the prognosis of treatment for achieving stability, function, and esthetics.

A sequential treatment plan will:
1. Establish timing priorities for each phase of therapy.
2. Establish proper sequence of treatments to achieve short-term and long-term objectives.
3. Assess treatment progress and update the biomechanical protocol accordingly on a regular basis.

Stages of development of occlusion

General considerations and principles of management: The stages of occlusal development include:
1. Primary dentition: Beginning in infancy with the eruption of the first tooth, usually about six months of age, and complete from approximately three to six years of age when all primary teeth

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are erupted.

2. Mixed dentition: From approximately age six to 13, primary and permanent teeth are present in the mouth. This stage can be further divided into early mixed and late mixed dentition.
3. Adolescent dentition: ~~All primary teeth have exfoliated~~, All succedaneous teeth have erupted, second permanent molars may be erupted or erupting, and third molars have not erupted.
4. Adult dentition: All permanent teeth are present.[7-10] ~~and eruptive growth is complete.~~

~~These stages may further be divided and referenced as early and late (e.g., early primary, late primary, early mixed, late mixed).(Dale and Dale 2012, Ferguson 2011, McNamara and Brudon 2001, Proffit 2012 Later stages~~

~~Evaluation and treatment of occlusal and skeletal disharmonies may be initiated at various stages of dental arch development, depending on the problems, growth, parental involvement, risks and benefits of treatment and of deferring treatment.(AAPD P_Ethics)~~

Historically, orthodontic treatment was provided mainly for adolescents. Interest continues to be expressed in the concept of interceptive (early) treatment as well as in adult treatment. Treatment and timing options for the growing patient, ~~especially in the mixed dentition and early permanent dentition,~~ have increased and continue to be evaluated by the research community.[9,11,12] Many clinicians seek to modify skeletal, muscular, and dentoalveolar abnormalities before the eruption of the full permanent dentition.[7]

A thorough knowledge of craniofacial growth and development of the dentition, as well as orthodontic treatment, must be used in diagnosing and reviewing possible interceptive treatment options before recommendations are made to parents.[9] Treatment is beneficial for many children, but may not be indicated for every patient with a developing malocclusion.

Treatment considerations: The developing dentition should be monitored throughout eruption. This monitoring at regular clinical examinations should include, but not be limited to, diagnosis of missing, supernumerary, developmentally defective, and fused or geminated teeth; ectopic eruption; space and tooth loss secondary to caries and periodontal and pulpal health of the teeth.

Radiographic examination, when necessary[13] and feasible, should accompany clinical examination.

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Diagnosis of anomalies of primary or permanent tooth development and eruption should be made to inform the patient's parent and to plan and recommend appropriate intervention. This evaluation is on-going throughout the developing dentition, at all stages.[6-10]

1. Primary dentition stage: Anomalies of primary teeth and eruption may not be evident/diagnosable prior to eruption, due to the child's not presenting for dental examination or to a radiographic examination not being possible in a ~~young~~ child due to age or behavior. Evaluation, however, should be accomplished when feasible. The objectives of evaluation include identification of:
   a. all anomalies of tooth number and size (as previously noted);
   b. anterior and posterior crossbites;
   c. presence of habits along with their dental and skeletal sequelae; ~~and~~
   d. airway problems.
   e. openbite

   Radiographs are taken with appropriate clinical indicators or based upon risk assessment/history.
2. Early mixed dentition stage: The objectives of evaluation continue as noted for the primary dentition stage. Palpation for unerupted teeth should be part of every examination. Panoramic, occlusal, and periapical radiographs, as indicated at the time of eruption of the lower incisors and first permanent molars, provide diagnostic information concerning:
   a. unerupted teeth;
   b. missing, supernumerary, fused, and geminated teeth;
   c. tooth size and shape (e.g., peg or small lateral incisors);
   d. positions (e.g., ectopic first permanent molars);
   e. developing skeletal discrepancies; and
   f. periodontal health.

   Space analysis can be used to evaluate arch length ~~/crowding~~ at the time of incisor eruption.
3. ~~Mid-to-~~ Late mixed dentition stage: The objectives of the evaluations remain consistent with the prior stages, with an emphasis on evaluation for ectopic tooth positions, especially canines, bicuspids, and second permanent molars.
4. Adolescent dentition stage: If not instituted earlier, orthodontic diagnosis and treatment should be planned for Class I crowded, Class II, and Class III malocclusions as well as posterior and anterior crossbites. Third molars should be monitored as to position and space, and parents should be informed of the dentist's observations.
5. Early adult dentition stage: Third molars should be evaluated. If orthodontic diagnosis has not been accomplished, recommendations should be made as necessary.

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Treatment objectives: At each stage, the objectives of intervention/treatment include: managing adverse growth, correcting dental and skeletal disharmonies, improving esthetics of the smile and the accompanying positive effects on self-image, and improving the occlusion.

1. Primary dentition stage: Habits and crossbites should be diagnosed and, if predicted not likely to be self-correcting, they should be addressed as early as feasible to facilitate normal occlusal relationships. Parents should be informed about findings of adverse growth and developing malocclusions. Interventions/ treatment can be recommended if diagnosis can be made, treatment is appropriate and possible, and parents are supportive and desire to have treatment done.
2. Early~~-to-mid~~ mixed dentition stage: Treatment consideration should address:
    a. habits;
    b. arch length shortage;
    c. intervention for crowded incisors;
    d. intervention for ectopic teeth;
    e. holding of leeway space;
    f. crossbites;
    g. openbite;
    ~~g.~~h. surgical needs; and
    ~~h.~~i. adverse skeletal growth.

    Intervention for ectopic teeth may include extractions of primary teeth and space maintenance/regaining to aid ~~eruption of succedaneous~~ erupting teeth and reduce the risk of the need for permanent tooth extraction or surgical bracket placement for orthodontic traction. Treatment should take advantage of ~~high rates of growth~~ the child's growth and should be aimed at prevention of adverse dental relationships and skeletal growth.
3. Late mixed dentition stage: Intervention for treatment of skeletal disharmonies and crowding may be instituted at this stage.
4. Adolescent dentition stage: In full permanent dentition, ~~final~~ orthodontic diagnosis and treatment ~~can~~ to provide the most functional, stable, and esthetic occlusion.
5. Early adult dentition stage: Third molar position or space can be evaluated and, if indicated, the tooth/ teeth removed. Full orthodontic treatment should be recommended if needed.

Recommendations

Oral habits

General considerations and principles of management: The habits of nonnutritive sucking, bruxing, tongue thrust swallow and abnormal tongue position, self-injurious/self-mutilating behavior, and OSAS are discussed in ~~this guideline~~ these recommendations.

Oral habits may apply negative forces to the teeth and dentoalveolar structures. The relationship between oral habits and unfavorable dental and facial development is associational rather than cause and effect.[14-16] Habits of sufficient frequency, duration, and intensity may be associated with dentoalveolar or skeletal deformations such as increased overjet, reduced overbite, openbite, posterior crossbite, or increased ~~long~~ facial height. The duration of force is more important than its magnitude; the resting pressure from the lips, cheeks, and tongue has the greatest impact on tooth position, as these forces are maintained most of the time.[17,18]

Nonnutritive sucking behaviors are considered normal in infants and young children. ~~Prolonged nonnutritive sucking habits have been associated with decreased maxillary arch width, increased overjet, decreased overbite, anterior open bite, and posterior crossbite.~~ Long term non-nutritive sucking habits (e.g., pacifier use, thumb/finger sucking) have been associated with anterior openbite and posterior crossbite.[15,17-21] Some ~~As preliminary~~ evidence indicates that ~~some~~ changes resulting from sucking habits persist past the cessation of the habit~~,~~; therefore, it has been suggested that early dental visits provide parents with anticipatory guidance to help their children stop sucking habits by age 36 months or younger.[15,17,18]

Bruxism, defined as the habitual nonfunctional and forceful contact between occlusal surfaces, can occur while awake or asleep. The etiology is multifactorial and has been reported to include central factors (e.g., emotional stress,[22] parasomnias,[23] traumatic brain injury,[24] neurologic disabilities[25]) and morphologic factors (e.g., malocclusion,[26] muscle recruitment[27]). The occlusal wear that may result from bruxism is important to differentiate from other forms of occlusal loss of enamel (e.g., erosion caused by diet or gastroesophageal reflux).[28] Reported complications of bruxism include dental attrition, headaches, temporomandibular dysfunction, and soreness of the masticatory muscles.[22] Evidence indicates that juvenile bruxism is self-limiting and does not persist in adults.[29] The spectrum of bruxism management ranges from patient/parent education, occlusal splints, and psychological techniques to medications.[22,24,30,31]

Tongue thrusting, an abnormal tongue position and deviation from the normal swallowing pattern, may be associated with anterior open bite, abnormal speech, and anterior protrusion of the maxillary incisors.[32]There is no evidence that intermittent short-duration pressures, created when the tongue and lips contact the teeth during swallowing or chewing, have significant impact on tooth position.[17,32] If the resting tongue posture is forward of the normal position, incisor displacement is likely, but if resting tongue posture is normal, a tongue thrust swallow has no clinical significance.[17]

Self-injurious or self-mutilating behavior (i.e., repetitive acts that result in physical damage to the individual) is extremely rare in the normal child.[33] Such behavior, however, has been associated with developmental delay or disabilities, psychiatric disorders, traumatic brain injuries, and some syndromes.[33,34] The spectrum of treatment options for developmentally disabled individuals includes pharmacologic management, behavior modification, and physical restraint.[35] Reported dental treatment modalities include, among others, lip-bumper and occlusal bite appliances, protective padding, and extractions.[33] Some habits, such as lip-licking and lip-pulling, are relatively benign in relation to an effect on the dentition.[33] More severe lip- and tongue-biting habits may be associated with profound neurodisability due to severe brain damage.[35] Management options include monitoring the lesion, odontoplasty, providing a bite-opening appliance, or extracting the teeth.[35]

Research on the relationship between malocclusion and mouth breathing suggests that impaired nasal respiration may contribute to the development of increased facial height, anterior open bite, increased overjet, and narrow palate, but it is not the sole or even the major cause of these conditions.[36]

OSAS may be associated with narrow maxilla, crossbite, low tongue position, vertical growth, increased overjet and open bite.[37-39] History associated with OSAS may include snoring, observed apnea, restless sleep, daytime neurobehavioral abnormalities or sleepiness, and bedwetting. Physical findings may include growth abnormalities, signs of nasal obstruction, adenoidal facies, and/ or enlarged tonsils.[36,40,41]

The identification of an abnormal habit and the assessment of its potential immediate and long-term effects on the craniofacial complex and dentition should be made as early as possible. The dentist should evaluate habit frequency, duration, and intensity in all patients with habits. Intervention to terminate the habit should be initiated if indicated and parents should be provided with information regarding consequences of a habit and tools to help in elimination of the habit.[15,16]

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~~Patients and their parents should be provided with information regarding consequences of a habit. Parents may play a negative role in the correction of an oral habit as nagging or punishment may result in an increase in habit behaviors; change in the home environment may be necessary before a habit can be overcome.(Warren et al 2001)~~

Treatment considerations: Management of an oral habit is indicated whenever the habit is associated with unfavorable dentofacial development or adverse effect on child health or when there is a reasonable indication that the oral habit will result in unfavorable sequelae in the developing permanent dentition. Any treatment must be appropriate for the child's development, comprehension, and ability to cooperate. Habit treatment modalities include patient/parent counseling, behavior modification techniques, myofunctional therapy, appliance therapy (extraoral and/or intraoral), or referral to other providers including, but not limited to, orthodontists, psychologists, myofunctional therapists, or otolaryngologists. ~~Use of an appliance to manage oral habits is indicated only when the child wants to stop the habit and would benefit from a reminder~~.The child's desire to stop the habit is beneficial for managing oral habits.[16]

Treatment objectives: Treatment is directed toward decreasing or eliminating the habit and minimizing potential deleterious effects on the dentofacial complex.

Disturbances in number

Congenitally missing teeth

General considerations and principles of management: Hypodontia, the congenital absence of one or more permanent teeth, has a prevalence of 3.5 to 6.5 percent.[42] Excluding third molars, the most frequently missing permanent tooth is the mandibular second premolar followed by the maxillary lateral incisor.[42] In the primary dentition, hypodontia occurs less (0.1 percent to 0.9 percent prevalence) and almost always affects the maxillary incisors and first primary molars.[43] The chance of familial occurrence of one or two congenitally missing teeth is to be differentiated from missing lateral incisors in cleft lip/palate[44] and multiple missing teeth (six or more) due to ectodermal dysplasia or other syndromes[45] as the treatment usually differs. A congenitally missing tooth should be suspected in patients with cleft lip/palate, certain syndromes, and a familial pattern of missing teeth. In addition, patients with asymmetric eruption sequence, over-retained primary teeth, or ankylosis of a primary mandibular second molar may have a congenitally missing tooth.[44,46,47]

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Treatment considerations: With congenitally missing permanent maxillary incisor(s) or mandibular second premolar(s), the decision to extract the primary tooth and close the space orthodontically versus opening the space orthodontically and placing a prosthesis or implant depends on many factors. For maxillary laterals, the dentist may move the maxillary canine mesially and use the canine as a lateral incisor or create space for a future lateral prosthesis or implant.[16,48]

Factors that influence the decision are: (1) patient age; (2) canine size and shape; (3) canine position; (4) child's occlusion and amount of crowding; (5) bite depth~~; and~~ (6) profile (7) smile line and (8) quality and quantity of bone in the edentulous area.[48,49] Early extraction of the primary canine and/or lateral may be needed.[48] Opening space for a prosthesis or implant requires less tooth movement, but the space needs to be maintained with an interim prosthesis, especially if an implant is planned.[45,48] Moving the canine into the lateral position produces little facial change, but the resultant tooth size discrepancy often does not allow a canine guided occlusion.[47,48] Parents generally prefer space closure over implants[49]

For a congenitally missing premolar, the primary molar ~~either~~ may either be maintained or extracted with ~~subsequent~~ placement of a prosthesis,~~or~~ autotransplantation,[50-52] ~~followed by orthodontic treatment~~ or ~~the primary molar may be extracted and~~ the space closed orthodontically.[48,53,54] ~~orthodontically~~ ~~orthodontic space closure~~ ~~closing the space~~. Maintaining the primary second molar may cause occlusal problems due to its larger mesiodistal diameter, compared to the second premolar.[48] Reducing the width of the second primary molar is a consideration, but root resorption and subsequent exfoliation may occur.[16,48] In crowded arches or with multiple missing premolars, extraction of the primary molar(s) can be considered, especially in mild Class III cases.[16,48,53] For a single missing premolar, if maintaining the primary molar is not possible, placement of a prosthesis, autotransplantation or implant should be considered.[16,49,53] Preserving the primary tooth may be indicated in certain cases. However, maintaining a submerged/ankylosed tooth may increase the likelihood of an alveolar defect which can compromise later implant success.[53,54] Consideration for extraction and space maintenance may be indicated.[53,54] Consultation with an orthodontist and/or prosthodontist may be considered.

Treatment objectives: Treatment is directed toward an esthetically pleasing occlusion that functions well for the patient.

Supernumerary teeth (primary, permanent, and mesiodens)

General considerations and principles of management: Supernumerary teeth, or hyperdontia, can

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occur in the primary or permanent dentition but are five times more common in the permanent.[55] Prevalence is reported in the primary dentition from 0.3-0.8% and mixed dentitions from 0.52 to ~~2~~ 3 percent.[55-58] Between 80 and 90 percent of all supernumeraries occur in the maxilla, with half in the anterior area and almost all in the palatal position.[55] A supernumerary primary tooth is followed by a supernumerary permanent tooth in one third of the cases.[59] Supernumerary teeth are classified according to their form and location.[55,60]

During the early mixed dentition, 79 to 91 percent of anterior permanent supernumerary teeth are unerupted.[47,56] While more erupt with age, only 25 percent of all mesiodens (a permanent supernumerary incisor located at the midline) erupt spontaneously.[55] Mesiodens can prevent or cause ectopic eruption of a central incisor. Less frequently, a mesiodens can cause dilaceration or resorption of the permanent incisor's root. Dentigerous cyst formation involving the mesiodens, in addition to eruption into the nasal cavity, has been reported.[55] If there is an asymmetric eruption pattern of the maxillary incisors, delayed eruption, an over-retained primary incisor, or ectopic eruption of an incisor, a supernumerary can be suspected.[43,44,56] Panoramic, occlusal, and periapical radiographs all can reveal a supernumerary tooth~~, but the best way to locate the supernumerary is two periapical or occlusal films reviewed by the parallax rule~~.~~(Russell and Folwarczna 2003).~~ To determine the supernumerary tooth's position either a cone beam radiograph or two periapical or occlusal films reviewed by the parallex rule are recommended.[55,57]

Treatment considerations: Management and treatment of hyperdontia differs if the tooth is primary or permanent. Primary supernumerary teeth normally are accommodated into the arch and usually erupt and exfoliate without complications.[59] ~~Extraction of an unerupted supernumerary tooth during the primary dentition usually is not done to allow it to erupt; S~~Surgical extraction of unerupted supernumerary teeth during the primary dentition can displace or damage the permanent incisor.[55] Removal of an erupted mesiodens or other permanent supernumerary incisor results in eruption of the permanent adjacent normal incisor in 75 percent of the cases.[55] Extraction of an unerupted supernumerary during the early mixed dentition, at age 6-7 when the permanent crown has completely formed and the root length is less than the crown height allows for a normal eruptive force and eruption of the adjacent normal permanent incisor.[55-57,61] Later removal of the mesiodens reduces the likelihood that the adjacent normal permanent incisor will erupt on its own, especially if the apex is completed.[55] Inverted conical supernumeraries can be harder to remove if removal is delayed, as they can migrate deeper into the jaw.[56] After removal of the supernumerary, clinical and radiographic follow-up is indicated in six months to determine if the normal incisor is erupting. If there is no eruption after six to 12 months and sufficient space exists, surgical

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exposure and orthodontic extrusion ~~is~~ may be needed.[55,62,63]

Treatment objectives: Removal of supernumerary teeth should facilitate eruption of permanent teeth and encourage normal alignment. In cases where normal alignment or spontaneous eruption does not occur, further orthodontic treatment is indicated.

Localized disturbances in eruption

Ectopic eruption

General considerations and principles of management: Ectopic eruption (**EE**) of permanent first molars occurs due to the molar's abnormal mesioangular eruption path, resulting in an impaction at the distal prominence of the primary second molar's crown.[64-65] EE can be suspected if asymmetric eruption is observed or if the mesial marginal ridge is noted to be under the distal prominence of the second primary molar.[64-65]

Ectopic Eruption of Molars

EE of permanent molars can be diagnosed from bitewing or panoramic radiographs in the early mixed dentition.[64,65] This condition occurs in up to three percent of the population.[64]~~, but is~~Ectopic permanent first molar eruption has been associated with transverse and sagittal crowding, is more common in the maxillary arch, and in children with cleft lip and palate.[65-67] Ectopic eruption of permanent second molars occur infrequently.[68] EE of permanent molars is classified into two types. There are those that self-correct and others that remain impacted. Previous data suggested ~~S~~sixty-six percent of EE permanent molars self-correct by age seven;[47,65]~~.~~ however, a recent cohort study demonstrated that 71% self-correct by age nine.[69] ~~Increased magnitude of impaction is the most reliable predictor of irreversible impaction (Dabbagh 2017).~~ In some cases, definitive treatment is indicated to manage and/or avoid early loss of the primary second molar and space loss.[64,65] Increase magnitude of impaction, increased resorption of the primary tooth and bilateral occurrence were positively associated with irreversible ectopic eruption and may indicate the need for early intervention.[69]

Treatment considerations: Treatment depends on how severe the impaction appears clinically and radiographically. For mildly impacted first permanent molars, where little of the tooth is impacted under the primary second molar, elastic or metal orthodontic separators can be placed to wedge the permanent first molar distally.[64] For more severe impactions, distal tipping of the permanent molar is required.[64] Tipping action can be accomplished with brass wires, removable appliances using springs, fixed

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appliances such as sectional wires with open coil springs,[70] sling shot-type appliances,[71] or a Halterman appliance.[72]

Ectopic Eruption of Canines

The maxillary canine appears in an impacted position in 1.5 - 2 percent of the population,.[73] ~~while~~ Maxillary canine impaction should be suspected when the canine bulge is not palpable, asymmetric canine eruption is evident, or maxillary lateral incisor agenesis or peg shaped lateral incisors are present.[73-77] Panoramic radiographs may demonstrate that the canine has an abnormal inclination and/or overlaps the lateral incisor root. Additional potential radiographic signs of maxillary canine impaction include: enlarged follicular sac, lack of root resorption of primary canines, and presence of premolar impaction.[75,76,78]

Treatment Considerations: Early diagnosis and treatment of impacted maxillary canines can lessen the severity of the impaction and may stimulate eruption of the canine. Extraction of the primary canine is indicated when the canine bulge cannot be palpated in the alveolar process and there is radiographic overlapping of the canine with the formed root of the lateral during the mixed dentition.[73,79,80] The use of rapid maxillary expansion alone[81,82] or with cervical pull headgear[83] in the early mixed dentition has been shown to increase the potential for eruption of palatally displaced maxillary cuspids. When the impacted canine is diagnosed at a later age (11 to 16-years-old), if the canine is not horizontal, extraction of the primary canine lessens the severity of the permanent canine impaction and 75 percent will erupt.[84] Extraction of the first primary molar also has been reported to allow eruption of first bicuspids and to assist in the eruption of the cuspids.[85] The need can be determined from a panoramic radiograph,[86,87] although CBCT will provide greater localization of the impacted canine.[88] Bonded orthodontic treatment normally is required to create space or align the canine. Long-term periodontal health of impacted canines after orthodontic treatment is similar to nonimpacted canines and there is insufficient data to conclude the best type of surgical technique.[89,90]

Ectopic Eruption of Incisors

~~m~~Maxillary incisors can erupt ectopically or be impacted from supernumerary teeth in up to two percent of the population.[60] Incisors also can have altered eruption due to pulp necrosis (following trauma or caries) or pulpal treatment of the primary incisor.[91] EE of permanent incisors can be suspected after trauma to primary incisors, with pulpally-treated primary incisors, with asymmetric eruption, or if a supernumerary incisor is diagnosed.[73,77]

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Treatment Considerations: Treatment of ectopically erupting incisors depends on the etiology. Extraction of necrotic or over-retained pulpally-treated primary incisors is indicated in the early mixed dentition.[91] Removal of supernumerary incisors in the early mixed dentition will lessen ectopic eruption of an adjacent permanent incisor.[55]After incisor eruption, orthodontic treatment involving removable or banded therapy may be needed.

~~EE of permanent molars is classified into two types. There are those that self-correct and others that remain impacted. Sixty-six percent of EE permanent molars self-correct by age seven;~~.~~(Robertson and Mohlin 2000, Barberia-Leache et al 2005) A permanent molar that presents with part of its occlusal surface clinically visible and part under the distal of the primary second molar usually does not self-correct and is the impacted type.(Yaseen et al 2011, Barberia-Leache et al 2005) After the age of seven, definitive treatment is indicated to manage and/or avoid early loss of the primary second molar and space loss.(Yaseen et al 2011, Barberia-Leache et al 2005)~~

~~Maxillary canine impaction should be suspected when the canine bulge is not palpable, asymmetric canine eruption is evident, or peg shaped lateral incisors are present. (Richardson and Russell 2000, Sachan and Chatunedi 2012) Panoramic radiographs may demonstrate that the canine has an abnormal inclination and/or overlaps the lateral incisor root. EE of permanent incisors can be suspected after trauma to primary incisors, with pulpally-treated primary incisors, with asymmetric eruption, or if a supernumerary incisor is diagnosed. (Richardson and Russell 2000, Sachan and Chatunedi 2012)~~

~~**Treatment considerations:** Treatment depends on how severe the impaction appears clinically and radiographically. For mildly impacted first permanent molars, where little of the tooth is impacted under the primary second molar, elastic or metal orthodontic separators can be placed to wedge the permanent first molar distally.(Warren et al 2001, Yaseen et al 2011) For more severe impactions, distal tipping of the permanent molar is required.(Yaseen et al 2011) Tipping action can be accomplished with brass wires, removable appliances using springs, fixed appliances such as sectional wires with open coil springs(Seerah 2011), sling shot-type appliances,(Gehm and Crespi 1997)~~ or ~~a Halterman appliance,(Halterman 1982) or surgical uprighting.(Terry and Hegtvedt 1992)~~

~~Early diagnosis and treatment of impacted maxillary canines can lessen the severity of the impaction and may stimulate eruption of the canine. Extraction of the primary canine is indicated when the canine bulge~~

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~~cannot be palpated in the alveolar process and there is radiographic overlapping of the canine with the formed root of the lateral during the mixed dentition.(Richardson and Russell 2000, Bedoya and Park 2009, Litsas and Acar 2011) The use of rapid maxillary expansion in the early mixed dentition has been shown to increase the rate of eruption of palatally displaced maxillary cuspidsWhen the impacted canine is diagnosed at a later age (11 to 16), if the canine is not horizontal, extraction of the primary canine lessens the severity of the permanent canine impaction and 75 percent will erupt.(Olive 2002) Extraction of the first primary molar also has been reported to allow eruption of first bicuspids and to assist in the eruption of the cuspids. The need can be determined from a panoramic radiograph. (D'Amico et al 2003, Bonetti et al 2011). Bonded orthodontic treatment normally is required to create space or align the canine. Long-term periodontal health of impacted canines after orthodontic treatment is similar to nonimpacted canines (Andreasen and Andreasen 1994-Avulsion injuries).~~

~~Treatment of ectopically erupting incisors depends on the etiology. Extraction of necrotic or over-retained pulpally-treated primary incisors is indicated in the early mixed dentition. (Coll and Sadrian 1996) Removal of supernumerary incisors in the early mixed dentition will lessen ectopic eruption of an adjacent permanent incisor. (Russell and Folwarczna 2003) After incisor eruption, orthodontic treatment involving removable or banded therapy may be needed.~~

Treatment objectives: Management of ectopically erupting molars, canines, and incisors should result in improved eruptive positioning of the tooth. In cases where normal alignment does not occur, subsequent comprehensive orthodontic treatment may be necessary to achieve appropriate arch form and intercuspation.

Ankylosis

General considerations and principles of management: Ankylosis is a condition in which the cementum of a tooth's root fuses directly to the surrounding bone.[92] The periodontal ligament is replaced with osseous tissue, rendering the tooth immobile to eruptive change.[92] An ankylosed tooth stays at the same vertical level; however, in a growing child appears to submerge as the other teeth continue to erupt.[93] Ankylosis can occur in the primary and permanent dentitions, with the most common incidence involving primary molars. The incidence is reported to be between seven and 14 percent in the primary dentition.[94] In the permanent dentition, ankylosis occurs most frequently following luxation injuries.[95,96]

Ankylosis is common in anterior teeth following trauma and is referred to as replacement resorption.

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Periodontal ligament cells are destroyed and the cells of the alveolar bone perform most of the healing. Over time, normal bony activity results in the replacement of root structure with osseous tissue.[94,95] Ankylosis can occur rapidly or gradually over time, in some cases as long as five years post trauma. It also may be transient if only a small bony bridge forms then is resorbed with subsequent osteoclastic activity.[97]

Ankylosis can be verified by clinical and radiographic means. Submergence of the tooth is the primary recognizable sign, but the diagnosis also can be made through percussion and palpation.[98] Radiographic examination also may reveal the loss of the periodontal ligament and bony bridging.[92]

Treatment considerations: With ankylosis of a primary molar, exfoliation usually occurs normally. Extraction is recommended if prolonged retention of the primary molar is noted. If a severe marginal ridge discrepancy develops, extraction should be considered to prevent the adjacent teeth from tipping and producing space loss[3,98] or vertical occlusal discrepancies.[99] Replacement resorption of permanent teeth usually results in the loss of the involved tooth.[94]

Mildly to moderately ankylosed primary molars without permanent successors may be retained and restored to function in arches without crowding.[99] Extraction of these molars can assist in resolving crowded arches in complex orthodontic cases.[100] Surgical luxation of ankylosed permanent teeth with forced orthodontic eruption has been described as an alternative to premature extraction.[101,102]

Treatment objectives: Treatment of ankylosis should result in the continuing normal development of the permanent dentition. In the case of replacement resorption of a permanent tooth, appropriate prosthetic replacement should be planned.

Primary failure of eruption

General considerations and management: Primary failure of eruption (PFE) is an eruption disorder characterized by partial or complete non-eruption of permanent teeth in the absence of any mechanical obstruction or syndrome.[103] Failure in eruptive mechanisms prevent permanent successors from following the eruption path after the exfoliation of deciduous teeth.[104] Posterior teeth are most commonly affected and one or all four quadrants may be involved[105] Although typically associated with permanent teeth, examples in the primary dentition have been noted.[106] Two main phenotypes of PFE have been identified: (1) All teeth distal to the most mesial non-erupted tooth are affected, or (2) unerupted teeth do not follow the pattern that all teeth distal to the most mesial involved tooth are also affected.[107] Hallmark features of PFE include: posterior open bite in the presence of normal vertical growth, infraocclusion of affected teeth, and the inability to move affected teeth orthodontically.[108]

The reported incidence of PFE is between 0.01 and 0.06 percent;[109,110] however, some data suggests PFE may be misdiagnosed as infra-occlusion or ankylosis.[111,112] PFE differs from ankylosis in that eruption fails to occur due to an imbalance in resorptive and appositional factors related to tooth eruption.[113,114] Teeth with PFE are not initially ankylosed but may become ankylosed when orthodontic forces are applied.[115]

A systematic review demonstrated 85% of patients with PFE have another family member with the condition.[105] PFE has variable expression and has been associated with mutations in the autosomal dominant parathyroid hormone receptor (PTH1R) gene.[115-118] A DNA sample of blood or saliva can be used to test for mutations in PTH1R.[117,119]

Treatment considerations: Diagnosis of PFE should be based on a combination of clinical, radiographic, and genetic information.[113-115] A positive family history also supports a diagnosis of PFE.[107] Other than a few anecdotal reports, PFE is strongly associated with the failure of orthodontically assisted eruption or tooth movement.[113,114] To that point early orthodontic intervention of the affected teeth should be avoided.[108,113,114,119] To date there are no established mechanotherapeutic methods of modifying dentoalveolar growth for these patients.[108,113,114,119] Space maintenance, up-righting adjacent teeth that have tipped into the sites, prevention of supra-eruption in opposing arch or modification of lateral tongue thrust habits may be additional considerations.[108,119] Once growth is complete, multidisciplinary treatment options such as single tooth or segmental osteomies with immediate traction, or selective extractions followed by implants can be considered to create a functioning occlusion.[108] Early extraction of first molars allowing the second molars to drift forward have also been suggested.[108]

Treatment objectives: Since best available evidence does not support early orthodontic intervention, treatment objectives of PFE should involve reassurance and education about the eruption disorder and preparation for future prosthetic rehabilitation.[108] In some cases, early extraction can improve normal development of the alveolus and permanent dentition.[108] Objectives include space and intra-arch maintenance in preparation for future implants, prosthetic rehabilitation, or corticotomy-assisted tooth movement.[108]

Tooth size/arch length discrepancy and crowding

General considerations and principles of management: Arch length discrepancies include inadequate arch length and crowding of the dental arches, excess arch length and spacing, and tooth size discrepancy, often referred to as a Bolton discrepancy.[120] These arch length discrepancies may be found in conjunction with complicating and other etiological factors including missing teeth, supernumerary teeth, and fused or geminated teeth. Inadequate arch length with resulting incisor crowding is a common occurrence with various negative sequelae and is particularly common in the early mixed dentition.[121-124] Studies of arch length in today's children compared to their parents and grandparents of 50 years ago indicate less arch length, more frequent incisor crowding, and stable tooth sizes.[125-127] This implies that the problem of incisor crowding and ultimate arch length discrepancies may be increasing in numbers of patients and in amount of arch length shortage.[125,126,128]

Arch length and especially crowding must be considered in the context of the esthetic, dental, skeletal, and soft tissue relationships. Mandibular incisors have a high relapse rate in rotations and crowding.[121,123] Growth of the aging skeleton causes further crowding and incisor rotations.[129] Functional contacts are diminished where rotations of incisors, canines, and bicuspids exist.[130] Occlusal harmony and temporomandibular joint health are impacted negatively by less functional contacts.[130]

Initial assessment may be done in early mixed dentition, when mandibular incisors begin to erupt.[121] Evaluation of available space and consideration of making space for permanent incisors to erupt may be done initially utilizing appropriate radiographs to ascertain the presence of permanent successors. Comprehensive diagnostic analysis is suggested, with evaluation of maxillary and mandibular skeletal relationships, direction and pattern of growth, facial profile, facial width, muscle balance, and dental and occlusal findings including tooth positions, arch length analysis, and leeway space.

Derotation of teeth just after emergence in the mouth implies correction before the transseptal fiber arrangement has been established.[121,130] It has been shown that the transseptal fibers do not develop until the cementoenamel junction of erupting teeth pass the bony border of the alveolar process~~.~~;[130] therefore, long-term stability of aligned incisors may be increased.[131]

Treatment considerations: Treatment considerations may include, but are not limited to:

1. gaining space for permanent incisors to erupt and become straight naturally through primary canine extraction and space/arch length maintenance with holding arches. Extraction of primary or permanent teeth with the aim of alleviating crowding should not be undertaken without a comprehensive space analysis and a short and long term orthodontic treatment plan.
2. orthodontic alignment of permanent teeth as soon as erupted and feasible, expansion and correction of arch length as early as feasible.
3. utilizing holding arches in the mixed dentition until all permanent bicuspids and canines have erupted.
4. maintaining patient's original arch form.[130]
5. interproximal stripping (enamel removal) the mandibular primary canines to allow alignment of crowded lower permanent lateral incisors.[132]

Additional treatment modalities may include, but are not limited to: (1) interproximal reduction; (2) restorative bonding; (3) veneers; (4) crowns; (5) implants; and (6) orthognathic surgery.

Treatment objectives: Well-timed intervention can:

1. prevent crowded incisors.
2. increase long-term stability of incisor positions.
3. decrease ectopic eruption and impaction of permanent canines.
4. reduce orthodontic treatment time and sequelae.
5. improve gingival health and overall dental health.[121,133,134]

Space maintenance

General considerations and principles of management: The premature loss of primary teeth due to caries, infection, trauma, ectopic eruption, or crowding deviates from the normal exfoliation pattern and may lead to loss of arch length. ~~other causes may lead to undesirable tooth movements of primary and/or permanent teeth including loss of arch length.~~ Arch length deficiency can produce or increase the severity of malocclusions with crowding, rotations, ectopic eruption, crossbite, excessive overjet, excessive overbite, and unfavorable molar relationships.[135] Whenever possible, restoration of carious primary teeth should be attempted to avoid malocclusions that could result from their extraction.[136] The use of space maintainers to reduce the prevalence and severity of malocclusion following premature loss of primary teeth should be considered.[16,137,138] ~~is recommended~~. ~~Space maintenance may be a consideration in the primary dentition after early loss of a maxillary incisor when the child has an active digit habit. An intense habit may reduce the space for the erupting permanent incisor~~.

Adverse effects associated with space maintainers include: (1) dislodged, broken, and lost appliances; (2) plaque accumulation; (3) caries; (4) damage or interference with successor eruption; (5) undesirable tooth movement; (6) inhibition of alveolar growth; (7) soft tissue impingement; ~~and~~ (8) pain and (9) increase in microorganisms and increase in periodontal index scores.[135,139-145] Premature loss of a primary tooth ~~of any type,~~ especially in crowded dentitions, has the potential to cause loss of space available for the succeeding permanent tooth, but there is a lack of consensus or evidence regarding the effectiveness of space maintainers in preventing or reducing the severity of malocclusion.[135,140,141,146-155]

Treatment considerations: It is prudent to consider space maintenance when primary teeth are lost prematurely. Factors to consider include: (1) specific tooth lost; (2) time elapsed since tooth loss; (3) ~~pre-existing~~ occlusion and space assessment; (4) ~~favorable space analysis~~ dental age; (5) presence ~~and root development~~ of permanent successor; (6) root development and amount of alveolar bone covering permanent successor; (7) ~~patient's~~ health history and medical status; (8) patient's cooperative ability; (9) active oral habits; and (10) oral hygiene.[16,135,156]

The literature pertaining to the use of space maintainers specific to the loss of a particular primary tooth type include expert opinion, case reports, and details of appliance design.[16,137,138] Space maintainers can be designed as fixed unilateral (band and loop, crown and loop, distal shoe), fixed bilateral (lower lingual holding arch, Nance appliance, transpalatal arch) or removable (partial dentures, Hawley type appliance), Variations of these appliances have been described. Unilateral space maintainer kits as well as direct bonded techniques eliminate laboratory involvement and allow for single visit delivery; however, the literature describes mixed results on the longevity of these options compared to success rates of custom appliances.[157-160] ~~Treatment modalities may include, but are not limited to:~~

1. ~~Fixed appliances (e.g., band and loop, crown and loop, passive lingual arch, distal shoe, Nance appliance, transpalatal arch).~~
2. ~~Removable appliances (e.g., partial dentures, Hawley appliance). (Bell et al 2011, Ngan et al 1999, Terlaje and Donly 2001)~~

The placement and retention of space maintaining appliances requires ongoing compliant patient behavior. Follow-up of patients with space maintainers is necessary to assess integrity of cement and to evaluate and clean the abutment teeth.[144] The appliance should function until the succedaneous teeth have erupted into the arch; however, adjustments or new appliances may be necessary with continued development and changes in the dentition.

Treatment objectives: The goal of space maintenance is to prevent loss of arch length, width, and perimeter by maintaining the relative position of the existing dentition.[16,137]

The AAPD recognizes the need for controlled randomized clinical trials to determine efficacy of space maintainers as well as analysis of costs and side effects of treatment

Space regaining

General considerations and principles of management: Some of the more common causes of space loss within an arch are (1) primary teeth with interproximal caries; (2) ectopically erupting teeth; (3) alteration in the sequence of eruption; (4) ankylosis of a primary molar; (5) dental impaction; (6) transposition of teeth; (7) loss of primary molars without proper space management; (8) congenitally missing teeth; (9) abnormal resorption of primary molar roots; (10) premature and delayed eruption of permanent teeth; and (11) abnormal dental morphology.[16,135,138,161,162] Therefore, loss of space in the dental arch that interferes with the desired eruption of the permanent teeth may require evaluation.

The degree to which space is affected varies according to the arch, site in the arch, and time elapsed since tooth loss.[163] The quantity and incidence of space loss are dependent upon which adjacent teeth are present in the dental arch and their status.[16,135]. The amount of crowding or spacing in the dental arch will determine the consequence of space loss.[1,162]

Treatment considerations: Space can be maintained or regained with removable or fixed appliances.[135,137]Some examples of fixed space regaining appliances are active holding arches, pendulum appliances, Halterman type appliances and Jones jig. Examples of removable space regaining appliances are Hawley appliance with springs, lip bumper, and headgear.[137] If space regaining is planned, a comprehensive analysis should be completed prior to any treatment decisions. Some factors that should be considered in the analysis include: dentofacial development, age at time of tooth loss, tooth that has been lost, space available, and space needed.[1,135,137]

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Treatment objectives: The goal of space regaining intervention is the recovery of lost arch width and perimeter and/or improved eruptive position of succedaneous teeth. Space regained should be maintained until adjacent permanent teeth have erupted completely and/or until a subsequent comprehensive orthodontic treatment plan is initiated.

Crossbites (dental, functional, and skeletal)

General considerations and principles of management: Crossbites are defined as any abnormal buccal-lingual relation between opposing incisors, molars, or premolars in centric relation.[164-166] If the mid-lines undergo a compensatory or habitual shift when the teeth occlude in crossbite, this is termed a functional shift.[162] A crossbite can be of dental or skeletal origin or a combination of both.[162]

A simple anterior crossbite is of dental origin if the molar occlusion is Class I and the malocclusion is the result of an abnormal axial inclination of maxillary and or mandibular anterior teeth. This condition should be differentiated from a Class III skeletal malocclusion where the crossbite is the result of the basal bone position.[164] Posterior crossbites may be the result of bilateral or unilateral lingual position of the maxillary teeth relative to the mandibular posterior teeth due to tipping or alveolar discrepancy, or a combination. Most often, unilateral posterior crossbites are the manifestation of a bilateral crossbite with a functional mandibular shift.[166] Dental crossbites may be the result of tipping or rotation of a tooth or teeth. In this case, the condition is localized and does not involve the basal bone. In contrast, skeletal crossbites involve disharmony of the craniofacial skeleton.[166,167] Aberrations in bony growth may give rise to crossbites in two ways:

1. adverse transverse growth of the maxilla and mandible.
2. disharmonious or adverse growth in the sagittal (AP) length of the maxilla and mandible.[165,168]

Such growth aberrations can be due to inherited growth patterns, trauma, or functional disturbances that alter normal growth.[166-168]

Treatment considerations: Crossbites should be considered in the context of the patient's total treatment needs. Anterior crossbite correction can: (1) reduce dental attrition; (2) improve dental esthetics; (3) redirect skeletal growth; (4) improve the tooth-to-alveolus relationship; ~~and~~ (5) increase arch perimeter (6) avoid periodontal damage, and (7) prevent the potential for temporomandibular joint disfunction.[167, 169] If enough space is available, a simple anterior crossbite can be aligned as soon as the condition is noted.

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Treatment options include acrylic incline planes, acrylic retainers with lingual springs, or fixed appliances with springs. If space is needed, an expansion appliance also is an option.[165] Posterior crossbite correction can accomplish the same objectives and can improve the eruptive position of the succedaneous teeth. Early correction of ~~unilateral~~ posterior crossbites with a mandibular functional shift has been shown to improve functional conditions significantly and largely eliminate morphological and positional asymmetries of the mandible.[32,170,171] Contemporary evidence indicates a need for long-term studies to assess the possibility for spontaneous crossbite correction, as current proof is conflicting.[172] Functional shifts should be eliminated as soon as possible with early correction[168] to avoid temporomandibular joint dysfunction and/or asymmetric growth.[166,172] Treatment can be completed with:

1. equilibration.
2. appliance therapy (fixed or removable).
3. extractions.
4. a combination of these treatment modalities to correct the alveolar constriction.[173]

Skeletal expansion with fixed or removable palatal expanders can be utilized until midline suture fusion occurs.[162,164] Treatment decisions depend on the:

1. amount and type of movement (tipping vs. bodily movement, rotation, or dental vs. orthopedic movement).
2. space available.
3. AP, transverse, and vertical skeletal relationships.
4. growth status.
5. patient cooperation.

Patients with crossbites and concomitant Class III skeletal patterns and/or skeletal asymmetry should receive comprehensive treatment as covered in the Class III malocclusion section.

Treatment objectives: Treatment of a crossbite should result in improved intramaxillary alignment and an acceptable interarch occlusion and function.[170]

Class II malocclusion

General considerations and principles of management: Class II malocclusion (distocclusion) may be unilateral or bilateral and involves a distal relationship of the mandible to the maxilla or the mandibular teeth to maxillary teeth. This relationship may result from dental (malposition of the teeth in the arches),

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skeletal (mandibular retrusion and/or maxillary protrusion), or a combination of dental and skeletal factors.[6]

Results of randomized clinical trials indicate that Class II malocclusion can be corrected effectively with either a single or two-phase regimen.[174-177] Growth-modifying effects in some studies did not show an influence on the Class II skeletal pattern,[176,178,179] while other studies dispute these findings.[180,181] There is substantial variation in treatment response to growth modification treatments (headgear or functional appliance) and no reliable predictors for favorable growth response have been found.[174,180] Some reports state interceptive treatment does not reduce the need for either premolar extractions or orthognathic surgery,[175,176] while others disagree with these findings.[182] Two-phase treatment results in significantly longer treatment time~~.~~,[168,175,183] although the time spent in full bonded appliance therapy in the permanent dentition can be significantly less.[184]

Clinicians may decide to provide interceptive treatment based on other factors.[175, 180] Evidence suggests that, for some children, interceptive Class II treatment may improve self-esteem and decreases negative social experiences, although the improvement may not be different longterm.[180,185] Early Class II correction may improve facial convexity and /or reduce incidence of maxillary anterior tooth trauma.[186-191] Incisor ~~injury is associated with overjet greater than three millimeters.~~ An overjet in excess of three millimeters is associated with an increased risk of incisor injury, with large overjets (>8mm) resulting in trauma in more than 40% of children.[192,193] ~~Further, when injury is more severe than simple enamel fractures, increased overjet and prognathic position of the maxilla are more strongly associated (Kania et al 1996) Some studies indicate interceptive treatment for Class II malocclusions can be initiated, depending upon patient cooperation and management. (Baccetti et al 1997)~~

Treatment considerations: Factors to consider when planning orthodontic intervention for Class II malocclusion are: (1) facial growth pattern; (2) amount of AP discrepancy; (3) patient age; (4) projected patient compliance; (5) space analysis; (6) anchorage requirements; and (7) patient and parent desires.

Treatment modalities include: (1) extraoral appliances headgear; (2) functional appliances; (3) fixed appliances; (4) tooth extraction and interarch elastics; and (5) orthodontics with orthognathic surgery.[162]

Treatment objectives: Treatment of a developing Class II malocclusion should result in an improved overbite, overjet, and intercuspation of posterior teeth and an esthetic appearance and profile compatible

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with the patient's skeletal morphology.

Class III malocclusion

General considerations and principles of management: Class III malocclusion (mesio-occlusion) involves a mesial relationship of the mandible to the maxilla or mandibular teeth to maxillary teeth. This relationship may result from dental factors (malposition of the teeth in the arches), skeletal factors (asymmetry, mandibular prognathism, and/or maxillary retrognathism), anterior functional shift of the mandible, or a combination of these factors.[194]

The etiology of Class III malocclusions can be hereditary, environmental, or both. Hereditary factors can include clefts of the alveolus and palate as well as other craniofacial anomalies that are part of a genetic syndrome.[195,196] Some environmental factors are trauma, oral/digital habits, caries, and early child- hood OSAS.[197]

Treatment considerations: Treatment of Class III malocclusions is indicated to provide psychosocial benefits for the child patient by reducing or eliminating facial disfigurement and to reduce the severity of malocclusion by promoting compensating growth.[198] Interceptive Class III treatment has been proposed for years and has been advocated as a necessary tool in contemporary orthodontics; initiation in the primary-early mixed dentition is recommended.[199-208] Factors to consider when planning orthodontic intervention for Class III malocclusion are: (1) facial growth pattern; (2) amount of AP discrepancy; (3) patient age; (4) projected patient compliance and (5) space. ~~analysis;~~ (~~6) anchorage headgear; (7) functional appliances; fixed appliances; (9) tooth extraction; (10) interarch elastics; and (11) orthodontics with orthognathic surgery. (Proffit and Sarver 2012).~~

Treatment objectives: Interceptive Class III treatment may provide a more favorable environment for growth and may improve occlusion, function, and esthetics.[209] Although interceptive treatment can minimize the malocclusion and potentially eliminate future orthognathic surgery, this is not always possible. Typically, Class III patients tend to grow longer and more unpredictably and, therefore, surgery combined with orthodontics may be the best alternative to achieve a satisfactory result for some patients, especially if they exhibit facial characteristics as follows: mandible forward to cranial base, increased mandibular length, short ramal length or obtuse gonial angle.[162,210-212]

Treatment of a Class III malocclusion can be achieved using several modalities including: protraction therapy with or without rapid palatal expansion, functional appliances, intermaxillary elastics with modified miniplates, or chin cup therapy.[199,200-202,210,213-218] These interventions in a growing patient should result in improved overbite, overjet, and intercuspation of posterior teeth and an esthetic appearance and profile compatible with the patient's skeletal morphology.

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[Best Practices]

Pediatric Restorative Dentistry[*]

Review Council

Council on Clinical Affairs

Latest Revision

~~2016~~[†‡] 2019

Purpose

The American Academy of Pediatric Dentistry **(AAPD)** intends ~~this guideline~~ these recommendations to help practitioners make decisions regarding restorative dentistry, including when it is necessary to treat and what the appropriate materials and techniques are for restorative dentistry in children and adolescents.

Methods

A thorough review of the scientific literature in the English language pertaining to restorative dentistry in primary and permanent teeth was completed to revise the previous guideline. Electronic database and hand searches, for the most part between the years ~~1995-2013~~ 2000-2018, were conducted using the terms: restorative treatment decisions, caries diagnosis, caries excavation, dental amalgam, glass ionomers, resin modified glass ionomers, conventional glass ionomers, atraumatic/ alternative restorative technique (**ART**), interim therapeutic restoration (**ITR**), resin infiltration, dental composites, ~~pit and fissure sealants, resin-based sealants, glass ionomer sealants~~, resin based composite, dental composites, compomers, stainless steel crowns (**SSC**), primary molar, preformed metal crown, strip crowns, pre-veneered crowns, esthetic restorations, clinical trials and, randomized controlled clinical trials.

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[*] **ABBREVIATIONS**

AAPD: American Academy of Pediatric Dentistry. **ART**: Alternative restorative technique. **BPA**: Bisphenol A. **FDA**: Food and Drug Administration. **GIC**: Glass ionomer cement. **HT**: Hall technique. **ITR**: Interim therapeutic restoration. **RMGIC**: Resin modified glass ionomer cements. **SSC**: Stainless steel crowns.

[†] ~~*The 2016 revision is limited to the addition of Hall technique for preformed metal crowns.*~~

[‡] ~~*The AAPD, in conjunction with the American Dental Association, published in 2016 a separate document, Evidence-based Clinical Practice Guideline for the Use of Pit-and-Fissure Sealants (available at: "http://www.aapd.org/media/Policies_Guidelines/G_EBD-Sealants.pdf"). The clinical guidance in that document supersedes any conflicting recommendations which may be found in this section.*~~

Those papers that were used to evaluate clinical efficacy on specific restorative dentistry topics (e.g., amalgam, resin-based composite) initially were evaluated by abstract by two individuals. Criteria for evaluation included if the paper fulfilled the qualification of a controlled clinical trial, meta-analysis, or systematic review. Full evaluation and abstraction included examination of the research methods and potential for study bias (e.g., patient recruitment, randomization, blinding, subject loss, sample size estimates, conflicts of interest, statistics). Research that was considered deficient or had high bias was eliminated. In those topic areas for which there were rigorous meta-analyses or systematic reviews available, only those clinical trial articles that were not covered by the reviews were subjected to full evaluation and abstraction. This strategy yielded 35 meta-analyses/systemic reviews and 62 randomized controlled clinical trials that primarily made up the evidence for this guideline.

The assessment of evidence for each topic was based on a modification of the American Dental Association's grading of recommendations: strong evidence (based on well-executed randomized control trials, meta-analyses, or systematic reviews); evidence in favor (based on weaker evidence from clinical trials); and expert opinion (based on retrospective trials, case reports, in vitro studies, and opinions from clinical researchers).[1]

~~This guideline was~~ These recommendations were originally developed by the Restorative Dentistry Subcommittee of the Clinical Affairs Committee and adopted in 1991. The last comprehensive revision of this document was in 2014.

When to restore

Historically, the management of dental caries was based on the belief that caries was a progressive disease that eventually destroyed the tooth unless there was surgical and restorative intervention.[2] It is now recognized that restorative treatment of dental caries alone does not stop the disease process[3] and restorations have a finite lifespan. Conversely, some carious lesions may not progress and, therefore, may not need restoration. ~~Consequently, c~~Contemporary management of dental caries includes identification of an individual's risk for caries progression, understanding of the disease process for that individual, and active surveillance to assess disease progression and manage with appropriate preventive services, supplemented by restorative therapy when indicated.[4]

With the exception of reports of dental examiners in clinical trials, studies of reliability and

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reproducibility of detecting dental caries are not conclusive.[5] There also is minimal information regarding validity of caries diagnosis in primary teeth,[2] as primary teeth may require different criteria due to thinner enamel and dentin and broader proximal contacts.[6] Furthermore, indications for restorative therapy only have been examined superficially because such decisions generally have been regarded as a function of clinical judgment.[7] Decisions for when to restore carious lesions should include at least clinical criteria of visual detection of enamel cavitation, visual identification of shadowing of the enamel, and/ or radiographic recognition of enlargement of lesions.[4,8,9] ~~over time~~.

The benefits of restorative therapy include: removing cavitations or defects to eliminate areas that are susceptible to caries; stopping the progression of tooth demineralization; restoring the integrity of tooth structure; preventing the spread of infection into the dental pulp; and preventing the shifting of teeth due to loss of tooth structure. The risks of restorative therapy include lessening the longevity of teeth by making them more susceptible to fracture, recurrent lesions, restoration failure, pulp exposure during caries excavation, future pulpal complications, and iatrogenic damage to adjacent teeth.[10-12] Primary teeth may be more susceptible to restoration failures than permanent teeth.[13] Additionally, before restoration of primary teeth, one needs to consider the length of time remaining prior to tooth exfoliation

Recommendations:

1. Management of dental caries includes identification of an individual's risk for caries progression, understanding of the disease process for that individual, and active surveillance to assess disease progression and manage with appropriate preventive services, supplemented by restorative therapy when indicated.
2. Decisions for when to restore carious lesions should include at least clinical criteria of visual detection of enamel cavitation, visual identification of shadowing of the enamel, and/or radiographic recognition of ~~enlargement of lesions over time~~ progression of lesions.

Deep caries excavation and restoration

Among the objectives of restorative treatment are to repair or limit the damage from caries, protect and preserve the tooth structure, and maintain pulp vitality whenever possible. The AAPD Guideline on ~~Pulp Therapy for Primary and Immature Permanent Teeth~~ Use of Vital Pulp Therapies in Primary Teeth with Deep Caries Lesions and Best Practices for Pulp Therapy for Primary and Immature Permanent Teeth state~~s~~ the treatment objective for a tooth affected by caries is to maintain pulpal vitality, especially in immature permanent teeth for continued apexogenesis.[14]

With regard to the treatment of deep caries, three methods of caries removal have been compared to complete excavation, where all carious dentin is removed. Stepwise excavation is a two-step caries removal process in which carious dentin is partially removed at the first appointment, leaving caries over the pulp, with placement of a temporary filling. At the second appointment, all remaining carious dentin is removed and a final restoration placed.[15] Partial, or one-step, caries excavation removes part of the carious dentin, but leaves caries over the pulp, and subsequently places a base and final restoration.[16,17] No removal of caries before restoration of primary molars in children aged three to 10 years also has been reported.[18]

Evidence from randomized controlled trials and a systematic review shows that pulp exposures in primary and permanent teeth are significantly reduced using incomplete caries excavation compared to complete excavation in teeth with a normal pulp or reversible pulpitis. Two trials and a Cochrane review found that partial excavation resulted in significantly fewer pulp exposures compared to complete excavation.[19-21] Two trials of step-wise excavation showed that pulp exposure occurred more frequently from complete excavation compared to step-wise excavation.[15,20] There also is evidence of a decrease in pulpal complications and post-operative pain after incomplete caries excavation compared to complete excavation in clinical trials,[15,20,22,23] summarized in a meta-analysis.[24]

Additionally, a meta-analysis found the risk for permanent restoration failure was similar for incompletely and completely excavated teeth.[24] With regard to the need to reopen a tooth with partial excavation of caries, one randomized controlled trial that compared partial (one-step) to stepwise excavation in permanent molars found higher rates of success in maintaining pulp vitality with partial excavation, suggesting there is no need to reopen the cavity and perform a second excavation.[16] Interestingly, two randomized controlled trials suggest that no excavation can arrest dental caries so long as a good seal of the final restoration is maintained.[18,25]

Recommendations

1. There is evidence from randomized controlled trails and systematic reviews that incomplete caries excavation in primary and permanent teeth with normal pulps or reversible pulpitis, either partial (one-step) or stepwise (two-step) excavation, results in fewer pulp exposures and fewer signs and symptoms of pulpal disease than complete excavation.
2. There is evidence from two systematic reviews that the rate of restoration failure in permanent teeth

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is no higher after incomplete rather than complete caries excavation.

3. There is evidence that partial excavation (one-step) followed by placement of final restoration leads to higher success in maintaining pulp vitality in permanent teeth than stepwise (two-step) excavation.

~~Pit and fissure sealants~~

~~Pit and fissure caries account for approximately 80 to 90 percent of all caries in permanent posterior teeth and 44 percent in primary teeth.(Beauchamp et al 2008) Pit and fissure sealant has been described as a material placed into the pits and fissures of caries-susceptible teeth that micromechanically bonds to the tooth preventing access by cariogenic bacteria to their source of nutrients,(Simonsen 1978) thus reducing the risk of caries in those susceptible pits and fissures.~~

~~With regard to evidence of effectiveness, a Cochrane review found that sealants placed on the occlusal surfaces of permanent molars in children and adolescents reduced caries up to 48 months when compared to no sealant.(Ahovuo-Saloranta et al 2013) According to a meta-analysis of 24 studies, the overall effectiveness of auto-polymerised fissure sealants in preventing dental decay was 71 percent.(Llodra et al 1993) Another Cochrane review calculated that placement of resin-based sealant in children and adolescent reduces caries incidence of 86 percent after one year and 57 percent at 48 to 54 months.(Ahovuo-Saloranta et al 2004) Sealants must be retained on the tooth and should be monitored to be most effective. Studies incorporating recall and maintenance have reported sealant success levels of 80 to 90 percent after 10 or more years.(Simonsen 1991, Romcke et al 1990)~~

~~There are many systematic reviews and clinical trials regarding optimizing the effectiveness of dental sealants. Sealants are more cost-effective in children with caries risk and generally are recommended to be placed only in those children at caries risk. (AAPD BP_Caries risk, Beauchamp et al 2008, Weintraub 2001) The best evaluation of high caries risk is done by an experienced clinician using indicators of low socio-economic status, high frequency of sugar consumption, prior caries, active white spot lesions and enamel defects, and low salivary flow.(AAPD BP_Caries risk)~~

~~Pit-and-fissure sealants lower the number of viable bacteria, including *Streptococcus mutans* and lactobacilli, by at least 100-fold and reduced the number of lesions with any viable bacteria by about 50 percent.(Griffin et al 2009) This evidence supports recommendations to seal sound surfaces and non-cavitated enamel lesions.(Beauchamp et al 2008, Griffin et al 2009)~~

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~~Evidence-based reviews have found that caries risk for sealed teeth that have lost some or all sealant does not exceed the caries risk for never-sealed teeth. Therefore, it has been recommended to provide sealants to children even if follow-up cannot be ensured.(Griffin et al 2009)~~

~~Systematic reviews and clinical trials have evaluated techniques for placement of sealants. According to a systematic review, isolation of the tooth is an important aspect of sealant placement and use of rubber dam improves the retention rates of light-cured resin based sealants.[34] Moisture control systems (Isolite™, VacuEjector™, DrySheild ™) produce sealant retention rates comparable to cotton roll isolation or rubber dam, while decreasing procedure time.(Wood et al 1989, Collette et al 2010) Another systematic review has shown that four-handed technique has been associated with higher retention of resin based sealants.(Griffin et al 2008) Two systematic reviews have shown that teeth cleaned prior to sealant application with a tooth brush prophylaxis exhibited similar or higher success rate compared to those sealed after hand piece prophylaxis.(Griffin et al 2008, Gray et al 2009) Additionally, there is limited and conflicting evidence to support mechanical preparation with a bur prior to sealant placement, and it is not recommended.(Beauchamp et al 2008) There is evidence that mechanical preparation may make a tooth more prone to caries in case of resin-based sealant loss.(Dhar et al 2012)~~

~~With regard to primer placement before sealant application, there is one randomized clinical trial that suggests that acetone or ethanol solvent based primers, especially the single bottle system, enhanced the retention of sealants, whereas water-based primers were found to drastically reduce the retention of sealants.(Feigal 2000) With regard to self-etch bonding agents that do not involve a separate step for etching, a systematic review found that self-etch bonding agents may not provide as good retention as acid etch technique;(Muller-Bolla et al 2006) however, one recent randomized clinical trial reported similar retention rates of self-etch system compared to acid etch group.(Maher et al 2013)~~

~~Based on a systematic review and clinical trials, there is substantial data regarding the use of resin-based and glass ionomer-based sealants. One meta-analysis and a Cochrane review show high retention rates of resin-based sealants compared to glass ionomer-based sealants.(Ahovuo-Saloranta 2013, Kühnisch et al 2012) However, glass ionomer sealants exhibited good short term retention comparable with resin sealants at one year, and they may be used as an interim preventive agent when resin-based sealant cannot be placed as moisture control may compromise such placement.(Beauchamp et al 2008, Ahovuo-Saloranta 2013) Another systematic review of the caries-preventive effects of glass ionomer and resin-~~

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~~based fissure sealants suggests no difference between these two products.(Mickenautsch and Yengopal 2011)~~

~~There is insufficient data to support use of fissure sealants in primary teeth. One trial reported retention rate of 76.5 percent for light polymerized fissure sealants in the follow-up time of 2.8 years.(Hotuman et al 1998) Another randomized clinical trial studied effectiveness of glass ionomer sealants in primary molars and found retention rate as low as 18.7 percent in 1.38 years and no statistically significant caries reduction.(Chadwick et al 2005)~~

~~*Recommendations:*~~

1. ~~Based on a meta-analysis and Cochrane reviews, sealants should be placed on pit and fissure surfaces judged to be at risk for dental caries or surfaces that already exhibit incipient, non-cavitated carious lesions to inhibit lesion progression.~~
2. ~~According to a systematic review and a randomized clinical trial, sealant placement methods should include careful cleaning of the pits and fissures without mechanical tooth preparation.~~
3. ~~Based on a systematic review, resin-based sealants require placement in a moisture controlled environment, often facilitated by four-handed technique.~~
4. ~~There is evidence from a randomized clinical trial that a low-viscosity hydrophilic material bonding layer, as part of or under the actual sealant, is better for long-term retention and effectiveness.~~
5. ~~There is evidence from a Cochrane review and a systematic review that resin-based materials achieve better retention and, therefore, may be preferred as dental sealants, but glass ionomer sealants could be used as transitional sealants when moisture control is not possible.~~

Resin infiltration

Resin infiltration is ~~an innovative approach~~ utilized primarily to arrest the progression of non-cavitated interproximal caries lesions.[26,27] The aim of the resin infiltration technique is to allow penetration of a low viscosity resin into the porous lesion body of enamel caries.[26]

Most randomized clinical trials done on resin infiltration had industrial support with potential of conflict of interest. One such trial evaluated infiltration and sealants versus placebo and found significant differences between infiltration versus placebo with lesion progression 32 percent versus 70 percent respectively.[28] Another randomized clinical trial reported significant difference between infiltration (7 percent) versus placebo (37 percent) in the percentage of progression in lesion depth.[26] A systematic

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review on randomized clinical trials on resin infiltration rated the quality score to be low to moderate. The review concluded that resin infiltration has a potential consistent benefit in slowing the progression or reversing non-cavitated carious lesions.[29]

An additional use of resin infiltration has been suggested to restore white spot lesions formed during orthodontic treatment. Based on a randomized clinical trial, resin infiltration significantly improved the clinical appearance of such white spot lesions and visually reduced their size.[30]

Recommendation:

1. ~~From randomized controlled trials, t~~There is low to moderate[31] evidence in favor of resin infiltration as a treatment option for small, non-cavitated interproximal carious lesions in permanent teeth.

Dental amalgam

Dental amalgam has been the most commonly used restorative material in posterior teeth for over 150 years ~~and is still widely used throughout the world today~~.[32] Amalgam contains a mixture of metals such as silver, copper, and tin, in addition to approximately 50 percent mercury.[33] Dental amalgam has declined in use over the past decade,[32] perhaps due to the controversy surrounding perceived health effects of mercury vapor, environmental concerns from its mercury content, and increased demand for esthetic alternatives.

With regard to safety of dental amalgam, a comprehensive literature review of dental studies published between 2004 and 2008 found insufficient evidence of associations between mercury release from dental amalgam and the various medical complaints.[34] Two independent randomized controlled trials in children have examined the effects of mercury release from amalgam restorations and found no effect on the central and peripheral nervous systems and kidney function.[35,36] However, on July 28, 2009, the Food and Drug Administration (**FDA**) issued a final rule that reclassified dental amalgam to a Class II device (having some risk) and designated guidance that included warning labels regarding: (1) possible harm of mercury vapors; (2) disclosure of mercury content; and (3) contraindications for persons with known mercury sensitivity. Also in this final rule, the FDA noted that there is limited information regarding dental amalgam and the long-term health outcomes in pregnant women, developing fetuses, and children under the age of six.[33]

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With regard to clinical efficacy of dental amalgam, results comparing longevity of amalgam to other restorative materials are inconsistent. The majority of meta-analyses, evidence-based reviews, and randomized controlled trials report comparable durability of dental amalgam to other restorative materials,[37-42] while others show greater longevity for amalgam.[43,44]The comparability appears to be especially true when the restorations are placed in controlled environments such as university settings.[37]

Class I amalgam restorations in primary teeth have shown in a systematic review and two randomized controlled trials to have a success rate of 85 to 96 percent for up to seven years, with an average annual failure rate of 3.2 percent.[13,41,44] Efficacy of Class I amalgam restorations in permanent teeth of children has been shown in two independent randomized controlled studies to range from 89.8 to 98.8 percent for up to seven years.[41,43]

With regard to Class II restorations in primary molars, a 2007 systematic review concluded that amalgam should be expected to survive a minimum of 3.5 years and potentially in excess of seven years.[45] For Class II restorations in permanent teeth, one meta-analysis and one evidence-based review conclude that the mean annual failure rates of amalgam and composite are equal at 2.3 percent.[37,40] The meta-analysis comparing amalgam and composite Class II restorations in permanent teeth suggests that higher replacement rates of composite in general practice settings can be attributed partly to general practitioners' confusion of marginal staining for marginal caries and their subsequent premature replacements. Otherwise, this meta-analysis concludes that the median success rate of composite and amalgam are statistically equivalent after ten years, at 92 percent and 94 percent respectively.[37]

The limitation of many of the clinical trials that compare dental amalgam to other restorative materials is that the study period often is short (24 to 36 months), at which time interval all materials reportedly perform similarly.[46-50] Some of these studies also may be at risk for bias, due to lack of true randomization, inability of blinding of investigators, and in some cases financial support by the manufacturers of the dental materials being studied.

Recommendation:

1. There is strong evidence that dental amalgam is efficacious in the restoration of Class I and Class II cavity restorations in primary and permanent teeth.

Composites

Resin-based composite restorations were introduced in dentistry about a half century ago as an esthetic restorative material,[51,52] and composites are increasingly used in place of amalgam for the restoration of carious lesions.[53] Composites consist of a resin matrix and chemically bonded fillers.[37] They are classified according to their filler size, because filler size affects polishability/esthetics, polymerization depth, polymerization shrinkage, and physical properties. Hybrid resins combine a mixture of particle sizes for improved strength while retaining esthetics.[54] The smaller filler particle size allows greater polishability and esthetics, while larger size provides strength. Flowable resins have a lower volumetric filler percentage than hybrid resins.[55]

Several factors contribute to the longevity of resin composites, including operator experience, restoration size, and tooth position.[43] Resins are more technique sensitive than amalgams and require longer placement time. In cases where isolation or patient cooperation is in question, resin-based composite may not be the restorative material of choice.[56]

Bisphenol A (**BPA**) and its derivatives are components of resin-based dental sealants and composites. Trace amounts of BPA derivatives are released from dental resins through salivary enzymatic hydrolysis and may be detectable in saliva up to three hours after resin placement.[57] Evidence is accumulating that certain BPA derivatives may pose health risks attributable to their estrogenic properties. BPA exposure reduction is achieved by cleaning filling surfaces with pumice, cotton roll, and rinsing. Additionally, potential exposure can be reduced by using a rubber dam.[57] Considering the proven benefits of resin based dental materials and minimal exposure to BPA and its derivatives, it is recommended to continue using these products while taking precautions to minimize exposure.[57]

There is strong evidence from a meta-analysis of 59 randomized clinical trials of Class I and II composite and amalgam restorations showing an overall success rate about 90 percent after 10 years for both materials, with rubber dam use significantly increasing restoration longevity.[37] <u>Other isolation techniques may be used (e.g., Isolite®, Dry Shield™).</u> Strong evidence from randomized controlled trials comparing composite restorations to amalgam restorations showed that the main reason for restoration failure in both materials was recurrent caries.[41,43,58]

In primary teeth, there is strong evidence that composite restorations for Class I restorations are successful.[13, 41] There is only one randomized controlled trial showing success in Class II composite restorations in primary teeth that were expected to exfoliate within two years.[48] In permanent molars,

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composite replacement after 3.4 years was no different than amalgam,[41] but after seven to 10 years the replacement rate was higher for composite.[56] Secondary caries rate was reported as 3.5 times greater for composite versus amalgam.[43]

There is evidence from a meta-analysis showing that etching and bonding of enamel and dentin significantly decreases marginal staining and detectable margins in composite restorations.[37] Regarding different types of composites (packable, hybrid, nano, macro, and micro filled) there is strong evidence showing similar overall clinical performance for these materials.[59-62]

Recommendations:

1. In primary molars, there is strong evidence from randomized controlled trials that composite resins are successful when used in Class I restorations. For Class II lesions in primary teeth, there is one randomized controlled trial showing success of composite resin restorations for two years.
2. In permanent molars, there is strong evidence from meta-analyses that composite resins can be used successfully for Class I and II restorations.
3. Evidence from a meta-analysis shows enamel and dentin bonding agents decrease marginal staining and detectable margins for the different types of composites.

Glass ionomer cements

Glass ionomers cements have been used in dentistry as restorative cements, cavity liner/base, and luting cement since the early 1970s.[63] Originally, glass ionomer materials were difficult to handle, exhibited poor wear resistance, and were brittle. Advancements in conventional glass ionomer formulation led to better properties, including the formation of resin-modified glass ionomers. These products showed improvement in handling characteristics, decreased setting time, increased strength, and improved wear resistance.[64,65]All glass ionomers have several properties that make them favorable for use in children including: chemical bonding to both enamel and dentin; thermal expansion similar to that of tooth structure; biocompatibility; uptake and release of fluoride; and decreased moisture sensitivity when compared to resins.

Fluoride is released from glass ionomer and taken up by the surrounding enamel and dentin, resulting in teeth that are less susceptible to acid challenge.[66,67] One study has shown that fluoride release can occur for at least one year.[68] Glass ionomers can act as a reservoir of fluoride, as uptake can occur from dentifrices, mouth rinses, and topical fluoride applications.[69,70] This fluoride protection, useful in patients

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at high risk for caries, has led to the use of glass ionomers as luting cement for SSCs, space maintainers, and orthodontic bands.[71]

Regarding use of conventional glass ionomers in primary teeth, one randomized clinical trial showed the overall median time from treatment to failure of glass ionomer restored teeth was 1.2 years.[44] Based on findings of a systematic review and meta-analysis, conventional glass ionomers are not recommended for Class II restorations in primary molars.[72,73] Conventional glass ionomer restorations have other drawbacks such as poor anatomical form and marginal integrity.[74,75] Composite restorations were more successful than glass ionomer cements where moisture control was not a problem.[73]

Resin modified glass ionomer cements (**RMGIC**), with the acid-base polymerization supplemented by a second resin light cure polymerization, has been shown to be efficacious in primary teeth. Based on a meta-analysis, RMGIC is more successful than conventional glass ionomer as a restorative material.[73] A systematic review supports the use of RMGIC in small to moderate sized Class II cavities.[72] Class II RMGIC restorations are able to withstand occlusal forces on primary molars for at least one year.[73] Because of fluoride release, RMGIC may be considered for Class I and Class II restorations of primary molars in a high caries risk population.[75] There is also some evidence that conditioning dentin improves the success rate of RMGIC.[72] According to one randomized clinical trial, cavosurface beveling leads to high marginal failure in RMGIC restorations and is not recommended.[58]

With regard to permanent teeth, a meta-analysis review reported significantly fewer carious lesions on single-surface glass ionomer restorations in permanent teeth after six years as compared to restorations with amalgam.[75] Data from a meta-analysis shows that RMGIC is more caries preventive than composite resin with or without fluoride.[76] Another meta-analysis showed that cervical restorations (Class V) with glass ionomers may have a good retention rate, but poor esthetics.[77] For Class II restorations in permanent teeth, one randomized clinical trial showed unacceptable high failure rates of conventional glass ionomers, irrespective of cavity size. However, a high dropout rate was observed in this study limiting its significance.[78] In general, there is insufficient evidence to support the use of RMGIC as long-term restorations in permanent teeth.

Other applications of glass ionomers where fluoride release has advantages are for interim therapeutic restorations (**ITR**) and the atraumatic/alternative restorative technique (**ART**). These procedures have similar techniques but different therapeutic goals. ITR may be used in very young patients,[79] uncooperative patients, or patients with special health care needs[42] for whom traditional cavity preparation and/or placement of traditional dental restorations are not feasible or need to be postponed. Additionally, ITR may be used for caries control in children with multiple open carious lesions, prior to definitive restoration of the teeth.[80] In vitro, leaving caries-affected dentin does not jeopardize the bonding of glass ionomer cements to the primary tooth dentin.[81] ART, endorsed by the World Health Organization and the International Association for Dental Research, is a means of restoring and preventing caries in populations that have little access to traditional dental care and functions as definitive treatment.

According to a meta-analysis, single surface ART restorations showed high survival rates in both primary and permanent teeth.[82] One randomized clinical trial supported single surface restorations irrespective of the cavity size and also reported higher success in non-occlusal posterior ART compared to occlusal posterior ART.[83] With regard to multi-surface ART restorations, there is conflicting evidence. Based on a meta-analysis, ART restorations presented similar survival rates to conventional approaches using composite or amalgam for Class II restorations in primary teeth.[84] However, another meta-analysis showed that multi-surface ART restorations in primary teeth exhibited high failure rates.[82]

Recommendations:

1. There is evidence in favor of glass ionomer cements for Class I restorations in primary teeth.
2. From a systematic review, there is strong evidence that resin-modified glass ionomer cements for Class I restorations are efficacious, and expert opinion supports Class II restorations in primary teeth.
3. There is insufficient evidence to support the use of conventional or resin-modified glass ionomer cements as long-term restorative material in permanent teeth.
4. From a meta-analysis, there is strong evidence that interim therapeutic restoration/atraumatic restorative technique (ITR/ART) using high viscosity glass ionomer cements has value as single surface temporary restoration for both primary and permanent teeth. Additionally, ITR may be used for caries control in children with multiple open carious lesions, prior to definitive restoration of the teeth.

Compomers

Polyacid-modified resin-based composites, or compomers, were introduced into dentistry in the mid-1990s. They contain 72 percent (by weight) strontium fluorosilicate glass and the average particle size is

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2.5 micrometers.[85] Moisture is attracted to both acid functional monomer and basic ionomer-type in the material. This moisture can trigger a reaction that releases fluoride and buffers acidic environments.[86,87] Considering the ability to release fluoride, esthetic value, and simple handling properties of compomer, it can be useful in pediatric dentistry.[85]

Based on a recent randomized clinical trial, the longevity of Class I compomer restorations in primary teeth was not statistically different compared to amalgam, but compomers were found to need replacement more frequently due to recurrent caries.[41] In Class II compomer restorations in primary teeth, the risk of developing secondary caries and failure did not increase over a two-year period in primary molars.[49,88] Compomers also have reported comparable clinical performance to composite with respect to color matching, cavosurface discoloration, anatomical form, and marginal integrity and secondary caries.[89,90] Most randomized clinical trials showed that compomer tends to have better physical properties compared to glass ionomer and resin modified glass ionomer cements and in primary teeth, but no significant difference was found in cariostatic effects of compomer compared to these materials.[44,88,91]

Recommendations:

1. Compomers can be an alternative to other restorative materials in the primary dentition in Class I and Class II restorations.
2. There is not enough data comparing compomers to other restorative materials in permanent teeth of children.

Preformed metal crowns

Preformed metal crowns (also known as SSCs) are prefabricated metal crown forms that are adapted to individual teeth and cemented with a biocompatible luting agent. Preformed metal crowns have been indicated for the restoration of primary and permanent teeth with extensive caries, cervical decalcification and/or developmental defects (eg, hypoplasia, hypocalcification), when failure of other available restorative materials is likely (eg, interproximal caries extending beyond line angles, patients with bruxism), following pulpotomy or pulpectomy, for restoring a primary tooth that is to be used as an abutment for a space maintainer, for the intermediate restoration of fractured teeth, for definitive restorative treatment for high caries-risk children, and used more frequently in patients whose treatment is performed under sedation or general anesthesia.[92]

There are very few prospective randomized clinical trials comparing outcomes for preformed metal crowns to intracoronal restorations.[93,94] A Cochrane review and two systematic reviews conclude that the majority of clinical evidence for the use of preformed metal crowns has come from nonrandomized and retrospective studies.[13,95-97] However, this evidence suggests that preformed metal crowns showed greater longevity than amalgam restorations,[13] despite possible study bias of placing SSCs on teeth more damaged by caries.[95,96,98] Five studies which retrospectively compared Class II amalgam to preformed metal crowns showed an average five year failure rate of 26 percent for amalgam and seven percent for preformed metal crowns.[96]

A two-year randomized control trial regarding restoration of primary teeth that had undergone a pulpotomy procedure found a non-significant difference in survival rate for teeth restored with preformed metal crowns (95 percent) versus resin modified glass ionomer/composite restoration (92.5 percent).[93] In another prospective study, significantly less restoration failure and improved calcium hydroxide pulpotomy success was found with preformed metal crowns (79.7 percent) versus amalgam restorations (60 percent) after one year.[99] However, a systematic review did not show strong evidence that preformed metal crowns were superior over other restorations for pulpotomized teeth.[100]

With regards to gingival health adjacent to preformed metal crowns, a one year randomized controlled trial showed no difference in gingival inflammation between preformed metal crowns and composite restorations after pulpotomy.[95] Yet, a two year randomized clinical study showed more gingival bleeding for preformed metal crowns vs. composite/glass ionomer restorations.[93] Inadequately contoured crown and residues of set cement remaining in contact with the gingival sulcus are suggested as reasons for gingivitis associated with preformed metal crowns, and a preventive regime including oral hygiene instruction is recommended to be incorporated into the treatment plan.[96]

There is one randomized control trial on preformed metal crowns versus cast crowns placed on permanent teeth,[101] and this report found no difference between the two restoration types for quality and longevity after 24 months. The remaining evidence is case reports and expert opinion concerning indications for use of preformed metal crowns on permanent molars. The indications include teeth with severe genetic/developmental defects, grossly carious teeth, traumatized teeth, along with tooth developmental stage or financial considerations that require semi-permanent restoration instead of a permanent cast restoration.[97,98,101] The main reasons for pre-formed metal crown failure reportedly are crown loss[13,99,102] and perforation.[102]

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Hall Technique (HT). The Hall technique calls for cementation of a SSC over a caries-affected primary molar without local anesthetic, caries removal or tooth preparation. It is a less invasive caries management procedure for treating carious primary teeth, which involves the concept of caries control by managing the activity of the biofilm.[103]This technique was developed for use when delivery of ideal treatment was not feasible. Crowns fitted using the Hall Technique may reduce discomfort from local anesthetic and caries removal at the time of treatment compared to fillings,[104] but may add the discomfort of placement of separator bands prior to the SSC/HC, as well as the pain from biting the SSC/HC into place.[105] ~~While~~ The HT has gained some popularity in the United Kingdom (**U.K.**),[104] primarily from use by general dentists, who provide the majority of care for young children.[106] ~~the technique is highly controversial in the U.S.~~ All prospective investigations on the effectiveness of HT have been by general dentists in the U.K. ~~who provide care for the majority of young children~~ and comparison groups include restorative treatment as traditionally provided in those settings, where~~. T~~traditional use of SSCs to restore caries in primary teeth has not been a popular or a frequently used technique. ~~in the U.K.,~~ This is in spite of the existence of guidelines and policy statements from the British Society of Paediatric Dentistry that SSCs are the restoration of choice for primary molars with multisurface lesions or extensive caries, or when pulp treatment has been performed.[107-110]

Results of a 2003 repeat questionnaire of general dentists in the U.K. showed that the use of amalgam had declined with an increase in the use of glass ionomer cement (**GIC**) and very little change in the use of SSCs.[107] Placement of GIC restorations or observation without treatment was the management approach of choice, and the use of local anesthesia to provide dental care to children was infrequent.[108] ~~A recent systematic review indicates that HT is more effective when compared to GIC restorations in compromised, caries-affected primary molars,(Seale and Randall 2015) but it points out that reliable~~ Given the differences in treatment approaches in health care settings and systems between countries, the Hall technique has not been widely adapted in the US, and it is usually limited to individual situations where proven methods of caries management cannot be used. ~~s~~Studies that compare this technique to traditionally placed SSCs using radiographic assessment and caries removal are needed.[111]

A recent retrospective study for cost-effectiveness combined with a cross-sectional evaluation of patient acceptance showed that 95.8% of primary teeth restored using the HT remained asymptomatic after a follow-up period of up to 77 months; compared to 95.3% in the conventional methods (caries removal and placing SSC or other restorative material)l, but does not report a breakdown by follow-up time. Although both approaches had similar successful outcomes, using the Hall Technique was also associated with reduced treatment costs, and both approaches were accepted favorably by the children and care providers.[112].

SSCs continue to offer the advantages of full coverage to combat recurrent caries and provide strength as well as long term durability with minimal maintenance, both desirable outcomes for caries management on high-risk children.

Recommendations:

1. There is evidence from retrospective studies showing greater longevity of preformed metal crown restorations compared to amalgam or resin-based restorations for the treatment of carious lesions in primary teeth. Therefore, its use is supported on high risk children with large or multiple-surface lesions on primary molars, especially when children require general anesthesia for the provision of restorative dental care.
2. There is evidence from case reports and one randomized controlled trial supporting the use of preformed metal crowns in permanent teeth as a semi-permanent restoration for the treatment of severe enamel defects or grossly carious teeth.

Anterior esthetic restorations in primary teeth

Despite the continuing prevalence of dental caries in primary maxillary anterior teeth in children, the esthetic management of these teeth remains problematic.[113] Esthetic restoration of primary anterior teeth can be especially challenging due to: the small size of the teeth; close proximity of the pulp to the tooth surface; relatively thin enamel; lack of surface area for bonding; and issues related to child behavior.[113]

There is little scientific support for any of the clinical techniques that clinicians have utilized for many years to restore primary anterior teeth, and most of the evidence is regarded as expert opinion. While a lack of strong clinical data does not preclude the use of these techniques, it points out the strong need for well designed, prospective clinical studies to validate the use of these techniques.[114] Additionally, there is limited information on the potential psychosocial impact of anterior caries or unaesthetic restorations in primary teeth.[113]

Class III (interproximal) restorations of primary incisors ~~are often~~ can be prepared with labial or lingual dovetails to incorporate a large surface area for bonding to enhance retention.[115] Resin-based restorations are appropriate for anterior teeth that can be adequately isolated from saliva and blood. Resin-modified

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glass ionomer cements have been suggested for this category, especially when adequate isolation is not possible.[116,117] It has been suggested that patients considered at high-risk for future caries may be better served with placement of full tooth coverage restorations.[117]

Class V (cervical) cavity preparations for primary incisors are similar to those in permanent teeth. Due to the young age of children treated and associated behavior management difficulty, it is sometimes impossible to isolate teeth for the placement of composite restorations. In these cases, glass ionomer cement or resin-modified glass ionomer cement is suggested.[116,117]

Full coronal restoration of carious primary incisors may be indicated when: (1) caries is present on multiple surfaces, (2) the incisal edge is involved, (3) there is extensive cervical decalcification, (4) pulpal therapy is indicated, (5) caries may be minor, but oral hygiene is very poor, or (6) the child's behavior makes moisture control very difficult.[115] Successful full-coronal restorations of ~~extensively~~ decayed primary anterior teeth have been reported; however, due to the lack of available clinical studies, it is difficult to determine whether certain techniques of restoring carious primary anterior teeth are effective.[114,118] A retrospective study showed that 80 percent of strip crowns were completely retained after three years, and 20 percent were partially retained, with none being completely lost.[119] Another retrospective study, with 24-74 months follow-up, reported 80 percent retention of strip crowns.[120]

Pre-veneered stainless steel crowns also are among the options of restoring primary anterior teeth with full coronal coverage. Three retrospective studies report excellent clinical retention of these types of crowns, yet with a high incidence of partial or complete loss of the resin facings.[113,121,122] The pre-veneer stainless crowns have the concerns of color stability and surface roughness changes,[123] so long term clinical studies are required to establish their comparative effectiveness. Pre-formed stainless steel crowns and open-faced stainless steel crowns are ~~other options; however, there appears to be no published data on the use of either crown on primary anterior teeth.(Roshan et al 2003)~~ still an option for treatment on primary anterior teeth, but published studies reporting their effectiveness and use are sparse,[107] given the more esthetic and easier to use alternatives.

Preformed pediatric zirconia crowns are another option for esthetic full coronal coverage restoration.[124]As they require a passive fit, the amount of tooth reduction is greater than that required for stainless steel crowns (minimum of 1.5-2.0 mm), and technique for tooth preparation does vary significantly among different brands.[125] There are several preformed pediatric zirconia crowns available on the market and each brand has very different material composition, fabrication, surface treatment, retentive feature and cementation methods. Although an RCT with a follow-up of only six months suggests that zirconia crowns gave significantly better results than the others with regard to gingival health and crown fractures (reference 1), a systematic review on the topic (reference 2) concluded that due to the small number of RCTs on this topic and their risk of bias, future RCTs with better study design are required to compare differences between the different types of pediatric preformed zirconia crowns and between other esthetic treatment options.

Recommendations:

1. ~~There is expert opinion that suggests the use of resin-based composites as a~~ The use of resin-modified glass ionomer cement is a viable treatment option for Class III and Class V restorations in the primary and permanent dentition. (Based on expert opinion)
2. ~~There is expert opinion that suggests t~~The use of resin-modified glass ionomer cement ~~as a~~ is a viable treatment option for Class III and Class V restorations for primary teeth, particularly in circumstances where adequate isolation of the tooth to be restored is difficult. (Based on expert opinion)
3. ~~There is expert opinion that suggests that s~~Strip crowns, pre-veneered stainless steel crowns, preformed stainless steel crowns, ~~and~~ open-faced stainless steel crowns and zirconia crowns are ~~a~~ viable treatment options for full coronal coverage restorations in primary anterior teeth. (Based on expert opinion)

Posterior esthetic restorations in primary teeth

Scientific studies that evaluate esthetic options for large carious lesion of requiring full coverage restoration for primary posterior teeth are not widely reported in the literature. The most popular options are open-faced stainless-steel crowns, pre-veneered stainless-steel crowns or zirconia crowns. The interest in esthetic options from the clinicians as well as patients is increasing.[128,129] The indications for the preformed esthetic crowns are generally the same as those of the preformed stainless-steel crowns but with consideration of esthetics.[130] The amount of tooth reduction and technique for tooth preparation does vary significantly.[125] There is need for more circumferential tooth reduction requirements for proper fit and placement for zirconia crowns compared to SSC.[125] SSCs have comparatively better retention, but a recent study demonstrates that the gingival health plaque accumulation around a zirconia crowns is better than SSC.[130,131]

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Table 1. EVIDENCE OF EFFICACY OF VARIOUS DENTAL MATERIALS/TECHNIQUES IN PRIMARY TEETH WITH REGARD TO CAVITY PREPARATION CLASSIFICATIONS

Strong evidence – based on well executed randomized control trials, meta-analyses, or systematic reviews; **Evidence in favor** – based on weaker evidence from clinical trials; **Expert opinion** – based on retrospective trials, case reports, in vitro studies and opinions from clinical researchers; **Evidence against** – based on randomized control trials, meta-analysis, systematic reviews.

	Class I	Class II	Class III	Class IV	Class V
Amalgam	Strong evidence	Strong evidence	No data	No data	Expert opinion
Composite	Strong evidence	~~Expert opinion~~ Strong Evidence	Expert opinion	No data	Evidence in favor
Glass ionomer	Strong evidence[α]	Evidence against[β]	Evidence in favor[γ]	No data	Expert opinion[γ]
RMGIC	Strong evidence	Expert opinion[ε]	Expert opinion	No data	Expert opinion
Compomers	Evidence in favor	Evidence in favor	No data	No data	Expert opinion
SSC	Evidence in favor[δ]	Evidence in favor[δ]	No data	No data	No data
Anterior[φ] crowns	N/A	N/A	Expert opinion	Expert opinion	Expert opinion

RMGIC = resin modified glass ionomer cement.
α Evidence from ART trials.
β Conflicting evidence for multisurface ART restorations.
ε Small restorations; life span 1-2 years.

SSC = stainless steel crown.
γ Preference when moisture control is an issue.
φ Strip crowns, stainless steel crowns with/without facings.
δ Large lesions.

Table 2. EVIDENCE OF EFFICACY OF VARIOUS DENTAL MATERIALS/TECHNIQUES IN PERMANENT TEETH WITH REGARD TO CAVITY PREPARATION CLASSIFICATIONS

	Class I	Class II	Class III	Class IV	Class V
Amalgam	Strong evidence	Strong evidence	No data	No data	No data
Composite	Strong evidence	Evidence in favor	Expert opinion	No data	Evidence in favor
Glass ionomer	Strong evidence[α]	Evidence against	Evidence in favor[β]	No data	Expert opinion[β]
RMGIC	Strong evidence	No data	Expert opinion	No data	Evidence in favor
Compomers	Evidence in favor[φ]	No data	Expert opinion	No data	Expert opinion
SSC	Evidence in favor[γ]	Evidence in favor[γ]	No data	No data	No data
Anterior[δ] crowns	N/A	N/A	No data	No data	No data

RMGIC = resin modified glass ionomer cement.
α Evidence from ART trials.
β Preference when moisture control is an issue.
φ Evidence from studies in adults.

SSC = stainless steel crown.
γ For children and adolescents with gross caries or severely hypoplastic teeth.
δ Strip crowns, stainless steel crowns with/without facings.

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[Best Practices]

Use of Antibiotic Therapy for Pediatric Dental Patients*

Review Council

Council on Clinical Affairs

Latest Revision

~~2014~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes the increasing prevalence of antibiotic-resistant micro-organisms and potential for adverse drug reactions and interactions. This guideline is intended to provide guidance in the proper and judicious use of antibiotic therapy in the treatment of oral conditions.~~(Wilson et al 2007)~~

Methods

This guideline was originally developed by the Council on Clinical Affairs and adopted in 2001. This document is a revision of the previous version, last revised in ~~2009~~2014. The last revision was based upon a new systematic literature search of the PubMed®/MEDLINE database using the terms: antibiotic therapy, antibacterial agents, antimicrobial agents, dental trauma, oral wound management, orofacial infections, periodontal disease, viral disease, and oral contraception; fields: all; limits: within the last 10 years, humans, English, clinical trials, birth through age 18. One hundred sixty-five articles matched these criteria. Papers for review were chosen from this search and from hand searching. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians. This update is based on a review of current literature.

Background

Antibiotics are beneficial in patient care when prescribed and administered correctly for bacterial infections. However, the widespread use of antibiotics has permitted common bacteria to develop resistance to drugs that once controlled them.[1,2,3] (~~Wilson et al 2007~~) Drug resistance is prevalent throughout the world.[3] In the United States, at least 2 million people are infected by antibiotic-resistant bacteria per year.[2] Some microorganisms may develop resistance to a single antimicrobial agent, while

* **ABBREVIATION**
AAPD: American Academy Pediatric Dentistry.

others develop multidrug-resistant strains.[3] (~~CDC Antibiotic/Antimicrobial resistance~~) To diminish the rate at which resistance is increasing, health care providers must be prudent in the use of antibiotics.[2] (~~Wilson et al 2007~~) Conservative use of antibiotics is indicated to minimize the risk of developing resistance to current antibiotic regimens.[2,3] Adverse events such as allergic reactions, development of C. difficile, or drug interactions and side effects can occur.[4] The Centers for Disease Control and Prevention report that every year there are 140,000 emergency department visits for reactions to antibiotics, and that antibiotics are the most common cause of emergency department visits for adverse drug events in children under the age of 18 years.[4] Practitioners should adhere to the following general principles when prescribing antibiotics for the pediatric population.

The use of antibiotic prophylaxis for dental patients at risk for infection is addressed in a separate document.[5]

For a description of useful antibiotics, please see “Useful Medications for Oral Conditions” in the Resources Section.[6]

Recommendations

~~Conservative use of antibiotics is indicated to minimize the risk of developing resistance to current antibiotic regimens.(CDC Antibiotic/Antimicrobial resistance, Costelloe et al 2010) Practitioners should adhere to the following general principles when prescribing antibiotics for the pediatric population.~~

~~**Oral wound management**~~ *Oral Wounds*

Factors related to host risk (e.g., age, systemic illness, co-morbidities, malnutrition) and type of wound (e.g., laceration, puncture) must be evaluated when determining the risk for infection and subsequent need for antibiotics. Wounds can be classified as clean, potentially contaminated, or contaminated/dirty. Facial puncture wounds and lacerations may require topical antibiotic agents.[7] Intraoral puncture wounds and lacerations that appear to have been contaminated by extrinsic bacteria, debris (dirt, soil, gravel), foreign body, open fractures, and joint injury have an increased risk of infection and should be ~~covered~~ managed with systemic antibiotics.[7] Tetanus immunization status should be determined. If it is determined that antibiotics would be beneficial to the healing process, the timing of the administration of antibiotics is critical to supplement the natural host resistance in bacterial killing. The drug should be administered as soon as possible for the best result. The most effective route of drug administration (intravenous vs. intramuscular vs. oral) must be considered. The clinical effectiveness of the drug must be monitored. The minimal duration of drug therapy should be five days beyond the point of substantial improvement or resolution of signs and symptoms; this is usually a five- to seven-day course of treatment dependent upon the specific drug selected.[8-10] In light of the growing problem of drug resistance, the clinician should consider altering or discontinuing antibiotics following determination of either ineffectiveness or cure prior to completion of a full course of therapy.[11] If the infection is not responsive to the initial drug selection, a culture and sensitivity~~susceptibility~~ testing of a swab ~~isolates~~ from the infective site or, in some cases, a blood microbiology, culture and sensitivity may be indicated.

~~**Special conditions**~~

Pulpitis/apical periodontitis/draining sinus tract/localized intra- oral swelling

Bacteria can gain access to the pulpal tissue through caries, exposed pulp or dentinal tubules, cracks into the dentin, and defective restorations. If a child presents with acute symptoms of pulpitis, treatment (i.e., pulpotomy, pulpectomy, or extraction) should be rendered. Antibiotic therapy usually is not indicated nor effective if the dental infection is contained within the pulpal tissue or the immediate surrounding tissue. In this case, the child will have no systemic signs of an infection (i.e., no fever and no facial swelling).[1] ~~(Maestre-Vera 2004, Keenan et al 2006)~~

Consideration for use of antibiotics should be given in cases of advanced non-odontogenic bacterial infections such as staphylococcal mucositis, tuberculosis, gonococcal stomatitis, and oral syphilis. If suspected, it is best to refer patients for microbiology, culture and sensitivity, biopsy, or other laboratory tests for documentation and definitive treatment.

Acute facial swelling of dental origin

A child presenting with a facial swelling or facial cellulitis secondary to an odontogenic infection should receive prompt dental attention. In most situations, immediate surgical intervention is appropriate and contributes to a more rapid cure.[12] The clinician should consider age, cooperation, the ability to obtain adequate anesthesia (local vs. general), the severity of the infection, the medical status, and any social issues of the child.[12,13] Signs of systemic involvement and septicemia (~~i.e.,~~ e.g., fever, malaise, asymmetry, facial swelling, lymphadenopathy, trismus, tachycardia, dysphagia, respiratory distress) warrant emergency treatment. Additional testing such as a complete blood exam, c-reactive protein, blood cultures, and bacterial culture and sensitivity can aide in assessment and diagnosis. Intravenous antibiotic therapy ~~and/or referral for~~ medical management is ~~may be~~ indicated.[12,13] ~~(Maestre-Vera 2004, Keenan et al 2006)~~ Penicillin derivatives remain~~s~~ the empirical choice for odontogenic infections; however, consideration of additional adjunctive antimicrobial therapy (i.e., metronidazole) can be given where there is anaerobic bacterial involvement.[11,14] Cephalosporins could be considered as an alternative choice for odontogenic infections.[14]

Dental trauma

Systemic antibiotics have been recommended as adjunctive therapy for avulsed permanent incisors with an open or closed apex.[15-17] (~~Andreasen and Andreasen 2007~~) Tetracycline (doxycycline twice daily for seven days) is the drug of choice, but consideration of the child's age must be exercised in the systemic use of tetracycline due to the risk of discoloration in the developing permanent dentition. ~~(Rega et al 2006, Andreasen and Andreasen 2007)~~ Penicillin V or amoxicillin can be given as an alternative in patients under 12 years of age.[15,17]~~(Andreasen and Andreasen 2007)~~ The use of topical antibiotics (minocycline or doxycycline) to enhance ~~induce~~ pulpal revascularization and periodontal healing in immature non-vital traumatized teeth has shown some potential.[15,17,18] ~~(Andreasen and Andreasen 2007)~~ However, further randomized clinical trials are needed.[19,20] ~~(Thibodeau et al 2007)~~ For luxation injuries in the primary dentition, antibiotics ~~generally~~ are not indicated.[15,21] Antibiotics can be warranted in cases of concomitant soft tissue injuries (see **Oral wound management**) and when dictated by the patient's medical status.

Pediatric periodontal diseases

Gingival inflammation due to the presence of bacterial plaque accumulation is a key factor in the development of periodontal disease and must be controlled.[22] However, a distinction must be made between a site of gingival inflammation versus a gingival case, diagnosed at the patient level, using specific criteria, including bleeding on probing.[23] Periodontal diseases are now classified as necrotizing periodontal disease, periodontitis as manifestation of systemic diseases, and periodontitis.[24] The specifics of these new classifications are addressed in a future document.[25] Dental plaque-induced gingivitis is managed by appropriate local therapeutic interventions[22] including professional oral hygiene and re-enforcement of brushing twice daily for at last 2 minutes.[26] ~~does not require antibiotic therapy~~. ~~Treatment recommendations have not yet been made for these new periodontal classifications.~~ Based on previous definitions of periodontal diseases, ~~P~~pediatric patients with aggressive periodontal diseases may require adjunctive antimicrobial therapy in conjunction with localized treatment.[27,28] In pediatric periodontal diseases associated with systemic disease (e.g., severe congenital neutropenia, Papillon-Lefèvre syndrome, leukocyte adhesion deficiency), the immune system is unable to control the growth of periodontal pathogens and, in some cases, treatment may involve antibiotic therapy.[27, 28] ~~The use of~~

~~systemic antibiotics has been recommended as adjunctive treatment to mechanical debridement in patients with aggressive periodontal disease. (AAPerio 2003, Schmidt et al 2013~~ In severe and refractory cases, extraction is indicated.[27,28] Culture and susceptibility testing of isolates from the involved sites are helpful in guiding the drug selection.[27,28]

Viral diseases

Conditions of viral origin such as acute primary herpetic gingivostomatitis should not be treated with antibiotic therapy.[4] ~~unless there is strong evidence to indicate that a secondary bacterial infection exists.(AAP 2003).~~

Salivary gland infections

For acute salivary gland swellings of bacterial nature, antibiotic therapy is indicated.[29] If the patient does not improve in 24 – 48 hours on antibiotics alone, incision and drainage may be warranted.[29] ~~Many salivary gland infections, following confirmation of bacterial etiology, will respond favorable to antibiotic therapy. Acute bacterial parotitis has two forms: hospital acquired and community acquired.(Carlson 2009) Both can be treated with antibiotics.~~ Amoxicillin/clavulanate is used as empirical therapy to cover both staphylococcal and streptococcal species as most bacterial infections of the salivary glands originate from oral flora.[29] Clindamycin is appropriate for penicillin allergic patients.[29] The most common inflammatory salivary gland disorder in the United States is juvenile recurrent parotitis (JRP), with first onset of symptoms between ages 3 – 6 years old, continuing to puberty.[29] Although JRP is self-limiting, administration of B-lacatam antibiotics can shorten symptom duration.[29] ~~Hospital acquired usually requires intravenous antibiotics; oral antibiotics are appropriate for community acquired. Chronic recurrent juvenile parotitis generally occurs prior to puberty. Antibiotic therapy is recommended and has been successful.(Carlson 2009)~~ For both acute bacterial submandibular sialadenitis and chronic recurrent submandibular sialadenitis, antibiotic therapy is included as part of the treatment.[30]

Oral contraceptive use

Although caution is advised with the concomitant use of antibiotics and oral contraceptives,[31,32] a 2018 systematic review of drug interactions between non-rifamycin antibiotics and hormonal contraception found that most women can expect no reduction in hormonal contraceptive effect with the concurrent use of non-rifamycin antibiotics.[33] The World Health Organization (WHO), in 2015, also reported that most broad-spectrum antibiotics do not affect the contraceptive effectiveness of combined oral contraceptives, combined contraceptive patch, or the combined contraceptive vaginal ring.[34] In addition, no differences in ovulation were found when oral contraceptives were combined with ampicillin, doxycycline, temafloxacin, ofloxacin, ciprofloxacin, clarithromycin, roxithromycin, dirithromycin, or metronidazole.[33] Women should be encouraged to take oral contraceptives correctly and consistently at all times, including during periods of illness.[33]

Rifamcyin antibiotics, such as rifampin or rifabutin, induce hepatic enzymes that are required for hormonal contraceptive metabolism, which could compromise the contraceptive or antibiotic effect.[33,34] Use of other contraceptives should be advised with long-term use of these medications.[34] ~~Whenever an antibiotic is prescribed to a female patient taking oral contraceptives to prevent pregnancy, the patient must be advised to use additional techniques of birth control during antibiotic therapy and for at least one week beyond the last dose, as the antibiotic may render the oral contraceptive ineffective.(DeRossi and Hersh 2002, Becker 2011) Rifampicin has been documented to decrease the effectiveness of oral contraceptives. (DeRossi and Hersh 2002, Becker 2011) Other antibiotics, particularly tetracycline and penicillin derivatives, have been shown to cause significant decrease in the plasma concentrations of ethinyl estradiol, causing ovulation in some individuals taking oral contraceptives. (DeRossi and Hersh 2002, Becker 2011)~~

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[Best Practices]

Informed Consent*

Review Council

Council on Clinical Affairs

Latest Revision

~~2015~~ 2019

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that informed consent is essential in the delivery of health care. The informed consent process allows the patient or, in the case of minors, the parent† to participate in and retain autonomy over the health care received. Informed consent also may decrease the practitioner's liability from claims associated with miscommunication. ~~This guideline recognizes that~~ Informed consent is governed by the statutes and case laws of individual states; oral health care providers should review the applicable laws and regulations of their state.

Methods

~~This guideline was~~ Originally developed by the Council on Clinical Affairs and adopted in 2005, ~~This~~ this document is a revision of the previous version. ~~last~~ Last revised in ~~2014~~ 2015, ~~This~~ this revision included a systematic literature search of the PubMed®/MEDLINE database using the terms: informed consent, pediatric consent, pediatric informed consent, consent, informed refusal, cultural background informed consent, linguistic background informed consent, and interpreters informed consent: fields: all; limits: within the last 10 years, humans, English, review of legal cases. ~~One hundred fifty four~~ One hundred forty two articles matched these criteria. Papers for review were

* **ABBREVIATIONS**
ADA: American Dental Association. **AAPD**: American Academy Pediatric Dentistry.

† In all AAPD oral health care policies and clinical practice guidelines, the term "parent" has a broad meaning encompassing a natural/biological father or mother of a child with full parental legal rights, a custodial parent who in the case of divorce has been awarded legal custody of a child, a person appointed by a court to be the legal guardian of a minor child, or a foster parent (a noncustodial parent caring for a child without parental support or protection who was placed by local welfare services or a court order). American Academy of Pediatric Dentistry. Reference Manual: Introduction. Pediatr Dent 2015;37(special issue):2-3.

chosen from this list and from references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/ or consensus opinion by experienced researchers and legal practitioners.

Background

Informed consent is the process by which a health care provider gives relevant information concerning diagnosis and treatment needs to a patient ~~of providing that~~ ~~the patient~~ ~~or, in the case of a minor or incompetent adult, the parent, so with relevant information regarding diagnosis and treatment needs~~ so that the patient ~~or parent~~ can make a a~~n~~ voluntary, educated decision ~~regarding~~ to accept or refuse treatment.~~ can be made by the patient or parent.~~ Minor children are legally unable to give informed consent, and intellectually disabled adults lack capacity to give consent. Parents are authorized to grant or decline permission for treatment with assent or agreement from the child or incompetent adult whenever possible.[1-4] All requirements of informed consent apply when the parent is acting on behalf of the child.[1,3]

Informed consent involves both ethical and legal obligations of the health care provider to the patient. The American Dental Association (**ADA**) states that dentists are "required to provide information to patients/parents about the dental health problems the dentist observes, the nature of any proposed treatment, the potential benefits and risks associated with that treatment, any alternatives to the treatment proposed, and the potential risks and benefits of alternative treatments, including no treatment."[5] Following the informed consent discussion, an assessment of patient/parental understanding should be made, and any confusion about the treatment should be clarified by the provider before consent is granted.[2,6]

~~State laws and court decisions determine the criteria for informed consent.(De Bord 2014) (Sfikis 2003)~~ Autonomy over healthcare decisions is a patient's right. A ~~In~~ 1914~~, a~~ New York state court ruled that "every human being of adult years and sound mind has a right to determine what shall be done with his own body…."[7] ~~Although most cases have involved other health professionals, oral health care providers should follow the rulings established by these cases.~~ Additionally, ~~Ruling~~ ruling from the Supreme Court of North Dakota found that laws pertaining to a physician's duty to obtain informed consent also pertained to dentists.[8] As court rulings and laws differ in each state, it is difficult to develop an inclusive guideline.

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The law generally has several criteria for selecting information to provide to a patient/parent as part of an informed consent. Some states follow a patient-oriented standard—that information which a reasonably prudent patient/parent in same or similar circumstances would wish to know.[9,10,11] Other states follow a practitioner-oriented standard—that information which a health care provider, practicing within the standard of care, would reasonably provide to a patient/parent in the same circumstances.[9,10,12] A hybrid approach, combining the patient-oriented and practitioner-oriented standards, is followed by some states.[10,12] Finally, a subjective person standard requires the practioner to give information that the particular patient in question would want to know.[2,9]

Regardless of the standard a state has chosen to follow, the treating practitioner must disclose information that he/she considers material to the patient's/parent's decision-making process and provide a warning of death or serious bodily injury where that is a known risk of the procedure.[10,13] The informed consent process generally excludes adverse consequences associated with a simple procedure if the risk of occurrence is considered remote and when such circumstances commonly are understood by the profession to be so.

~~It generally is understood that the person granting consent is the patient of the age of majority. For Patients under the age of majority or adults with diminished mental capacity, informed consent permission should be obtained from a parent. (Sfikis 2003, LeBlang et al 2004)~~ The ADA code of ethics recommends that dentist provide information "in a manner that allows the patient to become involved in treatment decisions."[13] Pediatric dental health care providers have the opportunity to guide and support the child patient to become involved in his own health care. Young children lack the cognitive ability to participate in the informed consent discussion, but older children and adolescents who have gained experience as dental patients may be included. Information should be provided to the patient in an age appropriate manner and practitioners should seek assent (agreement) from the patient whenever possible.[15,16] Although the child can be involved, the parent is the individual giving consent and the parent is the individual who decides to accept or refuse treatment.

The practitioner should be aware that the adult accompanying the pediatric patient may not be a legal guardian allowed by law to consent to medical procedures. Examples of such an adult include a grandparent, step-parent, noncustodial parent in instances of divorce, babysitter, or friend of the family. A child in foster care or a ward of the state may be accompanied by a caretaker who may or

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may not be allowed to consent to medical procedures, according to individual state law. It is advisable that the oral health care provider obtain a copy of court orders appointing a guardian to verify who is authorized to consent for medical treatment for the patient.[16](~~Sfikis 2003~~) One option to consider is obtaining a parent's authorization via a consent by proxy or power of attorney agreement for any other individual to make dental treatment decisions for a child.[10,16] In situations where individuals other than the parent regularly bring the child to the dental office, this can help eliminate doubt as to whether such individual has the legal authority to provide informed consent. Practitioners, however, should consult their own attorney in deciding whether to utilize such a form in their own practice. Another option for obtaining authorization for treatment is a telephone conversation with the parent.[16,17] (~~Australian Capital Territory Government Health Directorate 2012~~) The parent should be told there are two people on the telephone and asked to verify the patient's name, date of birth, and address and to confirm he/she has responsibility for the patient.[17] (~~Australian Capital Territory Government Health Directorate 2012~~) The parent is presented with all elements of a valid informed consent followed by documentation in the patient's chart with signatures.[16,17] (~~Australian Capital Territory Government Health Directorate 2012~~)

Written consent is required by ~~some~~ most states before treatment of a patient.[10,] (~~Sfikis 2003~~) Even if not mandated by state law, written consent is advisable as it may decrease the liability from miscommunication.[17] A patient's or parent's signing a consent form should not preclude a thorough discussion. Studies have shown that even when seemingly adequate information has been presented to patients/parents, their ability to fully understand the information may be limited.[6,9] Dentists should be aware of the cultural and linguistic backgrounds of their patients and families and take care to ensure that information is available in culturally and linguistically competent formats to help parents in the decision-making process.[19](~~Australian Capital Territory Government Health Directorate 2012~~) Also, to assure a person who is deaf or hearing impaired can consent, a dentist carefully should consider the patient's self-assessed communication needs before any treatment. Practitioners may need to provide access to translation services (e.g., in person, by telephone, by subscription to a language line) and sign language services.[1,19] (~~Chen et al 2007~~) Practitioners who receive federal funding, as well as those in a significant number of states, are mandated to provide these services at no cost to the patient.[1,19](~~Chen et al 2007~~) Supplements such as informational booklets ,~~or~~ videos, or models may be helpful to the patient in understanding a proposed procedure. The oral discussion between provider and patient, not the completion of a form, is the important issue of informed consent. The consent form should document the oral discussion of the proposed therapy, including risks, benefits, and

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possible alternative therapy, as well as no treatment.[3,5,19] (~~Australian Capital Territory Government Health Directorate 2012~~)

Informed refusal occurs when the patient/parent refuses the proposed and alternative treatments.[5,17] (~~Australian Capital Territory Government Health Directorate 2012~~) The dentist must inform the patient/parent about the consequences of not accepting the proposed treatment ~~and obtain a signed informed refusal~~. It is recommended by the ADA that informed refusal be documented in the chart and that the practitioner should attempt to obtain an informed refusal signed by the parent for retention in the patient record. An informed refusal, however, does not release the dentist from the responsibility of providing a standard of care.[5] If the dentist believes the informed refusal violates proper standards of care, he/she should recommend the patient seek another opinion and/or dismiss the patient from the practice.[5] If the dentist suspects dental neglect, appropriate authorities should be informed.[18]

When a consent form is utilized, it is best to use simple words and phrases. ~~, avoiding technical terms, so that it may be easily understood.~~ A modified or customized ~~consent~~ form is preferred over a standard form and should be~~ in a format~~ written so that is readily understandable to a lay person.[3,5,17,19] (~~Australian Capital Territory Government Health Directorate 2012~~, ~~Tait et al 2005~~) Overly broad statements such as “any and all treatment deemed necessary…” or “all treatment which the doctor in his/her best medical judgment deems necessary, including but not limited to…” should be avoided. Courts have determined it to be so broad and unspecific that it does not satisfy the duty of informed consent. Informed consent discussion, when possible, should occur on a day separate from the treatment and the practitioner should avoid downplaying the risks involved with the proposed therapy.[6]Items that should appear on a consent form are listed under Recommendations.

Informed consent and informed refusal forms[20] should be procedure specific, with multiple forms likely to be used~~. Dentists should consult their own attorney and the state dental association as informed consent laws vary by state.~~ For example, risks associated with restorative procedures will differ from those associated with an extraction. Separate forms, or separate areas outlining each procedure on the same form, would be necessary to accurately advise the patient regarding each procedure.[5] Consent for sedation, general anesthesia, or behavior guidance techniques such as protective stabilization (i.e., immobilization) should be obtained separately from consent for other procedures.[4,21] Consent may need to be updated or changed accordingly as changes in treatment plans occur. When a primary tooth originally planned for pulp therapy is determined to be nonrestorable at the time of treatment, consent will need to be updated to reflect the change in treatment. Depending on state laws, this update may be in oral or written form. Dentists should consult their own attorney and state dental association as informed consent laws vary by state.[5]

Recommendations

Informed consent is the process of providing the patient ~~or, in the case of a minor or incompetent adult, the parent~~ with relevant information regarding diagnosis and treatment needs so that an educated decision regarding treatment can be made by the patient. In the case of a minor or intellectually disabled adult, the parent gives informed permission with assent or agreement from the child whenever possible. The oral discussion between provider and patient or parent, not the completion of a form, is the important issue of informed consent. A written consent form serves as documentation of the consent process and is required by most states. Other states allow the oral discussion to be documented in the patient record. Dentists should be aware of the cultural and linguistic backgrounds of their patients and families, and take care to ensure that information is available in culturally and linguistically competent formats to help patients and parents in the decision making process.

Statutes and case law of individual states govern informed consent. ~~Some states allow oral discussions, which should be documented in the medical record, while others may require written consent.~~ Oral health practitioners should review applicable state laws to determine their level of compliance. Consent forms should be procedure specific, utilize simple terms, and avoid overly broad statements. When a practitioner utilizes an informed consent form, the following should be included:

1. Legal name and date of birth of pediatric patient.
2. Legal name and relationship to the pediatric patient/legal basis on which the person is ~~consenting~~ granting permission on behalf of the patient.
3. Patient’s diagnosis.
4. Nature and purpose of the proposed treatment in simple terms.
5. Potential benefits and risks associated with that treatment.
6. Professionally-recognized or evidence-based alternative treatment – including no treatment – to recommended therapy and risk(s).
7. Place for parent to indicate that all questions have been asked and adequately answered.

8. Places for signatures of the parent or legal guardian, dentist, and an office staff member as a witness.

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[Best Practices]

Acquired Temporomandibular Disorders in Infants, Children, and Adolescents[*]

Review Council

Council on Clinical Affairs

Latest Revision

~~2015~~ 2019

Key words: pediatric, adolescent, temporomandibular joint, temporomandibular disorders, temporomandibular joint dysfunction syndrome

Methods

This ~~guideline~~ document was originally developed by the Clinical Affairs Committee – Temporomandibular Joint Problems in Children Subcommittee and adopted in 1990. This document is a revision of the previous version, last revised in 2010. The update included an electronic search using the terms: temporomandibular disorder, TMJ dysfunction, TMD AND adolescents, TMD AND gender differences, TMD AND occlusion, TMD AND treatment; fields: all fields; limits: within the last 15 years, humans, English, clinical trials. The reviewers agreed upon the inclusion of ~~78~~ 102 references to support this document~~guideline~~. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Definition of TMD

TMD is a collective term for a group of musculoskeletal and neuromuscular conditions which includes several clinical signs and symptoms involving the muscles of mastication, the TMJ, and associated structures.[1] While TMD has been defined as "functional disturbances of the masticatory system",[2] others include masticatory muscle disorders,[3] degenerative and inflammatory TMJ disorders,[4] and TMJ disk

[*] **ABBREVIATIONS**
AAPD: American Academy Pediatric Dentistry. **CBCT**: Cone-beam computed tomography. **TMD**: Temporomandibular disorder. **TMJ**: Temporomandibular joint. **DC**: Diagnostic criteria

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displacements[5] under the umbrella of TMD.

~~In a recent update, the American Academy of Orofacial Pain divided TMD in two broad categories: TMJ disorders and masticatory muscle disorders.~~

Prevalence of TMD in children and adolescents

TMDs have been identified as a major cause of nonodontogenic pain in the orofacial region[6] ~~(Bells Oral and Facial Pains 2014).~~ The reported prevalence of TMD in infants, children, and adolescents varies widely in the literature.[7-12] This variation may be due to differences in populations studied, diagnostic criteria, examination methods, and inter- and/or intra-rater~~-d~~ variations of examining practitioners.[13,14] The Diagnostic Criteria (**DC**) TMD examination protocol is used in research settings to decrease variability in diagnosis; however, few pediatric studies use this methodology.[15,16] One study using the DC-TMD criteria demonstrated an 11.9 percent prevalence of TMD in adolescents.[16] Most data suggests the ~~P~~prevalence of signs and symptoms of TMD increases with age.[12,16,17] One study reported ~~the~~that TMD-related symptoms were rare in three~~-~~ and five-year-olds whereas five to nine percent of 10- and 15-year-olds reported more severe symptoms.[17] Another study found that 4.2 percent of adolescents aged 12-19 years reported TMD pain.[14] A study of children in the primary dentition ~~reported~~ found that 34 percent of patients have ~~with~~ signs and/or symptoms of TMD.[18] This could, in part, be due to inclusion of muscular signs such as tenderness to palpation which can be difficult to assess in young children.[11,18] ~~versus symptoms~~. ~~An epidemiological study of 4,724 children aged five through 17 years reported 25 percent with symptoms. Clicking was seen in 2.7 percent of children in the primary dentition and 10.1 percent in late mixed dentition, and further increased to 16.6 percent in patients with permanent dentition.(Thilander et al 2002)~~ A systematic review and meta-analysis of intra-articular TMD in children and adolescents found a 16 percent prevalence of clinical signs and a 14 percent prevalence of TMJ sounds.[11] ~~Headaches appear to be independently and highly associated with TMD in adolescents, with headaches most commonly occurring before the onset of TMD jaw pain (odds ratio 9.4).(Nilsson et al 2013)~~ Although TMD pain in children increases with age in both boys and girls, recent surveys have indicated a significantly higher prevalence of symptoms and greater need for treatment in girls than boys.[12,19] ~~with t~~ The development of symptomatic TMD has been correlated with the onset of puberty in girls.[20] For ages 16-19 years, 32.5 percent of girls compared to 9.7 percent of boys reported school absences and analgesic consumption due to TMD-related pain.[19] Headaches appear to be independently and highly associated with TMD in adolescents, with most occurring before the onset of jaw pain.[21]

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Etiology of TMD

Temporomandibular disorders have multiple etiological factors.[22] There is ~~Research is~~ insufficient evidence to reliably predict which patients will or will not develop TMD.[23] ~~as most published investigations evaluate static, morphologic variables rather than study the dynamic relationship between the joint and the teeth during function.(Howard 2013)~~ ~~There are p~~Predisposing (or risk) factors, precipitating (or initiating) factors, and perpetuating (or sustaining) factors ~~that~~ contribute to the development of TMDs.[23] ~~Many studies show a~~The available evidence base suggests a poor correlation between any single etiological factor and resulting signs (i.e., findings identified by the dentist during the examination) and symptoms (i.e., findings reported by the child or parent).[24] Alterations in any one or a combination of teeth, periodontal ligament, the TMJ, or the muscles of mastication may lead to TMD.[24] Furthermore, systemic and psychosocial factors may reduce the adaptive capacity of the masticatory system and contribute to TMD.[1]

Etiologic factors suggested as contributing to the development of TMD are:

1. Macrotrauma: ~~This would include impact injuries such as trauma to the chin.~~ A common occurrence in childhood because of falling, chin trauma is reported to be a factor in the development of TMD in pediatric patients.[25-28] Additional macrotraumatic injuries occur due to motor vehicle accidents, sports, physical abuse, forceful intubation, and third molar extraction.[25,29] Unilateral and bilateral intracapsular or subcondylar fractures are the most common mandibular fractures in children.[30] Closed reduction and prolonged immobilization can result in ankylosis.[31,32] Improperly treated fractures may result in facial asymmetry.[31,32] Traumatic brain injury (TBI) may accompany mandibular fracture and other types of jaw injuries.[25] Indirect trauma such as flexion-extension (whiplash) injuries may alter pain processing and lead to TMD symptoms; however, a direct relationship between TMD and indirect trauma has yet to be established.[1]

2. Microtrauma from parafunctional habits: Bruxism, clenching, hyperextension, and other repetitive habitual behaviors are thought to contribute to the development of TMD by joint overloading that leads to cartilage breakdown, synovial fluid alterations, and other changes within the joint.[33] Bruxism may occur while the patient is asleep or awake; sleep bruxism is a different entity from daytime bruxism. Sleep bruxism has been classified as a sleep-related movement disorder.[34] A study of 854 patients younger than 17 years old found the prevalence of bruxism to be 38 percent,[35] but studies generally do not distinguish between sleep or daytime bruxism. The literature on the association between parafunction and TMD in pediatric patients is contradictory.[36,37,38] However,

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childhood parafunction was found to be a predictor of the same parafunction 20 years later.[39] Other studies found ~~correlations~~ a significant association between reported bruxism and TMD~~.~~[40,41] ~~with a 3.4 odds ratio~~ Children who grind their teeth were found to complain more often of pain and muscle tenderness when eating.[42] Other examples of microtrauma include repetitive strain such as playing a wind instrument, fingernail biting,[23] or another activity in which the mouth is held open outside of rest position.

3. Anatomical factors (skeletal and occlusal) and orthodontic treatment: There is a relatively ~~low~~ weak association of skeletal and occlusal factors and the development of TMD.[1,43,44,45] ~~It is reasonable that some occlusal factors may place greater adaptive demands on the masticatory system. Current literature~~ Furthermore, the available data does not support that the development of TMD is caused or improved by orthodontic treatment,[46,47,48,49,50] regardless of whether premolars were extracted ~~prior to treatment~~.[29] Changes in freeway dimension of the rest position (normally two to four millimeters) may be impinged by occlusal changes, disease, muscle spasms, nervous tension, and/or restorative prosthetics.[2] While most children and adolescents may be able to compensate without problem, in others, failure of the masticatory system to adapt may lead to greater risk of dysfunction. ~~In a study of 4,724 children aged five-17 years grouped by stage of dental development, the following malocclusions were found to be associated with TMD: (Thilander et al 2002)~~ Although there is little evidence to implicate skeletal or occlusal factors with TMD the following have some association across studies:
   - Skeletal anterior open bite~~.~~[51,52]
   - Steep articular eminence of the temporal bone~~.~~[1]
   - Overjet greater than six to seven millimeters~~.~~[51,52,53,54]
   - Skeletal class II profile[55]
   - Hyperdivergent growth pattern[55]
   - Class III malocclusion~~.~~[51, 52]
   - Unilateral ~~P~~posterior crossbite[43,52.]
   - Loss of posterior support[43]

Craniocervical posture has been suggested to be associated with occlusion and with dysfunction of the TMJ, including abnormalities of the mandibular fossa, condyle, ramus, and disc.[56] Cervical pain and dysfunction can be a result of poor posture.[57] Cervical pain is frequently referred to orofacial structures and can be misinterpreted as TMD.[6)]

4. Psychosocial factors: Psychosocial factors may play a part in the etiology of TMD.[58,59] Behavioral

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factors such as somatization, anxiety, obsessive-compulsive feelings, and psychologic stress were predictors of TMD onset.[58]~~.~~ Emotional stress predisposes to clenching and bruxism which in turn contribute to orofacial pain.[60] Results from a case-control study indicate that management of stress and anxiety can mitigate the signs and symptoms of TMD.[59] Depression, anxiety, post- traumatic stress disorder, psychologic distress, and sleep dysfunction may influence TMD prognosis and symptoms.[61] ~~Behavioral factors such as somatization and depression influence TMD pain to a larger degree in girls than in boys.~~ Higher pain intensity in the orofacial region correlated with greater impact on quality of life including difficulty with prolonged jaw opening, eating hard/soft foods, and sleeping.[61)]

5. Systemic and pathologic factors: Systemic factors contributing to TMD include connective tissue diseases such as rheumatoid arthritis, systemic lupus erythematosus, juvenile idiopathic arthritis, and psoriatic arthritis.[62,63,23] These systemic diseases occur as a result of imbalance of pro-inflammatory cytokines which causes oxidative stress, free radical formation, and ultimately joint damage.[64] Other systemic factors may include joint hypermobility, genetic susceptibility, and hormonal fluctuations. Generalized joint laxity or hypermobility (e.g., Ehler Danlos syndrome) has been cited but has a weak association with TMD.[65,66]Pathologic destructive and overgrowth processes such as post radiation therapy deformity, post traumatic tumor resection defect, condylar hyperplasia, and condylar tumors represent a unique category of TMDs.[63]
6. Genetic and hormonal factors: There is little research in regard to the genetic susceptibility for development of TMD. Recently, study of catechol-O-methyl-transferase (COMT) haplotypes found that the presence of one low pain sensitivity haplotype decreased the risk of developing TMD.[58] The role of hormones in the etiology of TMD is debatable. Randomized controlled trials indicate that estrogen does not play a role in the etiology of TMD, whereas cohort and case-controlled studies show the opposite.[1] Although the biological basis for gender-based disparity in TMD is unclear, the time course of symptoms is of note in females. Additional studies have shown that TMJ pain and other symptoms vary in relation to phases of the menstrual cycle.[67] The suggestion of a hormonal influence in development of TMD is supported clinically by a study of 3,428 patients who sought treatment for TMD. This study revealed that 85.4 percent of patients seeking treatment were female and the peak age for treatment seeking was 33.8 years.[67] In a similar study of adolescents,[68] 15.1 percent of all patients evaluated for TMD were less than 20 years of age and girls accounted for 89.9 percent of patients aged 15-19 seeking care and 75.5 percent of patient six-14 years of age.

Diagnosing TMD

All comprehensive dental examinations should include a screening evaluation of the TMJ and surrounding area.[69,70] Diagnosis of TMD is based upon a combination of historical information, clinical examination, and/or craniocervical and TMJ imaging.[1] The findings are classified as symptoms and signs.[69] These symptoms may include pain, headache, TMJ sounds, TMJ locking, and ear pain.[71] Certain medical conditions are reported to occasionally mimic TMD. Among these differential diagnoses are trigeminal neuralgia, central nervous system lesions, odontogenic pain, sinus pain, otological pain, developmental abnormalities, neoplasias, parotid diseases, vascular diseases, myofascial pain, cervical muscle dysfunction, and Eagle's syndrome.[6] Other common medical conditions (e.g., otitis media, allergies, airway congestion, rheumatoid arthritis) can cause symptoms similar to TMD.[71]

Clinical and physical assessment of the patient may include history and determination of joint sounds, evaluation of mandibular range of motion, appraisal of pain, evaluation for signs of inflammation, and select radiographic examination.[71]

A screening history, as part of the health history, may include questions such as: [1,23]

- Do you have difficulty opening your mouth?
- Do you hear noises within your jaw joint?
- Do you have pain in or around your ears or your cheeks?
- Do you have pain when chewing, talking, or using your jaws?
- Do you have pain when opening your mouth wide or when yawning?
- Has your bite felt uncomfortable or unusual?
- Does your jaw ever lock or go out?
- Have you ever had an injury to your jaw, head, or neck? If so, when? How was it treated?
- Have you previously been treated for a temporomandibular disorder? If so, when? How was it treated?

Physical assessment should include the following: [1,23,71]

1. Palpation of the muscles of mastication and cervical muscles for tenderness, pain, or pain referral patterns. ~~(American Academy of Orofacial Pain-Orofacial Pain: Guidelines)~~
2. Palpation of the lateral capsule of the TMJs.~~(Howard 2014)~~
3. Mandibular function and provocation tests. ~~(American Academy of Orofacial Pain-Orofacial Pain: Guidelines, Howard 2014)~~

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4. Palpation and auscultation for TMJ sounds.~~(Howard 2014)~~
5. Mandibular range of motion.~~(Howard 2014)~~

Evaluation of jaw movements including assessment of mandibular range of motion using a millimeter ruler (i.e., maximum unassisted opening, maximum assisted opening, maximum lateral excursion, maximum protrusive excursion) and mandibular opening pattern (i.e., symmetrical vs. asymmetrical) may be helpful in the diagnosis of TMD. In addition, b~~B~~oth limited and excessive mandibular range of motion may be seen in TMD.[1,23]

TMJ imaging is recommended when there is a recent history of trauma or developing facial asymmetry, or when hard-tissue grinding or crepitus is detected.[72] Imaging should also be considered in patients that have failed to respond to conservative TMD treatment.[33] TMJ imaging ~~Radiographic~~ assessment may include:

- Panoramic radiograph~~or full mouth periapical films;~~
- ~~Lateral cephalogram;~~
- Mandible radiographs including oblique views
- Conventional computed tomography (CT) or cone-beamed CT
- ~~TMJ tomography;~~
- Magnetic resonance imaging (both open and closed mouth to view disc position)~~; or~~
- Ultrasound
- ~~Cone-beam computed tomography (**CBCT**).~~

TMJ arthography is not recommended as a routine diagnostic procedure.[73,74,75] The readily available panoramic radiograph is reliable for evaluating condylar head morphology and angulation but does not permit evaluation of the joint space, soft tissues, or condylar motion.[23] The ~~panograph~~ panoramic radiograph may indicate osseous changes, but negative findings do not rule out TMJ pathology.[76] The CBCT can be used to detect boney abnormalities and fractures and to assess asymmetry,[74,75,76] but generates a much higher radiation burden than the panoramic image. Magnetic resonance imaging provides visualization of soft tissues, specifically the position and contours of the TMJ disc, and can be used to detect inflammation.[72, 23,75] Ultrasound is a noninvasive imaging method for viewing superficial lateral aspects of the TMJ.[77]

TMD has been divided into two broad categories, TMJ disorders and masticatory muscles disorders,~~1~~

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which are listed below.

I. TMJ disorders:
   a. Joint pain:
      1. A~~a~~rthralgia ~~(synovitis, capsulitis, and retro- discitis)~~
      2. Arthritis
   b. Joint disorders:
      1. Disc-condyle complex disorders (disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction, with limited opening, disc displacement without reduction without limited opening).
      2. Hypomobility disorders (~~intra-articular~~ ankylosis, bony ankylosis, fibrous adhesions, ankylosis)~~.~~
      3. Hypermobility disorders (subluxation, luxation)~~.~~
   c. Joint diseases:
      1. Osteoarthritis ~~also known as~~ [degenerative joint disease(DJD), condylysis/idiopathic condylar resorption, osteochondritis dissecans, osteonecrosis]~~.~~
      2. Systemic arthritides such as rheumatoid arthritis, JIA~~idiopathic juvenile arthritis~~, spondyloarthropathies, psoriatic arthritis, infections arthritis, Reiter syndrome, and crystal induced disease~~.~~
      3. Neoplasms~~.~~
      4. Fractures (open and closed condylar and subcondylar)~~.~~

II. Masticatory muscle disorders:
   a. Muscle pain limited to orofacial region (local myalgia, myofascial pain with spreading, myofascial pain with referral, tendonitis, myositis, spasm)~~.~~
   b. Muscle pain due to systemic/central disorders (centrally mediated myalgia, fibromyalgia)~~.~~
   c. Movement disorders (dyskinesia, dystonia)~~.~~
   d. Other muscle disorders (contracture, hypertrophy, neoplasm)~~.~~

Treatment of TMD

The goals of TMD treatment include restoration~~al~~ of function, decreased pain, decreased aggravating or contributing factors, and improved~~return of~~ quality of life.[78,79] Few studies document success or failure of specific treatment modalities for TMD in infants, children, and adolescents on a long-term basis. It has been suggested that simple, conservative, and reversible types of therapy are effective in reducing most TMD symptoms in children.[79,80] The focus of treatment should be to find a balance between active and

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passive treatment modalities. Active modalities include participation of the patient whereas passive modalities may include wearing a stabilization splint. In a randomized trial, adolescents undergoing occlusal appliance therapy combined with information attained a clinically significant improvement on the pain index.[81] Combined approaches may be more successful in treating TMD than single treatment modalities.[79]

Treatment of TMD can be divided into reversible and irreversible treatment. Reversible therapies may include:

- Patient education (e.g., explanation in clear and simple terms describing the nature of the disorder, the significance of predisposing, precipitating, and perpetuating factors, anatomy of the TMJ, management options, and goals of therapy).[1,79] ~~relaxation training, developing behavior coping strategies, modifying inadequate perceptions about TMD, patient awareness of clenching and bruxing habits, if present).(Michelotti et al 2004~~)
- Physical therapy [e.g., jaw exercises or transcutaneous electrical nerve stimulation (TENS), ultrasound, iontophoresis, massage, TMJ distraction and mobilization, thermotherapy, coolant therapy)].[79,1,82,33,83, 84]
- Behavioral therapy (e.g., biofeedback, relaxation training, cognitive behavioral therapy (CBT) for developing behavior coping strategies and modifying perceptions about TMD, habit reversal and awareness of daytime clenching and bruxing, avoiding excessive chewing of hard foods or gum, voluntary avoidance of stressors, ~~habit reversal; decreasing stress,~~ treatment of co-morbid behavioral health conditions~~anxiety, and/or depression~~ obtaining adequate, uninterrupted sleep).[79,33,84]
- Prescription medication (e.g., non-steroidal anti- inflammatory drugs, anxiolytic agents, muscle relaxers). While antidepressants have proved to be beneficial, they should be prescribed by a practitioner familiar with pain management.[79,1,33,85,]
- Occlusal splints. The goal of an occlusal appliance is to provide orthopedic stability to the TMJ. These alter the patient's occlusion temporarily and may ~~be used to~~ decrease parafunctional activity and pain.[86,81,87,88] Occlusal splints may be made of hard or soft acrylic. The stabilization type of splint covers all of the teeth on either the maxillary or mandibular arch and is balanced so that all teeth are in occlusion when the patient is closed and the jaw is in a musculoskeletally stable position.[6,33]
- Additional reversible therapies may include TMJ arthrocentesis, TMJ injections, nerve blocks,

acupuncture, trigger point injections, and off-label use of Botulinum toxin A injections.[89-93]

Irreversible therapies can include:

- Occlusal adjustment (i.e., permanently altering the occlusion or mandibular position by selective grinding or full mouth restorative dentistry).[94] A systematic review and meta-analysis demonstrated that occlusal alteration seems to have no effect on TMD [95]
- Orthodontics. This may include mandibular positioning devices designed to alter the growth or permanently reposition the mandible (e.g., headgear, functional appliances). There is little evidence that orthodontic treatment can prevent or relieve TMD.[1,96,97]
- Surgery. Surgical interventional includes orthognathic surgery, open joint TMJ surgery to removed diseased synovium, and TMJ reconstruction. [63] Data suggests surgery is limited in most situations to cases of severe joint degeneration or destruction following trauma or tumor resection [98,63,79]
- ~~Botulinum toxin A injections. Although recently approved for use in adults to provide masticatory muscle relaxation, this modality has not been approved for use in children.(Dym and Israel 2012)~~

Controversy surrounds the significance of signs and symptoms in ~~this age group~~ children and adolescents, the value of certain diagnostic procedures, and what constitutes appropriate therapy.[100,55,99] It is not clear whether these signs and symptoms constitute normal variation, preclinical features, or manifestations of a disease state.[101] Whether these signs and symptoms warrant treatment as predictors of TMD in adulthood is questionable.[101,39)]

~~Referral should be made to other health care providers, including those with expertise in TMD, oral surgery, or pain management, when the diagnostic and/or treatment needs are beyond the treating dentist's scope of practice.~~

Recommendations

Every comprehensive dental history and examination should include a TMJ history and assessment.[70] The history should include questions concerning the presence of head and neck pain and mandibular dysfunction, previous orofacial trauma, and history of present illness with an account of current symptoms.[100] In the presence of a positive history and/or signs and symptoms of TMD, a more comprehensive examination (e.g., palpation of masticatory and associated muscles and the TMJs,

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documentation of joint sounds, occlusal analysis, and assessment of range of mandibular movements including maximum opening, protrusion, and lateral excursions) should be performed.[100] ~~A referral may be considered.~~ Joint imaging may be recommended in some cases(Hammer 2018)~~by other specialists to investigate joint sounds in the absence of other TMD signs and symptoms~~. Referral should be made to other health care providers, including those with expertise in TMD, oral surgery, or pain management, when the diagnostic and/or treatment needs are beyond the treating dentist's scope of practice.[1]

~~Therapeutic modalities to prevent TMD in the pediatric population are yet to be supported by controlled studies.~~ Reversible therapies should be considered f~~F~~or children and adolescents with signs and symptoms of TMD~~, reversible therapies should be considered.~~ [81,102] Because of inadequate data regarding their effectiveness ~~usefulness~~, irreversible therapies should be avoided.[81,94,97] Referral to a medical specialist may be indicated when primary headaches, otitis media, allergies, abnormal posture, airway congestion, rheumatoid arthritis, connective tissue disease, psychiatric disorders, or other medical conditions are suspected.

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[Endorsement]

Policy on the Management of Patients with Cleft Lip/ Palate and Other Craniofacial Anomalies*

Review Council

Council on Clinical Affairs

Latest Revision

~~2012~~ 2019

The American Academy of Pediatric Dentistry (**AAPD**), in its efforts to promote optimal health for children with cleft lip/ palate and other craniofacial anomalies, endorses the current statements of the American Cleft Palate-Craniofacial Association (**ACPA**).[1]

A child born with cleft lip/palate or other craniofacial anomalies has multiple and complex problems, including early feeding and nutritional concerns, middle ear disease, hearing deficiencies, deviations in speech and resonance, dentofacial and orthodontic abnormalities, and psychosocial adjustment problems.

Reports by the U.S. Surgeon General[2,3] on children with special needs issued in 1987 and 2005 stressed that the care of these children should be comprehensive, coordinated, culturally sensitive, specific to the needs of the individual, and readily accessible. Recognizing that children with clefts and other craniofacial anomalies have special needs, the Maternal and Child Health Bureau in 1991 provided funding to ACPA to develop parameters of care for these patients through a series of consensus conferences among a multidisciplinary group of specialists.[1] In addition, the ACPA joined with the Cleft Palate Foundation to create standards for approval of teams to ensure that care is provided in a coordinated and consistent manner, including an appropriate sequence of evaluations and treatment for the patient's overall developmental, medical, and psychological needs.[4]

* **ABBREVIATIONS**
AAPD: American Academy Pediatric Dentistry. **ACPA**: American Cleft Palate-Craniofacial Association.

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As part of the parameters[1] and standards,[4] several fundamental principles were identified as critical to optimal cleft/ craniofacial care. These principles are:

1. Management of patients with craniofacial anomalies is best provided by an interdisciplinary team of specialists.[1] These teams are composed of qualified health professionals from medical, surgical, dental, and allied health fields working together in a coordinated system. A designated patient care coordinator should be included in the team to assist in coordinated care for patients and their families/caregivers.[4]
2. Optimal care for patients with craniofacial anomalies is provided by teams that see sufficient numbers of these patients each year to maintain clinical expertise in diagnosis and treatment.
3. The optimal time for the first evaluation is within the first few weeks of life and, whenever possible, within the first few days. However, referral for team evaluation and management is appropriate for patients of any age.[1]
4. From the time of first contact with the child and family, every effort must be made to assist the family in adjusting to the birth of a child with a craniofacial anomaly and the consequent demands and stress placed upon that family.[1]
5. Parents/caregivers must be given information about recommended treatment procedures, options, risk factors, benefits, and costs to assist them in: (1) making informed decisions on the child's behalf, and (2) preparing the child and themselves for all recommended procedures. The team should actively solicit family participation and collaboration in treatment planning.[1,4] When the child is mature enough to do so, he or she should also participate in treatment decisions.[1]
6. Treatment plans should be developed and implemented on the basis of team recommendations.[1]
7. Care should be coordinated by the team, but should be provided at the local level whenever possible; however, complex diagnostic or surgical procedures should be restricted to major centers with appropriate treatment facilities and experienced care providers.
8. It is the responsibility of each team to be sensitive to linguistic, cultural, ethnic, psychosocial, economic, and physical factors that affect the dynamic relationship between the team, the patient, and his/her family.[1]
9. It is the responsibility of the team to monitor both short-term and long-term outcomes. Thus, longitudinal follow up of patients, including appropriate documentation and record-keeping, is essential.[1]
10. Evaluation of treatment outcomes must take into account the satisfaction and psychosocial

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well-being of the patient, as well as effects on growth, function, and appearance.[1]

Patients with craniofacial anomalies require dental care throughout life as a direct result of their condition and as an integral part of the treatment process. A dental home should be established within six months of eruption of the first tooth and no later than 12 months of age. It includes oral health examinations, caries control, and preventive, restorative, and prosthetic dental treatment as needed. Patients should be closely monitored for periodontal disease and anomalies in dentition and eruption. The condition of the developing dentition and supporting tissues, with counseling regarding early oral hygiene and prevention of early childhood caries is essential. Prosthetic appliances such as an obturator may help to close a fistula or aid in speech. Orthodontic treatment is also an integral part of the rehabilitative process and often takes place in phases. The skeletal and dental components should be regularly evaluated. When indicated, orthodontic treatment prepares a child for alveolar bone grafting of the cleft maxilla, correcting malocclusions, and preparation for jaw surgery.[1] As members of the interdisciplinary team of physicians, dentists, speech-language pathologists, and other allied health professionals, pediatric dentists should provide dental services in close cooperation with their orthodontic, oral and maxillofacial surgery, and prosthodontic colleagues.[1,4] All dental specialists should ensure that[1]:

1. Consult with an appropriate dental specialist for cleft lip taping and or pre-surgical orthopedics including but not limited to nasal alveolar molding (NAM). A craniofacial orthodontist (or appropriately trained clinician) who can discuss with the family the types of infant orthopedic services available and the rationale for using infant orthopedics prop initial cleft lip repair is necessary
~~1~~2. Dental radiographs, cephalometric radiographs, and other imaging modalities as indicated should be utilized to evaluate and monitor dental and facial growth and development.
~~2~~3. Diagnostic records, including properly occluded dental study models, should be collected at ~~Diagnostic records, including properly occluded dental study models, should be collected at~~ appropriate intervals for patients at risk for developing malocclusion or maxillary-mandibular discrepancies.
~~3~~4. As the primary dentition erupts, the team evaluation should include a dental examination and, if such services are not already being provided, referral to appropriate providers for caries control, preventive measures, restorative care, and space management.
~~4~~5. Before the primary dentition has completed eruption, the skeletal and dental components should be evaluated to determine if a malocclusion is present or developing.

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~~5~~6. Depending upon the specific goals to be accomplished and also upon the age at which the patient is initially evaluated, orthodontic management of the malocclusion may be performed in the primary, mixed, or permanent dentition. In some cases, orthodontic treatment may be necessary in all three stages.

~~6~~7. While continuous active orthodontic treatment from early mixed dentition to permanent dentition should be avoided, each stage of orthodontic therapy may be followed by retention and regular observation. Orthodontic retention for the permanent dentition may extend into adulthood.

~~7~~8. For some patients with craniofacial anomalies, functional orthodontic appliances may be indicated.

~~8~~9. For patients with craniofacial anomalies, orthodontic treatment may be needed in conjunction with surgical correction (and/or distraction osteogenesis) of the facial deformity.

~~9~~10. Congenitally missing teeth may be replaced with a removable appliance, fixed restorative bridgework, or osseointegrated implants.

~~10~~11. Patients should be closely monitored for dental and periodontal disease.

~~11~~12. Prosthetic obturation of palatal fistulae may be necessary in some patients.

~~12~~13. A prosthetic speech device may be used to treat velopharyngeal inadequacy in some patients.

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Monitoring and Management of Pediatric Patients Before, During, and After Sedation for Diagnostic and Therapeutic Procedures: Update 2016

Developed and Endorsed by
American Academy of Pediatric Dentistry and American Academy of Pediatrics

Latest Revision*
~~2016~~2019[1]

Abbreviations
AAP: American Academy of Pediatrics
AAPD: American Academy of Pediatric Dentistry
ASA: American Society of Anesthesiologists
BIS: Bispectral index
CPAP: Continuous positive airway pressure
ECG: Electrocardiography
EEG: Electroencephalogram/electroencephalography.
EMS: Emergency medical services
LMA: Laryngeal mask airway
MRI: Magnetic resonance imaging
OSA: Obstructive sleep apnea
PALS: Pediatric advanced life support

Abstract

The safe sedation of children for procedures requires a systematic approach that includes the following: no administration of sedating medication without the safety net of medical/dental supervision, careful presedation evaluation for underlying medical or surgical conditions that would place the child at increased risk from sedating medications, appropriate fasting for elective procedures and a balance between the depth of sedation and risk for those who are unable to fast because of the urgent nature of the procedure, a focused airway examination for large (kissing) tonsils or anatomic airway abnormalities that might increase the potential for airway obstruction, a clear understanding of the medication's pharmacokinetic and pharmacodynamic effects and drug interactions, appropriate training and skills in airway management to allow rescue of the patient, age- and size-appropriate equipment for airway management and venous access, appropriate medications and reversal agents, sufficient numbers of staff to both carry out the procedure and monitor the patient, appropriate

[1] 2019 revision limited to Personnel section. Approved by AAP Board December 2018

physiologic monitoring during and after the procedure, a properly equipped and staffed recovery area, recovery to the presedation level of consciousness before discharge from medical/dental supervision, and appropriate discharge instructions. This report was developed through a collaborative effort of the American Academy of Pediatrics and the American Academy of Pediatric Dentistry to offer pediatric providers updated information and guidance in delivering safe sedation to children.

Introduction

The number of diagnostic and minor surgical procedures performed on pediatric patients outside of the traditional operating room setting has increased in the past several decades. As a consequence of this change and the increased awareness of the importance of providing analgesia and anxiolysis, the need for sedation for procedures in physicians' offices, dental offices, subspecialty procedure suites, imaging facilities, emergency departments, other inpatient hospital settings, and ambulatory surgery centers also has increased markedly.[1–52] In recognition of this need for both elective and emergency use of sedation in nontraditional settings, the American Academy of Pediatrics (**AAP**) and the American Academy of Pediatric Dentistry (**AAPD**) have published a series of guidelines for the monitoring and management of pediatric patients during and after sedation for a procedure.[53–58] The purpose of this updated report is to unify the guidelines for sedation used by medical and dental practitioners; to add clarifications regarding monitoring modalities, particularly regarding continuous expired carbon dioxide measurement; to provide updated information from the medical and dental literature; and to suggest methods for further improvement in safety and outcomes. This document uses the same language to define sedation categories and expected physiologic responses as The Joint Commission, the American Society of Anesthesiologists (**ASA**), and the AAPD.[56,57,59–61]

This revised statement reflects the current understanding of appropriate monitoring needs of pediatric patients both during and after sedation for a procedure.[3,4,11,18,20,21,23,24,33,39,41,44,47,51,62–73] The monitoring and care outlined may be exceeded at any time on the basis of the judgment of the responsible practitioner. Although intended to encourage high-quality patient care, adherence to the recommendations in this document cannot guarantee a specific patient outcome. However, structured sedation protocols designed to incorporate these safety principles have been widely implemented and shown to reduce morbidity.[11,23,24,27,30–33,35,39,41,44,47,51,74–84] These practice recommendations are proffered with the awareness that, regardless of the intended level of sedation or route of drug administration, the sedation of a pediatric patient represents a continuum and may result in respiratory depression, laryngospasm, impaired airway patency, apnea, loss of the patient's protective airway reflexes, and cardiovascular instability.[38,43,45,47,48,59,62,63,85–112]

Procedural sedation of pediatric patients has serious associated risks.[2,5,38,43,45,47,48,62,63,71,83,85,88–105,107–138] These adverse responses during and after sedation for a diagnostic or therapeutic procedure may be minimized, but not completely eliminated, by a careful preprocedure review of the patient's underlying medical conditions and consideration of how the sedation process might affect or be affected by these conditions: for example, children with developmental disabilities

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have been shown to have a threefold increased incidence of desaturation compared with children without developmental disabilities.[74,78,103] Appropriate drug selection for the intended procedure, a clear understanding of the sedating medication's pharmacokinetics and pharmacodynamics and drug interactions, as well as the presence of an individual with the skills needed to rescue a patient from an adverse response are critical.[42, 48,62,63,92,97,99,125–127,132,133,139–158] Appropriate physiologic monitoring and continuous observation by personnel not directly involved with the procedure allow for the accurate and rapid diagnosis of complications and initiation of appropriate rescue interventions.[44,63,64,67,68,74,90,96,110,159–174] The work of the Pediatric Sedation Research Consortium has improved the sedation knowledge base, demonstrating the marked safety of sedation by highly motivated and skilled practitioners from a variety of specialties practicing the above modalities and skills that focus on a culture of sedation safety.[45,83,95,128–138] However, these groundbreaking studies also show a low but persistent rate of potential sedation-induced life-threatening events, such as apnea, airway obstruction, laryngospasm, pulmonary aspiration, desaturation, and others, even when the sedation is provided under the direction of a motivated team of specialists.[129] These studies have helped define the skills needed to rescue children experiencing adverse sedation events.

The sedation of children is different from the sedation of adults. Sedation in children is often administered to relieve pain and anxiety as well as to modify behavior (e.g., immobility) so as to allow the safe completion of a procedure. A child's ability to control his or her own behavior to cooperate for a procedure depends both on his or her chronologic age and cognitive/ emotional development. Many brief procedures, such as suture of a minor laceration, may be accomplished with distraction and guided imagery techniques, along with the use of topical/local anesthetics and minimal sedation, if needed.[175–181] However, longer procedures that require immobility involving children younger than 6 years or those with developmental delay often require an increased depth of sedation to gain control of their behavior.[86,87,103] Children younger than 6 years (particularly those younger than 6 months) may be at greatest risk of an adverse event.[129] Children in this age group are particularly vulnerable to the sedating medication's effects on respiratory drive, airway patency, and protective airway reflexes.[62,63] Other modalities, such as careful preparation, parental presence, hypnosis, distraction, topical local anesthetics, electronic devices with age-appropriate games or videos, guided imagery, and the techniques advised by child life specialists, may reduce the need for or the needed depth of pharmacologic sedation.[29,46,49,182–211]

Studies have shown that it is common for children to pass from the intended level of sedation to a deeper, unintended level of sedation,[85,88,212,213] making the concept of rescue essential to safe sedation. Practitioners of sedation must have the skills to rescue the patient from a deeper level than that intended for the procedure. For example, if the intended level of sedation is "minimal," practitioners must be able to rescue from "moderate sedation"; if the intended level of sedation is "moderate," practitioners must have the skills to rescue from "deep sedation"; if the intended level of sedation is "deep," practitioners must have the skills to rescue from a state of "general anesthesia." The ability to rescue means that practitioners must be able to recognize the various levels of sedation and have the skills and age- and size-appropriate equipment necessary to provide appropriate cardiopulmonary support if needed.

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These guidelines are intended for all venues in which sedation for a procedure might be performed (hospital, surgical center, freestanding imaging facility, dental facility, or private office). Sedation and anesthesia in a nonhospital environment (e.g., private physician's or dental office, freestanding imaging facility) historically have been associated with an increased incidence of "failure to rescue" from adverse events, because these settings may lack immediately available backup. Immediate activation of emergency medical services (**EMS**) may be required in such settings, but the practitioner is responsible for life-support measures while awaiting EMS arrival.[63,214] Rescue techniques require specific training and skills.[63,74,215,216] The maintenance of the skills needed to rescue a child with apnea, laryngospasm, and/or airway obstruction include the ability to open the airway, suction secretions, provide continuous positive airway pressure (**CPAP**), perform successful bag-valve-mask ventilation, insert an oral airway, a nasopharyngeal airway, or a laryngeal mask airway (**LMA**), and, rarely, perform tracheal intubation. These skills are likely best maintained with frequent simulation and team training for the management of rare events.[128,130,217–220] Competency with emergency airway management procedure algorithms is fundamental for safe sedation practice and successful patient rescue (see Figs. 1, 2, and 3).[215,216,221–223]

Practitioners should have an in-depth knowledge of the agents they intend to use and their potential complications. A number of reviews and handbooks for sedating pediatric patients are available.[30,39,65,75,171,172,201,224–233] There are specific situations that are beyond the scope of this document. Specifically, guidelines for the delivery of general anesthesia and monitored anesthesia care (sedation or analgesia), outside or within the operating room by anesthesiologists or other practitioners functioning within a department of anesthesiology, are addressed by policies developed by the ASA and by individual departments of anesthesiology.[234] In addition, guidelines for the sedation of patients undergoing mechanical ventilation in a critical care environment or for providing analgesia for patients postoperatively, patients with chronic painful conditions, and patients in hospice care are beyond the scope of this document.

Goals of sedation

The goals of sedation in the pediatric patient for diagnostic and therapeutic procedures are as follows: (1) to guard the patient's safety and welfare; (2) to minimize physical discomfort and pain; (3) to control anxiety, minimize psychological trauma, and maximize the potential for amnesia; (4) to modify behavior and/or movement so as to allow the safe completion of the procedure; and (5) to return the patient to a state in which discharge from medical/dental supervision is safe, as determined by recognized criteria (Supplemental Appendix 1).

These goals can best be achieved by selecting the lowest dose of drug with the highest therapeutic index for the procedure. It is beyond the scope of this document to specify which drugs are appropriate for which procedures; however, the selection of the fewest number of drugs and matching drug selection to the type and goals of the procedure are essential for safe practice. For example, analgesic medications, such as opioids or ketamine, are indicated for painful procedures. For nonpainful procedures, such as computed tomography or MRI, sedatives/hypnotics are preferred. When both sedation and analgesia are desirable (e.g., fracture reduction), either single agents with analgesic/sedative properties or combination regimens are commonly used. Anxiolysis and amnesia are additional goals that should be considered in the selection of agents for particular patients. However, the potential for an adverse outcome may be increased when 2 or more sedating medications are administered.[62,127,136,173,235] Recently, there has been renewed interest in noninvasive routes of medication administration, including intranasal and inhaled routes (e.g., nitrous oxide; see below).[236]

Knowledge of each drug's time of onset, peak response, and duration of action is important (e.g., the peak EEG effect of intravenous midazolam occurs at ~ 4.8 minutes, compared with that of diazepam at ~ 1.6 minutes[237–239]). Titration of drug to effect is an important concept; one must know whether the previous dose has taken full effect before administering additional drugs.[237] Drugs that have a long duration of action (e.g., intramuscular pentobarbital, phenothiazines) have fallen out of favor because of unpredictable responses and prolonged recovery. The use of these drugs requires a longer period of observation even after the child achieves currently used recovery and discharge criteria.[62,238–241] This concept is particularly important for infants and toddlers transported in car safety seats; re-sedation after discharge attributable to residual prolonged drug effects may lead to airway obstruction.[62,63,242] In particular, promethazine (Phenergan; Wyeth Pharmaceuticals, Philadelphia, Pa.) has a "black box warning" regarding fatal respiratory depression in children younger than 2 years.[243] Although the liquid formulation of chloral hydrate is no longer commercially available, some hospital pharmacies now are compounding their own formulations. Low-dose chloral hydrate (10–25 mg/kg), in combination with other sedating medications, is used commonly in pediatric dental practice.

General guidelines

Candidates
Patients who are in ASA classes I and II are frequently considered appropriate candidates for minimal, moderate, or deep sedation (Supplemental Appendix 2). Children in ASA classes III and IV, children with special needs, and those with anatomic airway abnormalities or moderate to severe tonsillar hypertrophy present issues that require additional and individual consideration, particularly for moderate and deep sedation.[68,244–249] Practitioners are encouraged to consult with appropriate subspecialists and/ or an anesthesiologist for patients at increased risk of experiencing adverse sedation events because of their underlying medical/surgical conditions.

Responsible person
The pediatric patient shall be accompanied to and from the treatment facility by a parent, legal guardian, or other responsible person. It is preferable to have 2 adults accompany children who are still in car safety seats if transportation to and from a treatment facility is provided by 1 of the adults.[250]

Facilities
The practitioner who uses sedation must have immediately available facilities, personnel, and equipment to manage emergency and rescue situations. The most common serious complications

of sedation involve compromise of the airway or depressed respirations resulting in airway obstruction, hypoventilation, laryngospasm, hypoxemia, and apnea. Hypotension and cardiopulmonary arrest may occur, usually from the inadequate recognition and treatment of respiratory compromise.[42,48,92,97,99,125,132,139–155] Other rare complications also may include seizures, vomiting, and allergic reactions. Facilities providing pediatric sedation should monitor for, and be prepared to treat, such complications.

Back-up emergency services

A protocol for immediate access to back-up emergency services shall be clearly outlined. For nonhospital facilities, a protocol for the immediate activation of the EMS system for life-threatening complications must be established and maintained.[44] It should be understood that the availability of EMS does not replace the practitioner's responsibility to provide initial rescue for life-threatening complications.

On-site monitoring, rescue drugs, and equipment

An emergency cart or kit must be immediately accessible. This cart or kit must contain the necessary age-and size appropriate equipment (oral and nasal airways, bag-valve-mask device, LMAs or other supraglottic devices, laryngoscope blades, tracheal tubes, face masks, blood pressure cuffs, intravenous catheters, etc.) to resuscitate a nonbreathing and unconscious child. The contents of the kit must allow for the provision of continuous life support while the patient is being transported to a medical/dental facility or to another area within the facility. All equipment and drugs must be checked and maintained on a scheduled basis (see Supplemental Appendices 3 and 4 for suggested drugs and emergency life support equipment to consider before the need for rescue occurs). Monitoring devices, such as electrocardiography (**ECG**) machines, pulse oximeters with size-appropriate probes, end-tidal carbon dioxide monitors, and defibrillators with size-appropriate patches/ paddles, must have a safety and function check on a regular basis as required by local or state regulation. The use of emergency checklists is recommended, and these should be immediately available at all sedation locations; they can be obtained from *http://www.pedsanesthesia.org/*.

Documentation

Documentation prior to sedation shall include, but not be limited to, the following recommendations:

1. Informed consent: The patient record shall document that appropriate informed consent was obtained according to local, state, and institutional requirements.[251,252]
2. Instructions and information provided to the responsible person: The practitioner shall provide verbal and/or written instructions to the responsible person. Information shall include objectives of the sedation and anticipated changes in behavior during and after sedation.[163,253–255] Special instructions shall be given to the adult responsible for infants and toddlers who will be transported home in a car safety seat regarding the need to carefully observe the child's head position to avoid airway obstruction. Transportation in a car safety seat poses a particular risk for infants who have received medications known to have a long half-life, such as chloral hydrate, intramuscular pentobarbital, or

phenothiazine because deaths after procedural sedation have been reported.[62,63,238,242,256,257] Consideration for a longer period of observation shall be given if the responsible person's ability to observe the child is limited (e.g., only 1 adult who also has to drive). Another indication for prolonged observation would be a child with an anatomic airway problem, an underlying medical condition such as significant obstructive sleep apnea (**OSA**), or a former preterm infant younger than 60 weeks' post-conceptional age. A 24-hour telephone number for the practitioner or his or her associates shall be provided to all patients and their families. Instructions shall include limitations of activities and appropriate dietary precautions.

Dietary precautions

Agents used for sedation have the potential to impair protective airway reflexes, particularly during deep sedation. Although a rare occurrence, pulmonary aspiration may occur if the child regurgitates and cannot protect his or her airway.[95,127,258] Therefore, the practitioner should evaluate preceding food and fluid intake before administering sedation. It is likely that the risk of aspiration during procedural sedation differs from that during general anesthesia involving tracheal intubation or other airway manipulations.[259,260] However, the absolute risk of aspiration during elective procedural sedation is not yet known; the reported incidence varies from ~1 in 825 to ~1 in 30037.[95, 127,129,173,244,261] Therefore, standard practice for fasting before elective sedation generally follows the same guidelines as for elective general anesthesia; this requirement is particularly important for solids, because aspiration of clear gastric contents causes less pulmonary injury than aspiration of particulate gastric contents.[262,263]

For emergency procedures in children undergoing general anesthesia, the reported incidence of pulmonary aspiration of gastric contents from 1 institution is ~ 1 in 373 compared with ~ 1 in 4544 for elective anesthetics.[262] Because there are few published studies with adequate statistical power to provide guidance to the practitioner regarding the safety or risk of pulmonary aspiration of gastric contents during procedural sedation,[95,127,129,173,244,259-261,264-268] it is unknown whether the risk of aspiration is reduced when airway manipulation is not performed/ anticipated (e.g., moderate sedation). However, if a deeply sedated child requires intervention for airway obstruction, apnea, or laryngospasm, there is concern that these rescue maneuvers could increase the risk of pulmonary aspiration of gastric contents. For children requiring urgent/emergent sedation who do not meet elective fasting guidelines, the risks of sedation and possible aspiration are as-yet unknown and must be balanced against the benefits of performing the procedure promptly. For example, a prudent practitioner would be unlikely to administer deep sedation to a child with a minor condition who just ate a large meal; conversely, it is not justifiable to withhold sedation/analgesia from the child in significant pain from a displaced fracture who had a small snack a few hours earlier. Several emergency department studies have reported a low to zero incidence of pulmonary aspiration despite variable fasting periods[260,264,268]; however, each of these reports have, for the most part, clearly balanced the urgency of the procedure with the need for and depth of sedation.[268,269] Although emergency medicine studies and practice guidelines generally support a less restrictive approach to fasting for brief urgent/ emergent procedures, such as care of wounds, joint dislocation, chest tube placement, etc., in healthy children, further research in many thousands of patients would be desirable to better define the relationships between various fasting intervals and sedation complications.[262–270]

Before elective sedation

Children undergoing sedation for elective procedures generally should follow the same fasting guidelines as those for general anesthesia (Table 1).[271] It is permissible for routine necessary medications (e.g., antiseizure medications) to be taken with a sip of clear liquid or water on the day of the procedure.

For the emergency patient

The practitioner must always balance the possible risks of sedating nonfasted patients with the benefits of and necessity for completing the procedure. In particular, patients with a history of recent oral intake or with other known risk factors, such as trauma, decreased level of consciousness, extreme obesity (BMI ≥95% for age and sex), pregnancy, or bowel motility dysfunction, require careful evaluation before the administration of sedatives. When proper fasting has not been ensured, the increased risks of sedation must be carefully weighed against its benefits, and the lightest effective sedation should be used. In this circumstance, additional techniques for achieving analgesia and patient cooperation, such as distraction, guided imagery, video games, topical and local anesthetics, hematoma block or nerve blocks, and other techniques advised by child life specialists, are particularly helpful and should be considered.[29,49,182–201,274,275] The use of agents with less risk of depressing protective airway reflexes, such as ketamine, or moderate sedation, which would also maintain protective reflexes, may be preferred.[276] Some emergency patients requiring deep sedation (e.g., a trauma patient who just ate a full meal or a child with a bowel obstruction) may need to be intubated to protect their airway before they can be sedated.

Use of immobilization devices (protective stabilization)

Immobilization devices, such as papoose boards, must be applied in such a way as to avoid airway obstruction or chest restriction.[277–281] The child's head position and respiratory excursions should be checked frequently to ensure airway patency. If an immobilization device is used, a hand or foot should be kept exposed, and the child should never be left unattended. If sedating medications are administered in conjunction with an immobilization device, monitoring must be used at a level consistent with the level of sedation achieved.

Documentation at the time of sedation

1. Health evaluation: Before sedation, a health evaluation shall be performed by an appropriately licensed practitioner and reviewed by the sedation team at the time of treatment for possible interval changes.[282] The purpose of this evaluation is not only to document baseline status but also to determine whether the patient has specific risk factors that may warrant additional consultation before sedation. This evaluation also facilitates the identification of patients who will require more advanced airway or cardiovascular management skills or alterations in the doses or types of medications used for procedural sedation. An important concern for the practitioner is the widespread use of medications that may interfere with drug absorption or metabolism and therefore enhance or shorten the effect time of sedating medications. Herbal medicines (e.g., St. John's wort, ginkgo, ginger, ginseng, garlic) may alter drug pharmacokinetics through

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inhibition of the cytochrome P450 system, resulting in prolonged drug effect and altered (increased or decreased) blood drug concentrations (midazolam, cyclosporine, tacrolimus).[283–292] Kava may increase the effects of sedatives by potentiating γ-aminobutyric acid inhibitory neurotransmission and may increase acetaminophen-induced liver toxicity.[293–295] Valerian may itself produce sedation that apparently is mediated through the modulation of γ-aminobutyric acid neurotransmission and receptor function.[291,296–299] Drugs such as erythromycin, cimetidine, and others may also inhibit the cytochrome P450 system, resulting in prolonged sedation with midazolam as well as other medications competing for the same enzyme systems.[300–304] Medications used to treat HIV infection, some anticonvulsants, immunosuppressive drugs, and some psychotropic medications (often used to treat children with autism spectrum disorder) may also produce clinically important drug-drug interactions.[305–314] Therefore, a careful drug history is a vital part of the safe sedation of children. The practitioner should consult various sources (a pharmacist, textbooks, online services, or handheld databases) for specific information on drug interactions.[315–319] The U.S. Food and Drug Administration issued a warning in February 2013 regarding the use of codeine for postoperative pain management in children undergoing tonsillectomy, particularly those with OSA. The safety issue is that some children have duplicated cytochromes that allow greater than expected conversion of the prodrug codeine to morphine, thus resulting in potential overdose; codeine should be avoided for postprocedure analgesia.[320–324]

2. Prescriptions. When prescriptions are used for sedation, a copy of the prescription or a note describing the content of the prescription should be in the patient's chart along with a description of the instructions that were given to the responsible person. Prescription medications intended to accomplish procedural sedation must not be administered without the safety net of direct supervision by trained medical/dental personnel. The administration of sedating medications at home poses an unacceptable risk, particularly for infants and preschool-aged children traveling in car safety seats because deaths as a result of this practice have been reported.[63,257]

The health evaluation should include the following:

- age and weight (in kg) and gestational age at birth (preterm infants may have associated sequelae such as apnea of prematurity); and
- health history, including (1) food and medication allergies and previous allergic or adverse drug reactions; (2) medication/drug history, including dosage, time, route, and site of administration for prescription, over-the-counter, herbal, or illicit drugs; (3) relevant diseases, physical abnormalities (including genetic syndromes), neurologic impairments that might increase the potential for airway obstruction, obesity, a history of snoring or OSA,[325–328] or cervical spine instability in Down syndrome, Marfan syndrome, skeletal dysplasia, and other conditions; (4) pregnancy status (as many as 1% of menarchal females presenting for general anesthesia at children's hospitals are pregnant)[329–331] because of concerns for the potential adverse effects of most sedating and anesthetic drugs on the fetus[329,332–338]; (5) history of prematurity (may be associated with subglottic stenosis or propensity to apnea after sedation); (6) history of any seizure disorder; (7) summary of previous relevant hospitalizations; (8) history of sedation or

general anesthesia and any complications or unexpected responses; and (9) relevant family history, particularly related to anesthesia (e.g., muscular dystrophy, malignant hyperthermia, pseudocholinesterase deficiency).

The review of systems should focus on abnormalities of cardiac, pulmonary, renal, or hepatic function that might alter the child's expected responses to sedating/analgesic medications. A specific query regarding signs and symptoms of sleep disordered breathing and OSA may be helpful. Children with severe OSA who have experienced repeated episodes of desaturation will likely have altered mu receptors and be analgesic at opioid levels one-third to one-half those of a child without OSA[325–328,339,340]; lower titrated doses of opioids should be used in this population. Such a detailed history will help to determine which patients may benefit from a higher level of care by an appropriately skilled health care provider, such as an anesthesiologist. The health evaluation should also include:

- vital signs, including heart rate, blood pressure, respiratory rate, room air oxygen saturation, and temperature (for some children who are very upset or noncooperative, this may not be possible and a note should be written to document this circumstance);
- physical examination, including a focused evaluation of the airway (tonsillar hypertrophy, abnormal anatomy [e.g., mandibular hypoplasia], high Mallampati score [i.e., ability to visualize only the hard palate or tip of the uvula]) to determine whether there is an increased risk of airway obstruction[74,341–344];
- physical status evaluation (ASA classification [see Appendix 2]); and
- name, address, and telephone number of the child's home or parent's, or caregiver's cell phone; additional information such as the patient's personal care provider or medical home is also encouraged.

For hospitalized patients, the current hospital record may suffice for adequate documentation of presedation health; however, a note shall be written documenting that the chart was reviewed, positive findings were noted, and a management plan was formulated. If the clinical or emergency condition of the patient precludes acquiring complete information before sedation, this health evaluation should be obtained as soon as feasible.

- 2. Prescriptions. When prescriptions are used for sedation, a copy of the prescription or a note describing the content of the prescription should be in the patient's chart along with a description of the instructions that were given to the responsible person. Prescription medications intended to accomplish procedural sedation must not be administered without the safety net of direct supervision by trained medical/dental personnel. The administration of sedating medications at home poses an unacceptable risk, particularly for infants and preschool-aged children traveling in car safety seats because deaths as a result of this practice have been reported.[63,257]

Documentation during treatment
The patient's chart shall contain a time-based record that includes the name, route, site, time, dosage/ kilogram, and patient effect of administered drugs. Before sedation, a "time out" should

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be performed to confirm the patient's name, procedure to be performed, and laterality and site of the procedure.[59] During administration, the inspired concentrations of oxygen and inhalation sedation agents and the duration of their administration shall be documented. Before drug administration, special attention must be paid to the calculation of dosage (i.e., mg/kg); for obese patients, most drug doses should likely be adjusted lower to ideal body weight rather than actual weight.[345] When a programmable pump is used for the infusion of sedating medications, the dose/kilogram per minute or hour and the child's weight in kilograms should be doublechecked and confirmed by a separate individual. The patient's chart shall contain documentation at the time of treatment that the patient's level of consciousness and responsiveness, heart rate, blood pressure, respiratory rate, expired carbon dioxide values, and oxygen saturation were monitored. Standard vital signs should be further documented at appropriate intervals during recovery until the patient attains predetermined discharge criteria (Appendix 1). A variety of sedation scoring systems are available that may aid this process.[212,238 346–348] Adverse events and their treatment shall be documented.

Documentation after treatment

A dedicated and properly equipped recovery area is recommended (see Appendices 3 and 4). The time and condition of the child at discharge from the treatment area or facility shall be documented, which should include documentation that the child's level of consciousness and oxygen saturation in room air have returned to a state that is safe for discharge by recognized criteria (see Appendix 1). Patients receiving supplemental oxygen before the procedure should have a similar oxygen need after the procedure. Because some sedation medications are known to have a long half-life and may delay a patient's complete return to baseline or pose the risk of re-sedation[62,104,256, 349,350] and because some patients will have complex multiorgan medical conditions, a longer period of observation in a less intense observation area (e.g., a step-down observation area) before discharge from medical/dental supervision may be indicated.[239] Several scales to evaluate recovery have been devised and validated.[212, 346–348, 351, 352] A simple evaluation tool may be the ability of the infant or child to remain awake for at least 20 minutes when placed in a quiet environment.[238]

Continuous quality improvement

The essence of medical error reduction is a careful examination of index events and root-cause analysis of how the event could be avoided in the future.[353–359] Therefore, each facility should maintain records that track all adverse events and significant interventions, such as desaturation; apnea; laryngospasm; need for airway interventions, including the need for placement of supraglottic devices such as an oral airway, nasal trumpet, or LMA; positive-pressure ventilation; prolonged sedation; unanticipated use of reversal agents; unplanned or prolonged hospital admission; sedation failures; inability to complete the procedure; and unsatisfactory sedation, analgesia, or anxiolysis.[360] Such events can then be examined for the assessment of risk reduction and improvement in patient/family satisfaction.

Preparation for sedation procedures

Part of the safety net of sedation is using a systematic approach so as to not overlook having an important drug, piece of equipment, or monitor immediately available at the time of a developing emergency. To avoid this problem, it is helpful to use an acronym that allows the same setup and checklist for every procedure. A commonly used acronym useful in planning and preparation for a procedure is SOAPME, which represents the following:

S = Size-appropriate suction catheters and a functioning suction apparatus (e.g., Yankauer-type suction).
O= an adequate Oxygen supply and functioning flow meters or other devices to allow its delivery.
A = size-appropriate Airway equipment (e.g., bag-valve-mask or equivalent device [functioning]), nasopharyngeal and oropharyngeal airways, LMA, laryngoscope blades (checked and functioning), endotracheal tubes, stylets, face mask.
P = Pharmacy: all the basic drugs needed to support life during an emergency, including antagonists as indicated.
M = Monitors: functioning pulse oximeter with size-appropriate oximeter probes,[361,362] end-tidal carbon dioxide monitor, and other monitors as appropriate for the procedure (e.g., noninvasive blood pressure, ECG, stethoscope).
E = special Equipment or drugs for a particular case (e.g., defibrillator).

Specific guidelines for intended level of sedation

Minimal sedation
Minimal sedation (old terminology, "anxiolysis") is a drug induced state during which patients respond normally to verbal commands. Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected. Children who have received minimal sedation generally will not require more than observation and intermittent assessment of their level of sedation. Some children will become moderately sedated despite the intended level of minimal sedation; should this occur, then the guidelines for moderate sedation apply.[85,363]

Moderate sedation
Moderate sedation (old terminology, "conscious sedation" or "sedation/analgesia") is a drug-induced depression of consciousness during which patients respond purposefully to verbal commands or after light tactile stimulation. No interventions are required to maintain a patent airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained. The caveat that loss of consciousness should be unlikely is a particularly important aspect of the definition of moderate sedation; drugs and techniques used should carry a margin of safety wide enough to render unintended loss of consciousness unlikely. Because the patient who receives moderate sedation may progress into a state of deep sedation and obtundation, the practitioner should be prepared to increase the level of vigilance corresponding to what is necessary for deep sedation.[85]

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Personnel

The practitioner. The practitioner responsible for the treatment of the patient and/or the administration of drugs for sedation must be competent to use such techniques, to provide the level of monitoring described in these guidelines, and to manage complications of these techniques (i.e., to be able to rescue the patient). Because the level of intended sedation may be exceeded, the practitioner must be sufficiently skilled to rescue a child with apnea, laryngospasm, and/or airway obstruction, including the ability to open the airway, suction secretions, provide CPAP, and perform successful bag-valve-mask ventilation should the child progress to a level of deep sedation. Training in, and maintenance of, advanced pediatric airway skills is required (e.g., pediatric advanced life support [**PALS**]); regular skills reinforcement with simulation is strongly encouraged.[79,80,128,130,217–220,364]

Support personnel. The use of moderate sedation shall include the provision of a person, in addition to the practitioner, whose responsibility is to monitor appropriate physiologic parameters and to assist in any supportive or resuscitation measures, if required. This individual may also be responsible for assisting with interruptible patient-related tasks of short duration, such as holding an instrument or troubleshooting equipment.[60] This individual should be trained in and capable of providing advanced airway skills (e.g., PALS). The support person shall have specific assignments in the event of an emergency and current knowledge of the emergency cart inventory. The practitioner and all ancillary personnel should participate in periodic reviews, simulation of rare emergencies, and practice drills of the facility's emergency protocol to ensure proper function of the equipment and coordination of staff roles in such emergencies.[133,365–367] It is recommended that at least 1 practitioner be skilled in obtaining vascular access in children.

Monitoring and documentation

Baseline.

Before the administration of sedative medications, a baseline determination of vital signs shall be documented. For some children who are very upset or uncooperative, this may not be possible, and a note should be written to document this circumstance.

During the procedure. The physician/dentist or his or her designee shall document the name, route, site, time of administration, and dosage of all drugs administered. If sedation is being directed by a physician who is not personally administering the medications, then recommended practice is for the qualified health care provider administering the medication to confirm the dose verbally before administration. There shall be continuous monitoring of oxygen saturation and heart rate; when bidirectional verbal communication between the provider and patient is appropriate and possible (i.e., patient is developmentally able and purposefully communicates), monitoring of ventilation by (1) capnography (preferred) or (2) amplified, audible pretracheal stethoscope (e.g., Bluetooth™ technology)[368-371] or precordial stethoscope is strongly recommended. If bi-directional verbal communication is not appropriate or not possible, monitoring of ventilation by capnography (preferred), amplified, audible pretracheal stethoscope, or precordial stethoscope is required. Heart rate, respiratory rate, blood pressure, oxygen saturation, and expired carbon dioxide values should be recorded, at minimum, every 10 minutes in a time-based record. Note that the exact value of expired carbon dioxide is less important than simple assessment of continuous respiratory gas exchange. In some situations, in which there is excessive patient agitation or lack of cooperation or during certain procedures such as bronchoscopy, dentistry, or repair of facial lacerations capnography may not be feasible, and this situation should be documented. For uncooperative children, it is often helpful to defer the initiation of capnography until the child becomes sedated. Similarly, the stimulation of blood pressure cuff inflation may cause arousal or agitation; in such cases, blood pressure monitoring may be counterproductive and may be documented at less frequent intervals (e.g., 10-15 minutes, assuming the patient remains stable, well oxygenated, and well perfused). Immobilization devices (protective stabilization) should be checked to prevent airway obstruction or chest restriction. If a restraint device is used, a hand or foot should be kept exposed. The child's head position should be continuously assessed to ensure airway patency.

After the procedure. The child who has received moderate sedation must be observed in a suitably equipped recovery area, which must have a functioning suction apparatus as well as the capacity to deliver >90% oxygen and positive-pressure ventilation (bag-valve mask) with an adequate oxygen capacity as well as age- and size-appropriate rescue equipment and devices. The patient's vital signs should be recorded at specific intervals (e.g., every 10–15 minutes). If the patient is not fully alert, oxygen saturation and heart rate monitoring shall be used continuously until appropriate discharge criteria are met (see Appendix 1). Because sedation medications with a long half-life may delay the patient's complete return to baseline or pose the risk of re-sedation, some patients might benefit from a longer period of less intense observation (e.g., a step-down observation area where multiple patients can be observed simultaneously) before discharge from medical/ dental supervision (see section entitled "Documentation Before Sedation" above).[62,256,349,350] A simple evaluation tool may be the ability of the infant or child to remain awake for at least 20 minutes when placed in a quiet environment.[238] Patients who have received reversal agents, such as flumazenil or naloxone, will require a longer period of observation, because the duration of the drugs administered may exceed the duration of the antagonist, resulting in re-sedation.

Deep sedation/General anesthesia

"Deep sedation" ("deep sedation/ analgesia") is a drug-induced depression of consciousness during which patients cannot be easily aroused but respond purposefully after repeated verbal or painful stimulation (e.g., purposefully pushing away the noxious stimuli). Reflex withdrawal from a painful stimulus is not considered a purposeful response and is more consistent with a state of general anesthesia. The ability to independently maintain ventilatory function may be impaired. Patients may require assistance in maintaining a patent airway, and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained. A state of deep sedation may be accompanied by partial or complete loss of protective airway reflexes. Patients may pass from a state of deep sedation to the state of general anesthesia. In some situations, such as during MRI, one is not usually able to assess responses to stimulation, because this would defeat the purpose of sedation, and one should assume that such patients are deeply sedated.

"General anesthesia" is a drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require assistance in maintaining a patent airway, and positive-pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.

Personnel

~~During deep sedation, there must be 1 person whose only responsibility is to constantly observe the patient's vital signs, airway patency, and adequacy of ventilation and to either administer drugs or direct their administration. This individual must, at a minimum, be trained in PALS and capable of assisting with any emergency event. At least 1 individual must be present who is trained in and capable of providing advanced pediatric life support and who is skilled to rescue a child with apnea, laryngospasm, and or airway obstruction. Required skills include the ability to open the airway, suction secretions, provide CPAP, insert supraglottic devices (oral airway, nasal trumpet, LMA), and perform successful bag-valve-mask ventilation, tracheal intubation, and cardiopulmonary resuscitation.~~

During office-based deep sedation/general anesthesia of a pediatric patient, there must be at least two individuals, an independent observer (licensed anesthesia provider) and the operating dentist; present with the patient throughout the extent of the procedure, including recovery. Both individuals, at a minimum, must maintain current training and certification in pediatric advanced life support (PALS) or advanced pediatric life support (APLS). One of these two must remain an independent observer, independent of performing or assisting with the dental procedure. This individual's sole responsibility is to administer pharmacologic agents or direct their delivery and to continuously monitor and record the patient's physiologic vital signs, cardiopulmonary and neurologic status, airway patency and adequacy of ventilation, while assuming the lead role during the management of any perioperative emergencies. Because the intended level of sedation may exceed the practitioner's objective, the practitioner must be skilled and trained to establish intravenous access, rescue a child with apnea, laryngospasm, airway obstruction, hypotension, anaphylaxis, or cardiopulmonary arrest including the ability to suction, open and maintain the airway. He/She must be experienced in placement of endotracheal tubes or supraglottic devices (oral airway, nasal trumpet, laryngeal mask airway, or *i*Gel©), providing constant positive airway pressure (CPAP) using bag-valve-mask ventilation, cardiopulmonary resuscitation, and the administration of rescue medications. As permitted by state regulation, the anesthesia provider may be a dentist or physician anesthesiologist, certified registered nurse anesthetist (CRNA), or a second oral and maxillofacial surgeon.

During deep sedation/general anesthesia of a pediatric patient in a hospital or ambulatory surgical center setting, at least two individuals must be present with the patient throughout the extent of the procedure experienced ~~in~~ in patient rescue and with current PALS or APLS certification. One of these individuals may either administer pharmacologic agents or direct their delivery by a skilled independent observer. The abilities of the individual directing or administering sedation/anesthetic medications must include those described in the previous paragraph. Providers who may fulfill the role of the skilled independent observer in a hospital or ambulatory surgical center, as permitted by state regulation, must be a dentist anesthesiologist, an oral and maxillofacial surgeon, physician with sedation training and advanced airway skills such as, but not limited to, an anesthesiologist, or other medical specialists with the requisite licensure, training and competencies; a CRNA, or certified anesthesiology assistant (**CAA**); a

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nurse with advanced emergency management skills such as several years of experience in the emergency room, pediatric recovery room, or intensive care setting (i.e. nurses who are experienced with assisting the individual administering or directing sedation with patient rescue during life-threatening emergencies).

Equipment
In addition to the equipment needed for moderate sedation, an ECG monitor and a defibrillator for use in pediatric patients should be readily available.

Vascular access
Patients receiving deep sedation should have an intravenous line placed at the start of the procedure or have a person skilled in establishing vascular access in pediatric patients immediately available.

Monitoring
A competent individual shall observe the patient continuously. Monitoring shall include all parameters described for moderate sedation. Vital signs, including heart rate, respiratory rate, blood pressure, oxygen saturation, and expired carbon dioxide, must be documented at least every 5 minutes in a time-based record. Capnography should be used for almost all deeply sedated children because of the increased risk of airway/ ventilation compromise. Capnography may not be feasible if the patient is agitated or uncooperative during the initial phases of sedation or during certain procedures, such as bronchoscopy or repair of facial lacerations, and this circumstance should be documented. For uncooperative children, the capnography monitor may be placed once the child becomes sedated. Note that if supplemental oxygen is administered, the capnograph may underestimate the true expired carbon dioxide value; of more importance than the numeric reading of exhaled carbon dioxide is the assurance of continuous respiratory gas exchange (i.e., continuous waveform). Capnography is particularly useful for patients who are difficult to observe (e.g., during MRI or in a darkened room).[64,67,72,90,96,110,159–162,164–166,167–170,372–375]

The physician/dentist or his or her designee shall document the name, route, site, time of administration, and dosage of all drugs administered. If sedation is being directed by a physician who is not personally administering the medications, then recommended practice is for the nurse administering the medication to confirm the dose verbally before administration.

The inspired concentrations of inhalation sedation agents and oxygen and the duration of administration shall be documented.

Postsedation care
The facility and procedures followed for postsedation care shall conform to those described under “moderate sedation.” The initial recording of vital signs should be documented at least every 5 minutes. Once the child begins to awaken, the recording intervals may be increased to 10 to 15 minutes. Table 2 summarizes the equipment, personnel, and monitoring requirements for moderate and deep sedation.

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Special considerations

Neonates and former preterm infants

Neonates and former preterm infants require specific management, because immaturity of hepatic and renal function may alter the ability to metabolize and excrete sedating medications,[376] resulting in prolonged sedation and the need for extended post-sedation monitoring. Former preterm infants have an increased risk of postanesthesia apnea,[377] but it is unclear whether a similar risk is associated with sedation, because this possibility has not been systematically investigated.[378]

Other concerns regarding the effects of anesthetic drugs and sedating medications on the developing brain are beyond the scope of this document. At this point, the research in this area is preliminary and inconclusive at best, but it would seem prudent to avoid unnecessary exposure to sedation if the procedure is unlikely to change medical/dental management (e.g., a sedated MRI purely for screening purposes in preterm infants).[379–382]

Local anesthetic agents

All local anesthetic agents are cardiac depressants and may cause central nervous system excitation or depression. Particular weight-based attention should be paid to cumulative dosage in all children.[118,120,125,383–386] To ensure that the patient will not receive an excessive dose, the maximum allowable safe dosage (e.g., mg/kg) should be calculated before administration. There may be enhanced sedative effects when the highest recommended doses of local anesthetic drugs are used in combination with other sedatives or opioids (see Tables 3 and 4 for limits and conversion tables of commonly used local anesthetics).[118,125,387–400] In general, when administering local anesthetic drugs, the practitioner should aspirate frequently to minimize the likelihood that the needle is in a blood vessel; lower doses should be used when injecting into vascular tissues.[401] If high doses or injection of amide local anesthetics (bupivacaine and ropivacaine) into vascular tissues is anticipated, then the immediate availability of a 20% lipid emulsion for the treatment of local anesthetic toxicity is recommended (Tables 3 and 5).[402–409] Topical local anesthetics are commonly used and encouraged, but the practitioner should avoid applying excessive doses to mucosal surfaces where systemic uptake and possible toxicity (seizures, methemoglobinemia) could result and to remain within the manufacturer's recommendations regarding allowable surface area application.[410–415]

Pulse oximetry

Newer pulse oximeters are less susceptible to motion artifacts and may be more useful than older oximeters that do not contain updated software.[416–420] Oximeters that change tone with changes in hemoglobin saturation provide immediate aural warning to everyone within hearing distance. The oximeter probe must be properly positioned; clip-on devices are easy to displace, which may produce artifactual data (under-or overestimation of oxygen saturation).[361,362]

Capnography

Expired carbon dioxide monitoring is valuable to diagnose the simple presence or absence of respirations, airway obstruction, or respiratory depression, particularly in patients sedated in less-accessible locations, such as in MRI machines or darkened rooms.[64,66,67,72,90,96,110,159–162,164–170,372–375,421–427] In patients receiving supplemental oxygen, capnography facilitates the recognition of apnea or airway obstruction several minutes before the situation would be detected just by pulse oximetry. In this situation, desaturation would be delayed due to increased oxygen reserves; capnography would enable earlier intervention.[161] One study in children sedated in the emergency department found that the use of capnography reduced the incidence of hypoventilation and desaturation (7% to 1%).[174] The use of expired carbon dioxide monitoring devices is now required for almost all deeply sedated children (with rare exceptions), particularly in situations in which other means of assessing the adequacy of ventilation are limited. Several manufacturers have produced nasal cannulae that allow simultaneous delivery of oxygen and measurement of expired carbon dioxide values.[421,422,427] Although these devices can have a high degree of false-positive alarms, they are also very accurate for the detection of complete airway obstruction or apnea.[164,168,169] Taping the sampling line under the nares under an oxygen face mask or nasal hood will provide similar information. The exact measured value is less important than the simple answer to the question: Is the child exchanging air with each breath?

Processed EEG (Bispectral Index)
Although not new to the anesthesia community, the processed EEG (bispectral index [**BIS**]) monitor is slowly finding its way into the sedation literature.[428] Several studies have attempted to use BIS monitoring as a means of noninvasively assessing the depth of sedation. This technology was designed to examine EEG signals and, through a variety of algorithms, correlate a number with depth of unconsciousness: that is, the lower the number, the deeper the sedation. Unfortunately, these algorithms are based on adult patients and have not been validated in children of varying ages and varying brain development. Although the readings correspond quite well with the depth of propofol sedation, the numbers may paradoxically go up rather than down with sevoflurane and ketamine because of central excitation despite a state of general anesthesia or deep sedation.[429,430]

Opioids and benzodiazepines have minimal and variable effects on the BIS. Dexmedetomidine has minimal effect with EEG patterns, consistent with stage 2 sleep.[431] Several sedation studies have examined the utility of this device and degree of correlation with standard sedation scales.[347,363,432–435] It appears that there is some correlation with BIS values in moderate sedation, but there is not a reliable ability to distinguish between deep sedation and moderate sedation or deep sedation from general anesthesia.[432] Presently, it would appear that BIS monitoring might provide useful information only when used for sedation with propofol[363]; in general, it is still considered a research tool and not recommended for routine use.

Adjuncts to airway management and resuscitation
The vast majority of sedation complications can be managed with simple maneuvers, such as supplemental oxygen, opening the airway, suctioning, placement of an oral or nasopharyngeal airway, and bag-mask-valve ventilation. Rarely, tracheal intubation is required for more prolonged ventilatory support. In addition to standard tracheal intubation techniques, a number of supraglottic devices are available for the management of patients with abnormal airway anatomy or airway obstruction. Examples include the LMA, the cuffed oropharyngeal airway, and a variety of kits to perform an emergency cricothyrotomy.[436,437]

The largest clinical experience in pediatrics is with the LMA, which is available in multiple sizes, including those for late preterm and term neonates. The use of the LMA is now an essential addition to advanced airway training courses, and familiarity with insertion techniques can be life-saving.[438–442] The LMA can also serve as a bridge to secure airway management in children with anatomic airway abnormalities.[443,444] Practitioners are encouraged to gain experience with these techniques as they become incorporated into PALS courses.

Another valuable emergency technique is intraosseous needle placement for vascular access. Intraosseous needles are available in several sizes; insertion can be life-saving when rapid intravenous access is difficult. A relatively new intraosseous device (EZ-IO Vidacare, now part of Teleflex, Research Triangle Park, N.C.) is similar to a hand-held battery powered drill. It allows rapid placement with minimal chance of misplacement; it also has a low-profile intravenous adapter.[445–450] Familiarity with the use of these emergency techniques can be gained by keeping current with resuscitation courses, such as PALS and advanced pediatric life support.

Patient simulators

High-fidelity patient simulators are now available that allow physicians, dentists, and other health care providers to practice managing a variety of programmed adverse events, such as apnea, bronchospasm, and laryngospasm.[133,220,450–452] The use of such devices is encouraged to better train medical professionals and teams to respond more effectively to rare events.[128,131,451,453–455] One study that simulated the quality of cardiopulmonary resuscitation compared standard management of ventricular fibrillation versus rescue with the EZ-IO for the rapid establishment of intravenous access and placement of an LMA for establishing a patent airway in adults; the use of these devices resulted in more rapid establishment of vascular access and securing of the airway.[456]

Monitoring during MRI

The powerful magnetic field and the generation of radiofrequency emissions necessitate the use of special equipment to provide continuous patient monitoring throughout the MRI scanning procedure.[457–459] MRI-compatible pulse oximeters and capnographs capable of continuous function during scanning should be used in any sedated or restrained pediatric patient. Thermal injuries can result if appropriate precautions are not taken; the practitioner is cautioned to avoid coiling of all wires (oximeter, ECG) and to place the oximeter probe as far from the magnetic coil as possible to diminish the possibility of injury. ECG monitoring during MRI has been associated with thermal injury; special MRI-compatible ECG pads are essential to allow safe monitoring.[460–463] If sedation is achieved by using an infusion pump, then either an MRI-compatible pump is required, or the pump must be situated outside of the room with long infusion tubing so as to maintain infusion accuracy. All equipment must be MRI compatible, including laryngoscope blades and handles, oxygen tanks, and any ancillary equipment. All individuals, including parents, must be screened for ferromagnetic materials, phones, pagers, pens, credit cards, watches, surgical implants, pacemakers, etc., before entry into the MRI suite.

Nitrous oxide

Inhalation sedation/analgesia equipment that delivers nitrous oxide must have the capacity of delivering 100% and never less than 25% oxygen concentration at a flow rate appropriate to the size of the patient. Equipment that delivers variable ratios of nitrous oxide >50% to oxygen that covers the mouth and nose must be used in conjunction with a calibrated and functional oxygen analyzer. All nitrous oxide-to-oxygen inhalation devices should be calibrated in accordance with appropriate state and local requirements. Consideration should be given to the National Institute of Occupational Safety and Health Standards for the scavenging of waste gases.[464] Newly constructed or reconstructed treatment facilities, especially those with piped-in nitrous oxide and oxygen, must have appropriate state or local inspections to certify proper function of inhalation sedation/analgesia systems before any delivery of patient care.

Nitrous oxide in oxygen, with varying concentrations, has been successfully used for many years to provide analgesia for a variety of painful procedures in children.[14,36,49,98,465–493] The use of nitrous oxide for minimal sedation is defined as the administration of nitrous oxide of ≤50% with the balance as oxygen, without any other sedative, opioid, or other depressant drug before or concurrent with the nitrous oxide to an otherwise healthy patient in ASA class I or II. The patient is able to maintain verbal communication throughout the procedure. It should be noted that although local anesthetics have sedative properties, for purposes of this guideline they are not considered sedatives in this circumstance. If nitrous oxide in oxygen is combined with other sedating medications, such as chloral hydrate, midazolam, or an opioid, or if nitrous oxide is used in concentrations >50%, the likelihood for moderate or deep sedation increases.[107,197,492,494,495] In this situation, the practitioner is advised to institute the guidelines for moderate or deep sedation, as indicated by the patient’s response.[496]

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Supplemental information

Appendix 1. Recommended Discharge Criteria

1. Cardiovascular function and airway patency are satisfactory and stable.
2. The patient is easily arousable, and protective reflexes are intact.
3. The patient can talk (if age appropriate).
4. The patient can sit up unaided (if age appropriate).
5. For a very young or handicapped child incapable of the usually expected responses, the presedation level of responsiveness or a level as close as possible to the normal level for that child should be achieved.
6. The state of hydration is adequate.

Appendix 2. ASA Physical Status Classification

Class I A normally healthy patient.
Class II A patient with mild systemic disease (e.g., controlled reactive airway disease).
Class III A patient with severe systemic disease (e.g., a child who is actively wheezing).
Class IV A patient with severe systemic disease that is a constant threat to life (e.g., a child with status asthmaticus).
Class V A moribund patient who is not expected to survive without the operation (e.g., a patient with severe cardiomyopathy requiring heart transplantation).

Appendix 3. Drugs* That May Be Needed to Rescue a Sedated Patient[44]

Albuterol for inhalation
Ammonia spirits
Atropine
Diphenhydramine
Diazepam
Epinephrine (1:1000, 1:10 000)
Flumazenil Glucose (25 percent or 50 percent)
Lidocaine (cardiac lidocaine, local infiltration)

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Lorazepam
Methylprednisolone
Naloxone
Oxygen
Fosphenytoin
Racemic epinephrine
Rocuronium
Sodium bicarbonate
Succinylcholine

* The choice of emergency drugs may vary according to individual or procedural needs.

Appendix 4. Emergency Equipment † That May Be Needed to Rescue a Sedated Patient ‡

Intravenous Equipment
Assorted IV catheters (e.g., 24-, 22-, 20-, 18-, 16-gauge)
Tourniquets
Alcohol wipes
Adhesive tape
Assorted syringes (e.g., 1-, 3-, 5-, 10-mL)
IV tubing
    Pediatric drip (60 drops/mL)
    Pediatric burette
    Adult drip (10 drops/mL)
    Extension tubing
    3-way stopcocks
IV fluid
    Lactated Ringer solution
    Normal saline solution
    D_5 0.25 normal saline solution
Pediatric IV boards
Assorted IV needles (e.g., 25-, 22-, 20-, and 18-gauge)
Intraosseous bone marrow needle
Sterile gauze pads

Airway Management Equipment
Face masks (infant, child, small adult, medium adult, large adult)
Breathing bag and valve set
Oropharyngeal airways (infant, child, small adult, medium adult, large adult)
Nasopharyngeal airways (small, medium, large)
Laryngeal mask airways (1, 1.5, 2, 2.5, 3, 4, and 5)
Laryngoscope handles (with extra batteries)
Laryngoscope blades (with extra light bulbs)

Straight (Miller) No. 1, 2, and 3
Curved (Macintosh) No. 2 and 3

Endotracheal tubes (2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, and 6.0 uncuffed and 6.0, 7.0, and 8.0 cuffed)
Stylettes (appropriate sizes for endotracheal tubes)
Surgical lubricant
Suction catheters (appropriate sizes for endotracheal tubes)
Yankauer-type suction
Nasogastric tubes
Nebulizer with medication kits
Gloves (sterile and nonsterile, latex free)

† The choice of emergency equipment may vary according to individual or procedural needs.
‡ The practitioner is referred to the SOAPME acronym described in the text in preparation for sedating a child for a procedure.

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Use of Anesthesia Providers in the Administration of Office-based Deep Sedation/General Anesthesia to the Pediatric Dental Patient

Review Council
Council on Clinical Affairs

Latest Revision
~~2018~~2019[1]

Abbreviations
AAPD: American Academy of Pediatric Dentistry
ASA: American Society of Anesthesiologists
CAA: Certified anesthesiologist assistant
CO_2: Carbon dioxide
CRNA: Certified registered nurse anesthetist

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that there are pediatric dental patients for whom routine dental care using nonpharmacologic behavior guidance techniques is not a viable approach.[1] The AAPD intends this guideline to assist the dental practitioner who elects to use a licensed anesthesia provider for the administration of deep sedation/general anesthesia for pediatric dental patients in a dental office or other facility outside of an accredited hospital or ambulatory surgical center. This document discusses personnel, facilities, documentation, and quality assurance mechanisms necessary to provide optimal and responsible patient care.

Methods

Recommendations on the use of anesthesia providers in the administration of office-based deep sedation/general anesthesia were developed by the Clinical Affairs Committee – Sedation and General Anesthesia Subcommittee and adopted in 2001. This document is a revision of the previous version, last revised in 2017. The revision is based upon a review of current dental and medical literature pertaining to deep sedation/general anesthesia of dental patients, including a search of the PubMed®/MEDLINE database using the terms: office-based general anesthesia, pediatric sedation, deep sedation, sleep dentistry, and dental sedation; fields: all; limits: humans, all children from birth through age 18, English, clinical trials, and literature reviews. The search

[1] 2019 revision limited to Personnel section.

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returned 69 articles; the reviewers agreed upon the inclusion of 12 articles that met the defined criteria. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Pediatric dentists seek to provide oral health care to infants, children, adolescents, and persons with special health care needs in a manner that promotes excellence in quality of care and concurrently induces a positive attitude in the patient toward dental treatment. Behavior guidance techniques have allowed most pediatric dental patients to receive treatment in the dental office with minimal discomfort and without expressed fear. Minimal or moderate sedation has allowed others who are less compliant to receive treatment. Some children and individuals with special care needs who have extensive oral healthcare needs, acute situational anxiety, uncooperative age-appropriate behavior, immature cognitive functioning, disabilities, or medical conditions require deep sedation/general anesthesia to receive dental treatment in a safe and humane fashion.[2] Access to hospital-based anesthesia services may be limited for a variety of reasons, including restriction of coverage of by third-party payors.[2,3] Pediatric dentists and others who treat children can provide for the administration of deep sedation/ general anesthesia by utilizing properly trained and currently licensed anesthesia providers in their offices or other facilities outside of the traditional surgical setting.

Office-based deep sedation/general anesthesia can provide benefits for the patient and the dental team. Such benefits may include:

- improved access to care;
- improved ease and efficiency of scheduling;
- decreased administrative procedures and facility fees when compared to a surgical center or hospital;
- minimized likelihood of patient's recall of procedures;
- decreased patient movement which may optimize quality of care; and
- use of traditional dental delivery systems with access to a full complement of dental equipment, instrumentation, supplies, and auxiliary personnel.

The use of licensed anesthesia providers to administer deep sedation/general anesthesia in the pediatric dental population is an accepted treatment modality.[4-8] Caution must be used in patients younger than two years of age. Practitioners must always be mindful of the increased risk associated with office-based deep sedation/general anesthesia in the infant and toddler populations. This level of pharmacologic behavioral modification should only be used when the risk of orofacial disease outweighs the benefits of monitoring, interim therapeutic restoration, or arresting medicaments to slow or stop the progression of caries. The AAPD supports the provision of deep sedation/general anesthesia when clinical indications have been met and additional properly-trained and credentialed personnel and appropriate facilities are used.[1,3,4] In many cases, the patient may be treated in an appropriate outpatient facility (including the dental

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office) because the extensive medical resources of a hospital may not be deemed necessary for delivering routine health care.

Recommendations

Clinicians may consider using deep sedation or general anesthesia in the office to facilitate the provision of oral health care. Practitioners choosing to use these modalities must be trained in rescue emergency procedures and be familiar with their patient's medical history, as well as the regulatory and professional liability insurance requirements needed to provide this level of pharmacologic behavior management. This guideline does not supersede, nor is it to be used in deference to, federal, state, and local credentialing and licensure laws, regulations, and codes.

Personnel

Deep sedation/general anesthesia techniques in the dental office require the presence of at least two ~~three~~ of the following individuals throughout the extent of the procedure:

- ~~independently practicing and currently licensed anesthesia provider~~ independent licensed anesthesia provider, who is independent of performing or assisting with the dental procedure.
- operating dentist.
- ~~support personnel.~~

~~The anesthesia care provider's responsibilities are to administer drugs or direct their administration and to continuously monitor the patient's vital signs, airway patency, cardiovascular and neurological status, and adequacy of ventilation. Both the surgical and anesthesia teams are responsible for maintaining optimal patient positioning, such as keeping the head and neck aligned and supported while padding all pressure points. Additional attention should be placed on moving extremities during long procedures so as to avoid the possibility of complications secondary to prolonged immobility (e.g., peripheral neuropathy).~~

It is the exclusive responsibility of ~~treating~~ ~~practitioners~~ the operating dentist, when employing anesthesia providers to administer deep sedation/general anesthesia, to verify and carefully review their credentials and experience. Significant pediatric training, including anesthesia care of the very young, and experience in a dental setting are important considerations, especially when caring for young pediatric and special needs populations. In order to provide anesthesia services in an office-based setting:

- the licensed anesthesia ~~care~~ provider must be a licensed dental and/or medical practitioner with current state certification to independently administer deep sedation/general anesthesia in a dental office. He/She must be in compliance with state and local laws regarding anesthesia practices. Laws vary from state to state and may supersede any portion of this document.
- if state law permits a certified registered nurse anesthetist (**CRNA**) or certified anesthesiologist assistant (**CAA**) to function under the direct supervision of a dentist, the

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dentist is required to have completed training in deep sedation/general anesthesia and be licensed or permitted for that level of pharmacologic management, appropriate to state law. Furthermore, to maximize patient safety, the dentist supervising the CRNA or CAA would not simultaneously be providing dental treatment. The CRNA or CAA must be licensed with current state certification to administer deep sedation/general anesthesia in a dental office. He/She must be in compliance with state and local laws regarding anesthesia practices. Laws vary from state to state and may supersede any portion of this document.

The dentist and anesthesia care provider must be compliant with the American Academy of Pediatrics/AAPD's *Guideline on Monitoring and Management of Pediatric Patients Before, During, and After Sedation for Diagnostic and Therapeutic Procedures: Update 2016*[4] or other appropriate guideline(s) of the American Dental Association **(ADA)**, American Society of Dentist Anesthesiologists (**ASDA**), American Society of Anesthesiologists (**ASA**), and other organizations with recognized professional expertise and stature. The recommendations in this document may be exceeded at any time if the change involves improved safety and/or is superseded by state law. The dentist and licensed anesthesia provider must collaborate to enhance patient safety. Continuous and effective perioperative communication and appropriately timed interventions are essential in mitigating adverse events or outcomes. The dentist introduces the concept of deep sedation/general anesthesia to the parent, justifies its necessity, and provides appropriate preoperative instructions and informational materials. The dentist or his/her designee coordinates medical consultations when necessary and conveys pertinent information to the anesthesia care provider. The anesthesia care provider explains potential risks and obtains informed consent for sedation/anesthesia. Office staff should understand their additional roles and responsibilities and special considerations (e.g., loss of protective reflexes) associated with office-based deep sedation/general anesthesia.

Both the licensed anesthesia provider and the operating dentist, ~~individuals, at a minimum,~~ must at a minimum, maintain current certification and training in pediatric advanced life support (PALS) or advanced pediatric life support (APLS), patient rescue, and be capable of managing potential airway complications related to the delivery of all levels of sedation.

The licensed anesthesia provider's sole responsibility is to administer pharmacologic agents or direct their administration and to continuously monitor and record the patient's depth of sedation, physiologic vital signs, cardiopulmonary and neurologic status, airway patency and adequacy of ventilation, while assuming the lead role during the management of any perioperative emergencies. Because the intended level of sedation may exceed the practitioner's objective, the practitioner must be skilled to establish intravenous access, rescue a child with apnea, laryngospasm, airway obstruction, hypotension, anaphylaxis, or cardiopulmonary arrest including the ability to suction and open the airway.[4] He/She must be experienced in placement of endotracheal tubes or supraglottic devices (oral airway, nasal trumpet, laryngeal mask airway, or *i*Gel©), providing constant positive airway pressure (CPAP), using bag-valve-mask

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ventilation, cardiopulmonary resuscitation, and the administration of rescue medications. As permitted by state regulation, the anesthesia provider may be one of the following:

- dentist or physician anesthesiologist
- certified registered nurse anesthetist, or
- an oral and maxillofacial surgeon.

It is the responsibility of the anesthesia provider to ensure that the operating dentist and supportive staff is capable of providing him/her with skilled assistance ~~support~~ and have an established emergency and transport protocol in place in the event of an adverse incident.

~~Advanced training in recognition and management of pediatric emergencies is critical in providing safe sedation and anesthetic care. During deep sedation/general anesthesia in the dental setting, there must be at least two individuals present with the skills in patient rescue and pediatric advanced life support (e.g., PALS) and capable of managing any emergency event.[4] One of the two must be an independent observer who sole responsibility is to constantly observe the patient's vital signs, levels of sedation, airway patency, and adequacy of ventilation. The independent observer must be capable of recognizing the depth of sedation as well as be skilled to establish intravenous access and draw up and administer rescue medications. This provider must have management skills to rescue the non-breathing child, a child with airway obstruction, and a child with hypotension, anaphylaxis, or cardiac arrest; this would include the ability to open the airway, suction secretions, provide continuous positive airway pressure (CPAP), insert supraglottic devices (oral airway, nasal trumpet, laryngeal mask airway [LMA]), and perform successful bag-valve-mask ventilation, tracheal intubation, and cardiopulmonary resuscitation.[4] The independent observer must be one of the following: (1) a physician anesthesiologist, (2) a dental anesthesiologist, (3) a certified registered nurse anesthetist, (4) an oral and maxillofacial surgeon. The second skilled individual (e.g., the responsible dental practitioner) must be trained in and capable of providing pediatric advanced life support and skilled in assisting the independent observer with the rescue of a child with any of the adverse events described above.~~

Personnel experienced in post anesthetic recovery care and trained in advanced resuscitative techniques (e.g., PALS) must be in attendance and provide continuous respiratory and cardiovascular monitoring during the recovery period.[4] The supervising anesthesia provider, not the operating dentist, shall determine when the patient exhibits respiratory and cardiovascular stability and appropriate discharge criteria[4] have been met. The operating dentist and his/her clinical staff must be well-versed in emergency recognition, rescue, and emergency protocols including maintaining cardiopulmonary resuscitation certification for healthcare providers.[6] In addition, it is highly recommended that the operating dentist be trained in advanced resuscitative techniques. Contact numbers for local emergency medical and ambulance services must be readily available, and a protocol for immediate access to backup emergency services must be clearly outlined.[4] Emergency preparedness must be updated and practiced on a regular (e.g., semi-annual) basis [see Table 1], so as to keep all staff members up to date on established protocols.[9]

Facilities

A continuum exists that extends from wakefulness across all levels of sedation. Often these levels are not easily differentiated, and patients may drift among them.[10] When anesthesia care providers are utilized for office-based administration of deep sedation or general anesthesia, the facilities in which the dentist practices must meet the guidelines and appropriate local, state, and federal codes for administration of the deepest possible level of sedation/anesthesia. Facilities must be in compliance with applicable laws, codes, and regulations pertaining to controlled drug storage, fire prevention, building construction and occupancy, accommodations for the disabled, occupational safety and health, and disposal of medical waste and hazardous waste.[4] The treatment room must accommodate the dentist and auxiliaries, the patient, the anesthesia care provider, the dental equipment, and all necessary anesthesia delivery equipment along with appropriate monitors and emergency equipment. Expeditious access to the patient, anesthesia machine (if present), and monitoring equipment should be available at all times.

It is beyond the scope of this document to dictate equipment necessary for the provision of deep sedation/general anesthesia, but equipment must be appropriate for the technique used and consistent with the guidelines for anesthesia providers, in accordance with governmental rules and regulations. Because laws and codes vary from state to state, *Guidelines for Monitoring and Management of Pediatric Patients Before, During, and After Sedation for Diagnostic and Therapeutic Procedures: Update 2016* [4] should be followed as the minimum requirements.

For deep sedation/general anesthesia, there must be continuous monitoring of the patient's level of consciousness and responsiveness, heart rate, blood pressure, respiratory rate, expired carbon dioxide (**CO_2**) values, and oxygen saturation.[4] When adequacy of ventilation is difficult to observe using capnography, use of an amplified, audible precordial stethoscope (e.g., Bluetooth technology) is encouraged.[4] In addition, an electrocardiographic monitor and a defibrillator capable of delivering an attenuated pediatric dose are required for deep sedation/general anesthesia.[4] Emergency equipment must be readily accessible and should include Yankauer suction, drugs necessary for rescue and resuscitation (including 100 percent oxygen capable of being delivered by positive pressure at appropriate flow rates for up to one hour), and age-/size-appropriate equipment to resuscitate and rescue a non-breathing and/or unconscious pediatric dental patient and provide continuous support while the patient is being transported to a medical facility.[4,5] The licensed practitioners are responsible for ensuring that medications, equipment, and protocols are available to treat malignant hyperthermia when triggering agents are used.[11] Recovery facilities must be available and suitably equipped. Backup power sufficient to ensure patient safety should be available in case of emergency power outage.[4]

Documentation

Prior to delivery of deep sedation/general anesthesia, patient safety requires that appropriate documentation shall address rationale for sedation/general anesthesia, anesthesia and procedural informed consent, instructions to parent, dietary precautions, preoperative health evaluation, and any prescriptions along with the instructions given for their use.[4] Because laws and codes vary from state to state, *Guidelines on Monitoring and Management of Pediatric Patients Before, During, and After Sedation for Diagnostic and Therapeutic Procedures: Update 2016* [4] should be followed as minimum requirements for a time-based anesthesia record.

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- Vital signs: Pulse and respiratory rates, blood pressure, heart rhythm, oxygen saturation, and expired CO_2 must be continuously monitored and recorded on a time-based record throughout the procedure, initially every five minutes and then, as the patient awakens, at 10-15 minute intervals until the patient has met documented discharge criteria.[4]
- Drugs: Name, dose, route, site, time of administration, and patient effects (e.g., level of consciousness, patient responsiveness) of all drugs, including local anesthesia, must be documented.[4] When anesthetic gases are administered, inspired concentration and duration of inhalation agents and oxygen shall be documented.[4]
- Recovery: The condition of the patient, that discharge criteria have been met, time of discharge, and into whose care the discharge occurred must be documented. Requiring the signature of the responsible adult to whom the child has been discharged, verifying that he/she has received and understands the post-operative instructions, is encouraged.[4]

Various business/legal arrangements may exist between the treating dentist and the anesthesia provider. Regardless, because services were provided in the dental facility, the dental staff must maintain all patient records, including time-based anesthesia records, so that they may be readily available for emergency or other needs. The dentist must assure that the anesthesia provider also maintains patient records and that they are readily available.

Risk management and quality assurance

Dentists who utilize office-based anesthesia care providers must take all necessary measures to minimize risk to patients. The dentist must be familiar with the ASA physical status classification.[12] Knowledge, preparation, and communication between professionals are essential. Prior to subjecting a patient to deep sedation/general anesthesia, the patient must undergo a preoperative health evaluation by an appropriate and currently licensed medical or anesthesia provider.[4,6] High-risk patients should be treated in a facility properly equipped and staffed to provide for their care.[4,6] The dentist and anesthesia care provider must communicate during treatment to share concerns about the airway or other details of patient safety. Furthermore, they must work together to develop and document mechanisms of quality assurance.

Untoward and unexpected outcomes must be documented and reviewed to monitor the quality of services provided. This will decrease risk, allow for open and frank discussions, document risk analysis and intervention, and improve the quality of care for the pediatric dental patient.[4,5]

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Table 1. CONSIDERATIONS IN FREQUENCY OF CONDUCTING EMERGENCY EXERCISES[9]

Changes in plans	Changes in the emergency response plan need to be disseminated and practiced.
Changes in personnel	New staff members need training in their emergency response roles. Emergency roles left by former staff members need to be filled.
Changes in property	Infrastructure changes can affect how the plan is implemented. New equipment may require training for their use.
Foreseen problems	Protocols for newly identified problems must be established, practiced and implemented.

Reprinted from *Guidance Materials: Hospital and Health Facility Emergency Exercises*, Emergency exercise basics, Page 4, Copyright © World Health Organization 2010. Available at: "http://www.wpro.who.int/publications/PUB_9789290614791/en/". Accessed August 24, 2018.

[Best Practices]

Classification of Periodontal Diseases in Infants, Children, Adolescents, and Individuals with Special Health Care Needs

Review Council
Council on Clinical Affairs
Adopted
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Keywords: classification, periodontal health, gingivitis, periodontitis, plaque.

Purpose

The American Academy of Pediatric Dentistry (**AAPD**) recognizes that although the prevalence of destructive forms of periodontal disease is low among children and adolescents, this population can develop several forms of periodontal diseases and conditions most frequently associated with an underlying systemic or immunologic disorder.[1-4] In addition, current and early studies show that gingivitis occurs in half of the population by age of 4 or 5 years and peaks nearly to 100% at puberty.[3] The prevalence of gingivitis can be similar to or greater than dental caries during childhood.[1] Nevertheless, when compared to dental caries, gingivitis in children has received much less attention in understanding the long-term impact that chronic inflammation of the periodontal tissues in childhood may have on overall health of the periodontium throughout life.[1] Therefore, it is critical that pediatric dental patients receive a periodontal assessment as part of their routine dental visits. Early diagnosis ensures the greatest opportunity for successful treatment, primarily by reducing etiological factors, establishing appropriate therapeutic measures, and developing an effective periodic maintenance protocol.[2]

In 2017, the American Academy of Periodontology and the European Federation of Periodontology co-sponsored the World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions. The objective of the workshop was to update the previous disease classification established at the 1999 International Workshop for Classification of Periodontal Diseases and Conditions.[5] One of the major highlights included the recategorization of three forms of periodontitis, the development of a multidimensional staging and grading system for periodontitis, and the new classification for peri-implant diseases and conditions.[6]

The intent of this best practices document is to present an abbreviated overview of the new classification of periodontal and peri-implant diseases and conditions, including gingivitis. In addition, this document aims to emphasize the key role dentists have in diagnosing, treating and/or referring pediatric patients and those medically compromised or with special health care needs affected by periodontal problems. A comprehensive review of the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions including the rationale, criteria, and implementation of the new classifications, is available at the Journal of Periodontology in June 2018, (Table 1).[6-28]

Methods

This document presents an abbreviated overview of the new classification of periodontal and peri-implant diseases and conditions.[6-28] In addition to reviewing the proceeding papers from the 2017 World Workshop, an electronic search was conducted using PubMed® using the terms: health, periodontal health, gingival disease and children and adolescents, periodontal disease and children and adolescents, gingivitis, periodontitis, gingival disease and prevalence, periodontal disease and prevalence, gingivitis and prevalence, periodontitis and prevalence, dental plaque, drug-influenced gingival enlargements/overgrowth/hyperplasia, necrotizing periodontitis, systemic disease, vitamin C, scurvy, puberty, pregnancy, menstrual cycle, oral contraceptives, hyperglycemia, leukemia, malnutrition, smoking; fields: all; limits: within the last 10 years, humans, English, and clinical trials. From this search, 158 articles matched these criteria and were evaluated by title and/or abstract. Information from 61 papers for review was chosen from this list and from references within selected articles. When data did not appear sufficient or were inconclusive, recommendations were based upon expert and/or consensus opinion by experienced researchers and clinicians.

Background

Periodontal health, gingival diseases and conditions

Periodontal health

The World Health Organization (**WHO**) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity".[29] Following this framework, periodontal health is defined as the absence of clinical inflammation associated with gingivitis, periodontitis, or any other periodontal conditions, and may include patients who have had a history of successfully treated gingivitis or periodontitis, or other periodontal conditions, and who have been and are able to maintain their dentition without signs of clinical gingival inflammation.[11] According to the WHO health framework,[29] the absence of inflammatory periodontal disease allows an individual to function normally and avoid the consequences (mental or physical) associated to present or past disease.[11]

Assessing periodontal health is important to establish a common reference point for diagnosing disease and determining therapy outcomes by practitioners.[11,21] Four levels of periodontal health have been proposed, depending on whether (1) the periodontium (attachment and bone level) is structurally and clinically sound or reduced, (2) the ability to control local and systemic modifying factors, as well as (3) the relative treatment outcomes. These levels are: (1) *pristine periodontal health*, characterized by total absence of clinical inflammation, and physiological immune surveillance on a periodontium with normal support; (2) *clinical periodontal health*, characterized by an absence or minimal levels of clinical inflammation in a periodontium with normal support; (3) *periodontal disease stability*, characterized as a state in which the periodontitis has been successfully treated and clinical signs of the disease do not appear to worsen in extent or severity despite the presence of a reduced periodontium; and (4) *periodontal disease remission/control*, characterized as a period in the course of disease when symptoms become less severe but may not be fully resolved with a reduced periodontium (Table 2).[6, 21] It should be noted that "pristine periodontal health" characterized by no attachment loss, no bleeding on probing (**BoP**), no sulcular probing >3 mm in the permanent dentition and no redness, clinical swelling/edema or pus is a rare entity, especially among adults.[21] Therefore,

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minimal levels of clinical inflammation observed in "clinical periodontal health" is compatible with a patient classified as periodontally healthy.

Monitoring gingival health or inflammation is best documented by the parameter of BoP since it is considered the primary parameter to set thresholds for gingivitis, and the most reliable for monitoring patients longitudinally in clinical practice.[6,21] Clinicians are encouraged to start probing regularly when the first permanent molars are fully erupted and the child is able to cooperate for this procedure in order to establish a baseline, detect early signs of periodontal disease and prevent its progression. . Probing prior to the eruption of the first permanent molars is encouraged in the presence or suspicion of any clinical and/or radiographic signs of periodontal disease. While probing, clinicians should rule out the presence of pseudo pockets associated, for example, with tooth exfoliation or partially erupted teeth. For patients with special health care needs receiving dental treatment under sedation and/or general anesthesia, clinicians are encouraged to take this opportunity and perform the periodontal probing. The probing force should not exceed 0.25 Newton (light probing) in order to rule out the confounding issue of BoP induced by too much pressure, as well as unnecessary bleeding resulting from trauma.[21] When probing positioning and pressure into the sulcus/pocket are performed correctly, the patient should not feel discomfort. With regards to periodontal probing depth (**PPD**), there is strong evidence that deep pockets are not necessarily consistent with disease. Deep pockets may remain stable and uninflamed, especially in cases where patients receive long term careful supportive periodontal care, and are referred to as "healthy pockets". PPD or probing attachment levels alone should not be used as evidence of gingival health or disease; however, be considered in conjunction with other important clinical parameters such as BoP, as well as modifying and predisposing factors. Radiographic assessment is a critical component of clinical assessment of the periodontal tissues. Radiographically, a normal, anatomically intact periodontium would present an intact lamina dura, no evidence of bone loss in furcation areas, and a 2 mm distance, on average, from the most coronal portion of the alveolar bone crest to the cementoenamel junction varying between 1.0 and 3.0 mm. While analyzing radiographic findings in children, it is important that clinicians do not focus only on diagnosing interproximal carious lesions, but also evaluate the periodontal status, especially as the child grows older. Tooth mobility is not recommended to be used as a clinical parameter of either periodontal health or disease status.[21]

Important main differences between periodontal disease stability and periodontal disease remission/control are the ability to control for any modifying factors and the therapeutic response. Stability is characterized by minimal inflammation (< 10% in BoP sites), optimal therapeutic response (no probing depths $\geq$ 4mm), lack of progressive periodontal destruction, while controlling for risk factors. Remission/control is characterized by a significant decrease in inflammation, some improvement in other clinical parameters, and stabilization of disease progression. Stability is the major treatment goal for periodontitis; however, remission/control may be the more realistically achievable therapeutic goal when it is not possible to fully control for modifying factors.[11,19,22,28]

There are three major determinants of clinical periodontal health. These include (1) *microbiological determinants* (e.g., supragingival plaque and subgingival biofilm compositions), (2) *host determinants* (local predisposing factors: e.g., periodontal pockets, dental restorations, root anatomy, tooth position and crowding; systemic modifying factors: e.g., host immune function, systemic health, genetics), and (3) *environment determinants* (e.g., smoking, medications, stress, nutrition). In order to attain or maintain clinical periodontal health, clinicians should not underestimate predisposing and modifying factors for each patient, and recognize when these factors can be fully controlled or not. Predisposing factors are any agent or condition that contributes to the accumulation of dental plaque (e.g., tooth anatomy, tooth position, restorations), while modifying factors are any agent or condition that alters the way in which an individual responds to subgingival plaque accumulation (e.g., smoking, systemic conditions, medications). Many factors are determined controllable (e.g., removal of overhangs, smoking cessation, good diabetes control) while others are not (e.g., genetics, immune status, use of critical medications).[21]

Gingival health

Gingival health is usually associated with an inflammatory infiltrate and host response in relatively stable equilibrium.[21] Gingival health in a patient with intact periodontium is diagnosed by (1) no probing attachment loss, (2) no radiographic bone loss, (3) $\leq$3mm of PPD, and (4) <10% BoP.[11]Gingival health can be restored following treatment of gingivitis and periodontitis. A patient with a current gingival health status who has a history of successful treated and stable periodontitis remains at an increased risk of recurrent periodontitis; therefore, the patient should be monitored closely to ensure optimal disease management.

The features of clinical gingival health are the same on an intact periodontium followed or not by treatment of gingivitis, that is, absence of BoP, erythema and edema, patient symptoms, and attachment and bone loss (physiological bone levels range from 1.0 to 3.0 mm apical to the cemento-enamel junction). The same gingival health features are also observed on a reduced periodontium following successful treatment of periodontitis.

Gingival diseases and conditions

Gingivitis is a reversible disease characterized by an inflammation of the gingiva that does not result in clinical attachment loss (**CAL**).[30] Gingivitis of varying severity is highly prevalent among children and adolescents[11,21] and necessary prerequisite for the development of periodontitis and progressive connective tissue attachment and bone loss.[6,22,28] Controlling gingival inflammation is considered the primary preventive strategy for periodontitis, as well as the secondary preventive strategy for recurrence of periodontitis. Even though there is a predilection of attachment loss to occur at inflamed sites of the gingiva, not all affected areas are destined to progress to periodontitis. This is because the inter-relationship between health, gingivitis and periodontitis is highly dependent on the host's susceptibility and immune-inflammatory response. Nevertheless, clinicians must understand their crucial role in ongoing management of gingivitis for their patients of all ages with and/or without a history of periodontal disease. There are broadly two categories of gingival disease and conditions: *dental plaque biofilm-induced gingivitis* and *non-dental plaque-induced gingival disease*.

Dental plaque biofilm-induced gingivitis

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During the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions, revisions of the 1999 classification system[5] for dental plaque-induced gingival diseases included four components: (1) description of the extent and severity of the gingival inflammation; (2) description of the extent and severity of gingival enlargements; (3) a reduction in gingival disease taxonomy; and (4) discussion of whether mild localized gingivitis should be considered a disease or variant of health.[22] These four components are addressed in this review.

Dental plaque biofilm-induced gingivitis is usually regarded as a localized inflammation initiated by microbial biofilm accumulation on teeth and considered one of the most common human inflammatory diseases (Table 2).[6,19] When dental plaque is not removed, gingivitis may initiate as a result of loss of symbiosis between the biofilm and the host's immune-inflammatory response. The common features of plaque-induced gingivitis include (1) clinical signs and symptoms of inflammation confined to the free and attached gingiva that do not extend to the periodontal attachment (cementum, periodontal ligament and alveolar bone); (2) reversibility of the inflammation achieved by biofilm removal at and apical to the gingiva margin; (3) presence of a high bacterial plaque burden needed to initiate the inflammation; and (4) stable attachment levels on a periodontium, which may or may not have experienced a loss of attachment or alveolar bone (Table 3).[11,22,28] The diagnostic criteria for gingivitis is based on clinical features. Radiographs and probing attachment level analysis should not be used to diagnose gingivitis since they usually do not indicate loss of supporting structures. Clinical signs of *inflammation* include erythema, edema, pain (soreness), heat, and loss of function. Clinical signs of *gingivitis* include swelling (loss of knife-edged gingival margin and blunting of papillae), redness, bleeding and discomfort on gentle probing. Patient symptoms may include bleeding gums, metallic/altered taste, pain/soreness, halitosis, difficulty eating, appearance of swollen red gums, and reduced oral health–related quality of life.[11]Although there are no objective clinical criteria for defining gingivitis severity, the extent of gingivitis referred as "*mild*, *moderate*, and *severe*" can be used as a patient communication tool. The definitions of mild, moderate, and severe gingivitis continue to be a matter of professional opinion. Practitioners may define gingivitis as percentages of BoP sites (e.g. *mild* = < 10%, *moderate* = 10%-30%, *severe* = >30% sites) or based on grading (e.g. grade 1 to 5 in 20% quintiles for % sites BoP).[10] The gingival index described by Löe[31] can also be used to describe the intensity of gingival inflammation as *mild* (area with a minor change in color and little change in the texture of the tissue); *moderate* (area with glazing, redness, edema, enlargement, and bleeding upon probing); and *severe* (area of overt redness and edema with a tendency toward bleeding when touched rather than probed). Lastly, the extent or the number of gingival sites exhibiting gingival inflammation can be described as either *localized* when < 30% of the teeth are affected or *generalized* when ≥30% of the teeth are affected.[22]

As mentioned above, one revision from the 1999 classification system[5] was the proposal to introduce the term "incipient gingivitis"…"*where, by definition, only a few sites are affected by mild inflammation, expressed as mild redness and/or a delayed and broken line of bleeding rather than edema or an immediate unbroken line of bleeding on probing. Incipient gingivitis may be regarded as a condition that is part of a spectrum of "clinical health," but may rapidly become localized gingivitis if untreated.*"[22]

The severity, extent and progression of plaque-induced gingivitis at specific sites or at the entire mouth varies between individuals and can be influenced by local (predisposing factors) and systemic factors (modifying factors). Local oral factors that exacerbate plaque-induced gingivitis are those that can influence the initiation or progression of gingival inflammation by facilitating accumulation of bacterial plaque at a specific site, inhibiting daily mechanical plaque removal, and/or creating a biological niche that encourages increased plaque accumulation. Examples of plaque-induced gingivitis exacerbated by plaque biofilm retention are prominent subgingival restoration margins and certain tooth anatomies that contribute with plaque accumulation increasing the risk for gingivitis and, consequently, compromising the gingival health. Oral dryness is a clinical condition frequently associated with symptoms of xerostomia, which in turn is a symptom caused by a decrease in the salivary flow (hyposalivation). Hyposalivation interferes with plaque removal increasing the risk of caries, halitosis, and gingival inflammation among other oral conditions. Xerostomia may occur as a side effect of medications such as antidepressants, antihistamines, decongestants, and antihypertensive

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medications. In addition, health diseases/conditions such as Sjögren's syndrome, anxiety, poorly controlled diabetes may cause xerostomia due to hyposalivation.[11,22]

Systemic risk factors (modifying factors) can modify the host immune inflammatory response in the presence of dental plaque biofilm resulting in exaggerated inflammatory response. Examples of systemic conditions include: (1) sex steroid hormones (e.g. puberty, pregnancy, menstrual cycle, and oral contraceptives); (2) hyperglycemia; (3) leukemia; (4) malnutrition; and (5) smoking.[11,22]

Elevations in sex steroid hormones, especially, during puberty and pregnancy may modify the gingival inflammatory response and result in an exaggerated gingival inflammation in the presence of even relatively small amounts of plaque. Other factors that predispose to gingivitis in both male and female adolescents to consider are dental caries, mouth breathing, crowding and eruption of teeth. As for the use of oral contraceptives, exaggerated gingival inflammatory responses to plaque is not reported in current oral contraceptive formulations with lower dosages as previously observed with first generation high-dose oral contraceptives.[32-34] Although modest gingival inflammation changes have been reported during ovulation,[35-37] most women with gingival inflammation associated with menstrual cycles will present with non-detectable clinical signs of the condition.[38-40]

Hyperglycemia, hematologic malignancies (e.g. leukemia), and nutritional deficiencies are also significant systemic conditions that can negatively affect the gingival tissues. Increased incidence of chronic gingivitis and risk of periodontitis among children with poorly controlled type 1 diabetes mellitus have been reported.[41-43] The severity of gingival inflammation may be more associated with the level of glycemic control rather than the quality of plaque control.[36-40] Hyperglycemia can alter the immune system, have a negative direct effect on periodontal cells and neutrophil activity, as well as an indirect adverse effect by stimulating immune system cells to release inflammatory cytokines.[44,45] Early diagnosis of periodontal problems among children and adolescents with poorly controlled diabetes through periodic periodontal screenings, as well as prevention of periodontal diseases among this population is of fundamental importance. It is

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also worth mentioning that in addition to gingivitis and periodontitis, xerostomia and candida infections are also associated with diabetes.[45] Certain hematologic malignancies such as leukemia are associated with signs of excess gingival inflammation inconsistent with levels of dental plaque biofilm accumulation. Oral manifestations include gingival enlargement/bleeding, petechia, oral ulcerations/infections, and cervical lymphadenopathy. Signs of gingival inflammation include swollen, glazed, and spongy tissues that are red to deep purple in appearance.[11,22,46,47] These oral manifestations may be either the result of direct gingiva infiltration of leukemic cells or thrombocytopenia and/or clotting-factor deficiencies. Both gingival bleeding and hyperplasia have been reported as initial oral signs and symptoms of patients with acute and chronic leukemias.[22,46,47] Through periodic clinical exams, dentists have an opportunity for early diagnosis of such malignant diseases, as well as timely referral and, subsequently, increased chances for improvement of patient treatment outcomes.

The literature lacks information regarding the exact role of nutrition in the initiation and/or progression of periodontal diseases. However, the role of vitamin C in supporting periodontal tissues due to its essential function in collagen synthesis is well-documented.[10,19] Vitamin C deficiency, or scurvy, compromises antioxidant micronutrient defenses to oxidative stress and collagen synthesis leading to weakened capillary blood vessels, consequently increasing the predisposition to gingival bleeding.[48] Nevertheless, gingival inflammation due to Vitamin C deficiency may be difficult to detect clinically and indistinguishable from plaque-induced gingivitis.[22] Scurvy may occur in certain populations of pediatric interest such as infants and children from low socioeconomic families.[22]

One major change in the 2017 classification of dental plaque–induced gingival diseases was to simplify the system for the clinician and condense the catalog to include only conditions affecting the gingiva that could be clinically identified. Therefore, terms previously used such as "menstrual cycle–associated gingivitis," "oral contraceptive–associated gingivitis," and "ascorbic acid–associated gingivitis" were eliminated from the classification system because the clinical signs of these conditions were not clinically evident to the dentist.[11]

Smoking is one of the major lifestyle and behavioral risk factors for periodontitis, mostly attributed to alterations in the microflora and/or host response.[11,22] Increased pocket depth measurements, attachment loss and alveolar bone loss are more prevalent in smokers than non-smokers.[49] Tobacco use is no longer classified as a habit, but as a dependence to nicotine and a chronic relapsing medical disorder.[50] Smoking and smokeless tobacco use almost always are initiated and established in adolescence.[51-57] The most common tobacco products used by middle 4school and high school students are reported to be e-cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, pipe tobacco, and bidis (unfiltered cigarettes from India).[52] However, the exposure to cannabis (marijuana) among children and adolescents has increased in the United States due to its legalization in many states.[55] Frequent cannabis use has been associated with deeper probing depths, more CAL, and increased risk of severe periodontitis.[55] Periodontitis, visible plaque, and gingival bleeding has also been reported among crack cocaine users.[56] Clinical signs associated with smokeless tobacco may include increased gingival recession and attachment loss, particularly at the sites adjacent to mucosal lesion associated with the habit.[55] Health professionals who treat adolescents and young adults should be aware of the signs of tobacco use, and be able to provide counseling (or referral to an appropriate provider) regarding the serious health consequences of tobacco and drug use, as well as use brief interventions for encouragement, support, and positive reinforcement for cessation when the habit is identified.

Drug-influenced gingival enlargements occur as a side effect in patients treated with anticonvulsant drugs (e.g., phenytoin and sodium valproate), certain calcium channel–blocking drugs (e.g., nifedipine, verapamil, diltiazem, amlodipine, felodipine), immune-regulating drugs (e.g., cyclosporine), and high-dose oral contraceptives.[11,57] For drug-influenced gingival conditions to occur, the presence of plaque bacteria is needed to produce a gingival response. The onset of this condition may occur within 3 months of the drug use,[11] but not all individuals taking these medications are susceptible and will develop gingival overgrowth. Reports show that approximately half of the people who take phenytoin, nifedipine, or cyclosporin are affected with this condition.[57] A major consideration during the 2017 workshop was to select an easy and appropriate clinical assessment to define the extent and severity of the drug-influenced overgrowth. The extent of gingival enlargements were defined as either *localized* (enlargement limited to the gingiva in relation to a single tooth or group of teeth) or *generalized* (enlargement involves the gingiva throughout the mouth).[22] *Mild* gingival enlargement involves enlargement of the gingival papilla; *moderate* gingival enlargement involves enlargement of the gingival papilla and marginal gingiva, and *severe* gingival enlargement involves enlargement of the gingival papilla, gingival margin, and attached gingiva.[22] Drug-influenced gingival enlargement is not associated with attachment loss or tooth mortality.

Non-dental plaque-induced gingival diseases

The gingiva and oral tissues may demonstrate a variety of non-dental plaque-induced gingival lesions that are not caused by plaque and usually do not resolve after plaque removal (Table 2).[6] However, the severity of the clinical manifestations of these lesions are often dependent upon plaque accumulation and subsequent gingival inflammation. These lesions may often be manifestations of a systemic condition or medical disorder. They may also represent pathologic changes confined to the gingiva. Because oral health and systemic health are strongly interrelated, it is important that dentists and other health care providers collaborate to adequately diagnose, educate the patient about their condition, treatment plan, treat, or refer to a specialist for treatment. The current classification of non-dental plaque-induced gingival conditions is based on the etiology of the lesions. These include: genetic/developmental disorders (e.g. hereditary gingival fibromatosis); specific infections of bacterial (e.g. necrotizing periodontal diseases, Streptococcal gingivitis), viral (e.g. hand-foot-and-mouth disease, primary herpetic gingivostomatitis) and fungal (e.g. candidosis) origins; inflammatory and immune conditions and lesions (e.g. hypersensitivity reactions, autoimmune disease of skin and mucous membranes); reactive processes (e.g. epulides); premalignant neoplasms (e.g. leukoplakia); malignant neoplasms (e.g. leukemia, lymphoma); traumatic lesions (e.g. physical, chemical and thermal insults); endocrine, nutritional and metabolic diseases (e.g. vitamin deficiencies); and gingival pigmentation (e.g. amalgam tattoo). The major difference between the 1999 and 2017 classifications is the development of a more comprehensive nomenclature of non-plaque induced gingival diseases and conditions based on the primary etiology, as well as the inclusion of the International Statistical Classification of Diseases and Related Health Problems (**ICD**)-10 diagnostic codes (e.g. ICD – 10 code for primary herpetic gingivostomatitis is B00.2).[6,11,19]

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Several of these conditions may occur in pediatric patients, as well as in those with special health care needs; therefore, they are of great interest to pediatric dentists. For a comprehensive review on this topic, the reader is encouraged to review the position paper on non-dental plaque-induced gingival diseases by Holmstrup et al[19] and the workshop consensus report by Chapple et al.[11]

Classification of periodontal diseases

The new classification of periodontal disease proposed in the 2017 workshop defines three distinct forms: (1) *periodontitis* (single category grouping the two forms of the disease formerly recognized as "aggressive" or "chronic"); (2) *necrotizing periodontitis*; and (3) *periodontitis as a manifestation of systemic conditions*. The new periodontitis classification was further characterized based on a multi-dimensional staging and grading framework system. The former indicates the disease severity and complex management, while the latter estimates the rate and likelihood of the disease progression and/or response to standard periodontal therapy taking into consideration the patient's biological features.[6,24,26] An individual case of periodontitis should be further defined using a simple matrix that describes the stage and grade of the disease[24] as seen in Table 4.

Periodontitis

Currently, there is insufficient evidence to support the notion that chronic and aggressive periodontitis are two pathophysiologically distinct diseases. Due to concerns from clinicians, researchers, educators, and epidemiologists regarding their ability to properly distinguish between chronic and aggressive periodontitis, the 2017 World Workshop members proposed grouping these two previously forms of periodontitis into a single category simply referred to as *periodontitis*.[24,27] The clinical entity previously referred to as "aggressive periodontitis" due to its rapid rate of progression is now categorized as "Grade C" periodontitis and represents the extreme end of a continuum of disease rates.

Periodontitis is a multifactorial, microbially-associated, host-mediated inflammatory disease characterized by progressive destruction of the periodontal attachment apparatus. Loss of periodontal tissue support is the primary feature of periodontitis, which is detected as clinical

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attachment loss (CAL) by circumferential assessment of erupted teeth with a standardized periodontal probe with reference to the cemento-enamel junction. Clinically, a patient is characterized as a "periodontitis case" if: (1) interdental CAL is detectable at ≥2 non-adjacent teeth; or (2) buccal or oral CAL ≥3 mm with pocketing >3 mm is detectable at ≥2 teeth. Furthermore, the CAL cannot be attributed to non-periodontal causes such as: (1) gingival recession of traumatic origin; (2) dental caries extending in the cervical area of the tooth; (3) the presence of CAL on the distal aspect of a second molar and associated with malposition or extraction of a third molar; (4) an endodontic lesion draining through the marginal periodontium; and (5) the occurrence of a vertical root fracture.[24,27]

In the context of the 2017 world workshop, three clearly different forms of periodontitis have been identified based on pathophysiology: (1) *necrotizing periodontitis*; (2) *periodontitis as a direct manifestation of systemic diseases*; and (3) *periodontitis*. Differential diagnosis is based on the history and the specific signs and symptoms of necrotizing periodontitis and the presence or absence of an uncommon systemic disease that definitively modify the host immune response.[6,24,27]

Evidence supports *necrotizing periodontitis* as a separate disease entity based on (1) distinct pathophysiology characterized by prominent bacterial invasion and ulceration of epithelium; (2) rapid and full thickness destruction of the marginal soft tissue resulting in characteristic soft and hard tissue defects; (3) obvious symptoms; and (4) faster resolution in response to specific antimicrobial treatment.[27] This painful and infectious condition should be diagnosed primarily based on its typical clinical features, which includes necrosis and ulceration in the interdental papilla, gingival bleeding, pseudomembrane formation, and halitosis.[18,24] In severe cases, bone sequestrum may also occur.[58] Pain and halitosis is less often observed among children, while systemic conditions such as fever, adenopathy, and sialorrhea (hypersalivation) are more frequently observed.[18,59] Necrotizing periodontal diseases are strongly associated with impairment of the host immune system. Predisposing factors include inadequate oral hygiene, chronic gingivitis, human immunodeficiency virus and acquired immune deficiency syndrome (HIV/AIDS), malnutrition, tobacco/alcohol consumption, psychological stress and insufficient sleep among others.[24] Among children, higher risk of necrotizing periodontitis are observed in those with HIV/AIDS, severe malnutrition, living in extreme conditions (e.g. substandard accommodations, limited access to potable water, poor sanitary disposal system), and exposed to severe (viral) infections (e.g. measles, chicken pox, malaria).[18,24] Although the prevalence of necrotizing periodontitis is low, it is a severe condition leading to very rapid tissue destruction that can be life-threating among compromised children.[18] For a more in-depth review of necrotizing periodontitis, readers are directed to the positional papers by Herrera et al[18] and Tonetti et al,[27] as well as to the consensus report by Papapanou et al.[24]

Systemic disease is defined as a disease that affects multiple organs and tissues or that affects the body as a whole.[60] Several systemic disorders and conditions can affect the course of periodontal diseases or have a negative impact on the periodontal attachment apparatus independently of dental biofilm-induced inflammation.[7,20] For some cases, the periodontal problems may be among the first signs of the disease. These disorders or conditions are grouped as *periodontitis as a manifestation of systemic disease* and classification should be based on and follow the classification of the primary systemic disease according to the respective ICD codes.[6] Moreover, they can be grouped into broad categories such as genetic disorders that affect the host immune response (e.g. down syndrome, Papillon-Lefèvre, Histiocytosis) or affect the connective tissues (e.g. Ehlers-Danlos syndrome, systemic lupus erythematosus); metabolic and endocrine disorders (e.g. hypophosphatasia, hypophosphatemic rickets); inflammatory conditions (e.g. epidermolysis bullosa acquisita, inflammatory bowel disease); as well as other systemic disorders (e.g. obesity, emotional stress and depression, diabetes mellitus, Langerhans Cell Histiocytosis (LCH), neoplasms). For a more comprehensive review of classifications, case definitions and diagnostic considerations, the reader is encouraged to read the positional paper and consensus report by Albandar et al[7] and Jepsen et al,[20] respectively.

The remaining clinical cases of periodontitis that do not present with the local characteristics of necrotizing periodontitis or the systemic characteristics of a rare immune disorder with a secondary manifestation of periodontitis should be diagnosed as *periodontitis* and be further characterized using the staging and grading system that describes clinical presentation,[6,7,18,20,24,27] (Table 4).

The concept of staging is adopted from the field of oncology that classifies staging of tumors based on baseline clinical observations of size or extent and whether it has metastasized or not.[61] Understanding the stage of the periodontal disease helps the clinician communicate with the patient the current severity and extent of the disease (*localized* or *generalized*), assess the complexities of disease management, develop a prognosis, and design an individualized treatment plan for the patient. Staging is determined by a number of variables such as probing depth, CAL, amount and percentage of bone loss, presence and extent of angular bony defects and furcation involvement, tooth mobility, and tooth loss due to periodontitis.[27] Staging involves four categories: *Stage I* (Initial Periodontitis), *Stage II* (Moderate Periodontitis), *Stage III* (Severe Periodontitis – potential for tooth loss), and *Stage IV* (Severe Periodontitis – potential for loss of dentition). Grading assesses the future risk of the periodontitis progression and anticipated treatment outcomes, but also estimates the positive or negative impact that periodontitis and its treatment have on the overall health status of the patient. Grading also allows the clinician to incorporate the individual patient risk factors (e.g. smoking, uncontrolled Type II diabetes, etc.) into the diagnosis, which may influence the comprehensive case management. Grading includes three levels: *Grade A* (Low Risk of Progression), *Grade B* (Moderate Risk of Progression), and *Grade C* (High Risk of Progression). Tables 4 shows the framework for staging and grading of periodontitis, as well as the criteria for periodontitis stage and grade, respectively.[27] Table 5 presents the three steps to staging and grading a patient with periodontitis.[27] For a more comprehensive description of staging and grading of periodontitis, the reader is encouraged to review an outcome workshop paper by Tonetti et al[27] and the workshop consensus report by Papapanou et al.[24]

Other conditions affecting the periodontium

Peridontal abscesses and endodontic-periodontal lesions

Both *periodontal abscesses* and *endodontic-periodontal lesions* share similar characteristics that differentiate them from other periodontal conditions. These include pain and discomfort requiring immediate emergency treatment, rapid onset and destruction of periodontal tissues, negative effect on the prognosis of the affected tooth, and possible severe systemic consequences.

Periodontal abscesses (**PA**) are defined as acute lesions characterized by localized accumulation of pus within the gingival wall of the periodontal pocket, initiated by either bacterial invasion or foreign body impaction.[18,24] The most prominent sign associated with PA is the presence of an ovoid elevation in the gingiva along the lateral part of the root. Other signs and symptoms may include pain, tenderness and swelling of the gingiva, bleeding and suppuration on probing, deep periodontal pocket, bone loss observed radiographically, and increased tooth mobility.[18,24] Facial swelling, elevated body temperature, malaise, regional lymphadenopathy or increased blood leukocytes are less commonly observed.[18] Etiology factors such as pulp necrosis, periodontal infections, pericoronitis, trauma, surgery, or foreign body impaction may explain the development of PAs. PA can develop in both periodontitis and non-periodontitis patients. Of interest to pediatric dentists, PA can occur in healthy sites due to impaction of foreign bodies (e.g. dental floss, orthodontic elastic, popcorn hulls); harmful habits (e.g. nail biting, clenching), inadequate orthodontic forces, gingival enlargement, and alterations of the root surface (e.g. invaginated tooth, alterations, enamel pearls, iatrogenic perforations, vertical root fracture, external root resorption).

Endodontic-periodontal lesions (**EPL**) are pathological communications between the endodontic and periodontal tissues at a given tooth that occur in either an acute or a chronic form and are classified according to the signs and symptoms that have direct impact on their prognosis and treatment (e.g. presence or absence of fractures and perforations, presence or absence of periodontitis and the extent of periodontal destruction around the affected teeth). The primary signs associated with EPL are deep periodontal pockets reaching or close to the apex and/or negative or altered response to pulp vitality tests. Other signs and symptoms may include radiographic evidence of bone loss in the apical or furcation region, spontaneous pain or pain on palpation and percussion, purulent exudate or suppuration, tooth mobility, sinus tract/fistula, crown and/or gingival color alterations.[18,24] Signs observed in endo-periodontal lesions associated with traumatic and/or iatrogenic factors may include root perforation, fracture/cracking, or external root resorption, commonly associated with the presence of an abscess accompanied by pain. In periodontitis patients, EPL usually presents low and chronic progression without evident symptoms. For further review on the classification, pathophysiology, microbiology, and histopathology of both PA and EPL, readers are directed to the positional paper by Herrera et al[18] and the consensus report by Papapanou et al.[24]

Mucogingival deformities and conditions

Normal mucogingival condition is defined as the absence of pathosis such as gingival recession, gingivitis, and periodontitis. Mucogingival deformities, including gingival recession, are a group of conditions that affect a large number of patients that are observed more frequently in adults and have a tendency to increase with age independent of the patient oral hygiene status. Recession is defined as an apical shift of the gingival margin caused by different conditions and pathologies that is associated with CAL in any surface (buccal/lingual/interproximal) of the teeth.[20] Although, gingival thickness has been referenced in the literature as "gingival biotype", the 2017 World Workshop group strongly suggested the adoption of the term "periodontal phenotype", which is determined by gingival phenotype (gingival thickness, keratinized tissue width) and bone morphotype (thickness of the buccal bone plate). Periodontal phenotype can be assessed by measuring the gingival thickness through the use of a periodontal probe. *Thin phenotype* is classified when the periodontal probe shining through the gingival tissue is ≤1 mm visible after being inserted into the sulcus, and classified as *thick phenotype* when the probe is > 1mm visible.[20] The development and progression of gingival recession is not associated with increased tooth mortality. However, this condition is often associated with patient esthetic concerns, dentinal hypersensitivity and carious/non-carious cervical lesions on the exposed root surface.[12,20] While lack of keratinized tissue is a predisposing factor for gingival recession and inflammation, periodontal health can be maintained despite the lack of keratinized tissues in most patients with optimal home care and professional maintenance. Conversely, patients with thin periodontal phenotypes, inadequate oral hygiene, and requiring cervical restorative and/or orthodontic treatment are at an increased risk for gingival recession.[12,20] Monitoring specific gingival recession sites is considered a proper approach in the absence of any pathosis. However, mucogingival surgical interventions may be necessary in the presence of esthetic concerns, dentin hypersensitivity, cervical lesions, thin gingival biotypes and mucogingival deformities.

Traumatic occlusal forces and occlusal trauma

Traumatic occlusal force is defined as any occlusal force that causes an injury to the teeth and/or the periodontal attachment apparatus. It may be indicated by one or more of the following: fremitus (visible tooth movement upon occlusal force), tooth mobility, thermal sensitivity, excessive occlusal wear, tooth migration, discomfort/pain on chewing, fractured teeth, radiographically widened periodontal ligament space, root resorption, and hypercementosis.[20] *Occlusal trauma* is a lesion in the periodontal ligament, cementum and adjacent bone caused by traumatic occlusal forces. It may be indicated by one or more of the following: progressive tooth mobility, adaptive tooth mobility (fremitus), radiographically widened periodontal ligament space, tooth migration, discomfort/pain on chewing, and root resorption.[20] Traumatic occlusal forces and occlusal trauma can be classified as: (1) primary occlusal trauma; (2) secondary occlusal trauma; and (3) orthodontic forces. Primary and secondary occlusal trauma have been defined as injuries resulting in tissue changes from traumatic occlusal forces, the former when applied to a tooth or teeth with normal periodontal support and the latter when applied to a tooth or teeth with reduced support.

There is either little or no evidence that traumatic occlusal forces can cause periodontal attachment loss, inflammation of the periodontal ligament, non-carious cervical lesions, abfraction or gingival recession.[14,20] Traumatic occlusal forces lead to adaptive mobility in teeth with normal support and are not progressive, while in teeth with reduced support they lead to progressive mobility usually requiring splinting. Although, there is evidence that traumatic occlusal forces may be associated periodontitis, there is no evidence that these forces can accelerate the progression of periodontitis in humans.[20] Moreover, there is insufficient clinical evidence regarding the impact that elimination of traumatic occlusal forces may have on the response to periodontal therapies. With regards to orthodontic forces, observational studies suggest that orthodontic treatment has minimal adverse effects to the periodontal supporting apparatus, especially in patients with good plaque control and healthy periodontium.[14,20]

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However, non-controlled orthodontic forces can have adverse effects on the periodontium such as pulpal disorders, root and alveolar bone resorptions.

Dental prostheses and tooth-related factors

Several conditions associated with the fabrication and presence of dental restorations and fixed prostheses, placement of orthodontic appliances, as well as tooth-related factors may facilitate the development of gingivitis and periodontitis, especially in individuals with poor compliance with homecare plaque control and attendance to periodic maintenance visits.[13,20]

Tooth anatomic factors (e.g. cervical enamel projections, enamel pearls, developmental grooves); root proximity, abnormalities, and traumatic dental injuries potentially altering the local anatomy of both hard and soft tissues; as well as tooth relationships in the dental arch and with the opposing dentition are associated with dental plaque-biofilm induced gingivitis and periodontitis. Placement of restoration margins infringing within the junctional epithelium and supracrestal connective tissue attachment (biological width) can also be associated with gingival inflammation and, potentially, recession. Tooth-supported and/or tooth-retained restorations and their design, fabrication, delivery, and materials have often been associated with plaque retention and loss of periodontal supporting tissues. However, optimal restoration margins located within the gingival sulcus do not cause gingivitis if patients are compliant with self-performed plaque control and periodic maintenance care.[13,20]

The available evidence does not support that optimal removable and fixed dental prostheses are associated with periodontitis when patients perform adequate plaque control and attend maintenance appointments. However, there is evidence to suggest that removable dental prostheses can serve as plaque retentive factors, be associated with gingivitis/periodontitis, increased mobility and gingival recession in patients with poor compliance. Moreover, there is evidence to suggest that design, fabrication, delivery and materials used for fixed dental prostheses procedures can be associated with plaque retention, gingival recession and loss of supporting periodontal tissues.[13,20]

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Lastly, it is important to point out that dental materials, including commonly used appliances (e.g., stainless steel crowns, space maintainers, ortho appliances) may be associated with hypersensitivity reactions observed clinically as a localized inflammation. If the hypersensitivity does not resolve with adequate measures of plaque control, additional treatment may be required, including removal of material or appliance. However, it appears that adequate periodontal assessment and treatment, appropriate instructions, and motivation in self-performed plaque control and compliance to periodic maintenance protocols are the most important factors to limit or avoid the potential negative effects on the periodontium caused by fixed and removable prostheses when hypersensitivity reactions are not suspected.[13]

Peri-implant diseases and conditions

The 2017 World Workshop members developed a new classification for *peri-implant health*, *peri-implant mucositis* and *peri-implantitis*. The case definitions were developed based on a review of the evidence applicable for diagnostic considerations for use by clinicians for both individual case management and population studies.[6,25] Because the majority of pediatric dentists are not the ones responsible for the placement of osseointegrated dental implants, the reader is encouraged to review the positional paper by Renvert et al.[25] and the consensus report by Berglundh et al[9] for more comprehensive information about the rationale, criteria and implementation of the new classification. Nevertheless, it is important that all clinicians are able to diagnose potential problems, complications, and failures associated with dental implants in order to either provide proper treatment or refer the patient to a specialist. Case definitions and clinical criteria of these conditions are presented below.

Peri-implant health

Clinically, peri-implant health is characterized by an absence of visual signs of inflammation such as redness, swelling, profuse BoP, as well as an absence of further additional bone loss following initial healing. Peri-implant health can occur around implants with normal or reduced bone support.[6,25]

Peri-implant mucositis

Peri-implant mucositis is characterized by visual signs of inflammation such as redness, swelling, line or drop of bleeding within 30 seconds following probing, combined with no additional bone loss following initial healing. There is strong evidence that peri-implant mucositis is caused by plaque, while very limited evidence for non-plaque induced peri-implant mucositis. Peri-implant mucositis can be reversed with dental plaque removal measures.[6,25]

Peri-implantitis

Peri-implantitis is defined as a plaque-associated pathologic condition occurring in the tissue around dental implants, characterized by signs of inflammation in the peri-implant mucosa, radiographic evidence of bone loss following initial healing, increasing probing depth as compared to probing depth values after the implant placement, and subsequent progressive loss of supporting bone. In the absence of baseline radiographs, radiographic bone level ≥3 mm in combination with BoP and probing depths ≥6mm is indicative of peri-implantitis. Peri-implantitis is preceded by peri-implant mucositis.[6,25]

Recommendations

1. Periodontal disease in children is of great interest in pediatric dentistry and a problem that should not be ignored. Therefore, it is critical that pediatric dental patients receive a periodontal assessment as part of their routine dental visits.
2. Early diagnosis of periodontal diseases ensures the greatest opportunity for successful treatment, primarily by reducing etiological factors, establishing appropriate therapeutic measures, and developing an effective periodic maintenance protocol.
3. Clinicians should become familiarized with the most current classification of periodontal diseases and conditions, including gingivitis, in order to properly diagnose patients affected by these problems.
4. Pediatric dentists are often the front line in diagnosing periodontal conditions and in great position to treat, refer, coordinate, collaborate and/or organize the patient care activities between two or more health care providers to ensure that the appropriate treatment is delivered in a timely fashion.

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5. Monitoring gingival health or inflammation is best documented by the parameter of bleeding on probing since it is considered the primary parameter to set thresholds for gingivitis, and the most reliable for monitoring patients longitudinally in clinical practice. Clinicians are encouraged to start probing regularly when the first permanent molars are fully erupted and the child is able to cooperate for this procedure in order to establish a baseline, detect early signs of periodontal disease and prevent its progression.
6. Probing prior to the eruption of the first permanent molars is encouraged in the presence or suspicion of any clinical and/or radiographic signs of periodontal disease. For patients with special health care needs receiving dental treatment under sedation and/or general anesthesia, clinicians are encouraged to take this opportunity and perform the periodontal probing.

The intent of this document was to present an abbreviated overview of the proceeding papers from the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions. Major highlights from the 2017 workshop included the recategorization of three forms of periodontitis, the development of a multidimensional staging and grading system for periodontitis, and the new classification for peri-implant diseases and conditions. A best practice document on periodontal disease therapies will be available in a future publication of the AAPD Reference Manual.

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TABLE 1. 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Adapted from Caton et al[6])

Periodontal Diseases and Conditions

Periodontal Health, Gingival Diseases and Conditions

Chapple, Mealey, et al. 2018 Rept
Trombelli et al. 2018 Case Definitions

Periodontal Health, Gingival Diseases and Conditions
Lang & Bartold 2018

1. Clinical gingival health on an intact periodontium
2. Clinical gingival health on a reduced periodontium
   a. Stable periodontitis patient
   b. Non-periodontitis patient

Gingivitis – Dental Biofilm-induced
Murakami et al. 2018

1. Associated with dental biofilm alone
2. Mediated by systemic or local risk factors
3. Drug-influenced gingival enlargement

Gingival diseases — Non-Dental Biofilm-induced
Holmstrup et al. 2018

1. Genetic/developmental disorders
2. Specific infections
3. Inflammatory and immune conditions
4. Reactive processes
5. Neoplasms
6. Endocrine, nutritional & metabolic diseases
7. Traumatic lesions
8. Gingival pigmentation

Periodontitis

Papapanou, Sanz et al. 2018 Consensus Rept
Jepsen, Caton et al. Consensus Rept
Tonetti, Greenwell, Komman. 2018 Case Definitions

Necrotizing Periodontal Diseases
Herrera et al. 2018

1. Necrotizing Gingivitis
2. Necrotizing Periodontitis
3. Necrotizing Stomatitis

Periodontitis as Manifestations of Systemic Diseases
Jepsen, Caton et al. 2018 Consensus Rept./Albandar et al. 2018

Classification of these conditions should be based on the primary systemic disease according to the International Statistical Classification of Diseases and Related Health Problems (ICD) codes

Periodontitis
Fine et al. 2018/Needleman et al. 2018/Billings et al. 2018

1. Stages: Based on Severity and Complexity of Management
   Stage I: Initial Periodontitis
   Stage II: Moderate Periodontitis
   Stage III: Severe Periodontitis with potential for additional tooth loss
   Stage IV: Sever Periodontitis with potential for loss of the dentition
2. Extent and distribution: localized; generalized; molar-incisor distribution
3. Grades: Evidence or risk of rapid progression, anticipated treatment response
   a. Grade A: Slow rate
   b. Grade B: Moderate rate of progression
   c. Grade C: Rapid rate of progression

Other Conditions Affecting the Periodontium

Jepsen, Caton et al. 2018 Consensus Rept
Papapanou, Sanz et al. 2018 Consensus Rept

Systemic Diseases or Conditions Affecting the Periodontal Supporting Tissues
Albandar et al. 2018

Periodontal Abscesses and Endodontic-Periodontal Lesions
Papapanou, Sanz et al. 2018
Herrera et al. 2018

Mucogingival Deformities and Conditions
Cortellini & Bissada 2018

1. Gingival phenotype
2. Gingival/soft tissue recession
3. Lack of gingiva
4. Decreased vestibular depth
5. Aberrant frenum/muscle position
6. Gingival excess
7. Abnormal color
8. Condition of the exposed root surface

Traumatic Occlusal Forces
Fan & Caton 2018

1. Primary occlusal trauma
2. Secondary occlusal trauma
3. Orthodontic forces

Tooth and Prosthesis-related Factors
Ercoli & Caton 2018

1. Localized tooth-related factors
2. Localized dental prostheses-related factors

Peri-Implant Diseases and Conditions

Berglundh, Armitage et al. 2018 Consensus Rept

Peri-Implant Health
Araujo & Lindhe 2018

Peri-Implant mucositis
Heitz-Mayfield & Salvi 2018

Peri-implantitis
Schwarz et al. 2018

Peri-Implant soft and hard tissue deficiencies
Hammerle & Tarnow 2018

CCA s BP ClassificationPeri dontalDiseases

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TABLE 2. Classification of Gingival Health and Gingival Diseases and Conditions
(Adapted from Chapple et al[11])

Periodontal Health

1. Clinical health on an intact periodontium
2. Clinical gingival health on a reduced periodontium
   a. Stable periodontitis patient
   b. Non-periodontitis patient

Gingivitis — Dental Plaque-induced

1. Associated with biofilm alone
2. Mediated by systemic or local risk factors
   a. Systemic risk factors (modifying factors)
      - Smoking
      - Hyperglycemia
      - Nutritional factors
      - Pharmacological agents (prescription, non-prescription and recreational)
      - Sex steroid hormones (puberty, menstrual cycle, pregnancy, oral contraceptives)
      - Hematological conditions
   b. Local risk factors

Gingival Disease — Non-dental Plaque-induced

1. Genetic/developmental disorders Hereditary gingival fibromatosis
2. Specific infections
   a. Bacterial origin
   b. Viral origin
   c. Fungal origin
3. Inflammatory and immune conditions
   a. Hypersensitivity reactions
   b. Autoimmune diseases of skin and mucous membranes
   c. Granulomatous inflammatory lesions (orofacial granulomatosis)
4. Reactive processes
   a. Epulides
5. Neoplasms
   a. Premalignancy
   b. Malignancy
6. Endocrine, nutritional and metabolic diseases
   a. Vitamin deficiencies
7. Traumatic lesions
   a. Physical/mechanical trauma
   b. Chemical (toxic) burn
   c. Thermal insults
8. Gingival pigmentation

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TABLE 3. Diagnostic look-up table for gingival health or dental plaque-induced gingivitis in clinical practice (Adapted from Chapple et al[11])

Intact periodontium Gingivitis	**Health**	**Gingivitis**
Probing attachment loss	No	No
*Probing pocket depths (assuming no pseudo pockets)**	≤3 mm	≤3 mm
Bleeding on probing	<10%	Yes (≥ 10%)
Radiological bone loss	No	No

**on fully erupted teeth*

Reduced periodontium Non-periodontitis patient	**Health**	**Gingivitis**
Probing attachment loss	Yes	Yes
*Probing pocket depths (all sites & assuming no pseudo pockets)**	≤3 mm	≤3 mm
Bleeding on probing	<10%	Yes (≥ 10%)
Radiological bone loss	Possible	Possible

Successfully treated stable periodontitis patient	**Health**	**Gingivitis in a patient with a history of periodontitis**
Probing attachment loss	Yes	Yes
*Probing pocket depths (all sites & assuming no pseudo pockets)**	≤4 mm (no site ≥ 4 mm with BOP)	≤3 mm
Bleeding on probing	<10%	Yes (≥ 10%)
Radiological bone loss	Yes	Yes

TABLE 4. Periodontitis Staging and Grading
(Adapted from Tonetti et al[27])

Framework for periodontitis staging and grading		Disease Severity and Complexity of Management			
		Stage I: Initial periodontitis	Stage II: Moderate periodontitis	Stage III: Severe periodontitis with potential for additional tooth loss	Stage IV: Advanced periodontitis with extensive tooth loss and potential for loss of dentition
Evidence or risk of rapid progression, anticipated treatment response, and effects on systemic health	Grade A	Individual Stage and Grade Assignment			
	Grade B				
	Grade C				

Periodontitis stage		**Stage I**	**Stage II**	**Stage III**	**Stage IV**
Severity	Interdental CAL at site of greatest loss	1 to 2 mm	3 to 4 mm	≥5 mm	≥5 mm
	Radiographic bone loss	Coronal third (<15%)	Coronal third (<15% to 33%)	Extending to mid-third of root and beyond	Extending to mid-third of root and beyond
	Tooth loss	No tooth loss due to periodontitis		Tooth loss due to periodontitis of ≤4 teeth	Tooth loss due to periodontitis of ≥5 teeth
Complexity	Local	Maximum probing depth ≤4 mm Mostly horizontal bone loss	Maximum probing depth ≤5 mm Mostly horizontal bone loss	In addition to stage II complexity: Probing depth ≥6 mm Vertical bone loss ≤3 mm Furcation involvement Class II or III Moderate ridge defect	In addition to stage III complexity: Need for complex rehabilitation due to: - Masticatory dysfunction - Secondary occlusal trauma (tooth mobility degree ≥2) - Severe ridge defect - Bite collapse, drifting, flaring - Less than 20 remaining teeth (10 opposing pairs)
Extent and distribution	Add to stage as descriptor	For each stage, describe extent as localized (<30% of teeth involved), generalized, or molar/incisor pattern			

Periodontitis grade			**Grade A: Slow rate of progression**	**Grade B: Moderate rate of progression**	**Grade C: Rapid rate of progression**
Primary Criteria	Direct evidence of progression	Longitudinal data (radiographic bone loss or CAL)	Evidence of no loss over 5 years	<2 mm over 5 years	≥2 mm over 5 years
	Indirect evidence of progression	% bone loss/age	<0.25	0.25 to 1.0	>1.0
		Case phenotype	Heavy biofilm deposits with low levels of destruction	Destruction commensurate with biofilm deposits	Destruction exceeds expectation given biofilm deposits; specific clinical patterns suggestive of periods of rapid progression and/or early onset disease (e.g., molar/incisor pattern; lack of expected response to standard bacterial control therapies)
Grade modifiers	Risk factors	Smoking	Non-smoker	Smoker <10 cigarettes/day	Smoker ≥10 cigarettes/day

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		Diabetes	Normoglycemic/no diagnosis of diabetes	HbAlc <7.0% in patients with diabetes	HbAlc ≥7.0% in patients with diabetes

TABLE 5. Three Steps to Staging and Grading a Patient with Periodontitis
(Adapted from Tonetti et al[27])

Step 1
Initial Case Overview to Assess Disease

Screen:

- Full mouth probing
- Full mouth radiographs
- Missing teeth

Mild to moderate periodontitis will typically be either Stage I or Stage II

Severe to very severe periodontitis will typically be either Stage III or g IV

Step 2
Establish Stage

For mild to moderate periodontitis (typically Stage I or Stage II):

- Confirm clinical attachment loss (CAL)
- Rule out non-periodontitis causes of CAL (e.g., cervical restorations or caries, root fractures, CAL due to traumatic causes)
- Determine maximum CAL or radiographic bone loss (RBL)
- Conform RBL patterns

For moderate to severe periodontitis (typically Stage III or Stage IV):

- Determine maximum CAL or RBL
- Confirm RBL patterns
- Assess tooth loss due to periodontitis
- Evaluate case complexity factors (e.g., severe CAL frequency, surgical challenges)

Step 3
Establish Grade

- Calculate RBL (% of root length x 100) divided by age
- Assess risk factors (e.g., smoking, diabetes)
- Measure response to scaling and root planning and plaque control
- Assess expected rate of bone loss
- Conduct detailed risk assessment
- Account for medical and systemic inflammatory considerations

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Policy on Management of the Frenulum in Pediatric Dental Patients

Originating Council

Council on Clinical Affairs

Adopted

2019

Purpose

Evidence suggests that the prevalence of frenotomy/frenectomies is increasing, with reports indicating as much as 90 percent increase in recent years.[1,2] American Academy of Pediatric Dentistry (**AAPD**) recognizes a policy on frenula would make the information and recommendations more accessible to dentists, physicians, and other allied health professionals in an evidence-based format.

Methods

This policy is a review of current dental and medical literature and sources of recognized professional expertise and stature, including both the academic and practicing health communities related to frenula/frenotomies. In addition, literature searches of PubMed/MEDLINE and Google Scholar databases were conducted using the terms: ankyloglossia, breast-feeding, frenotomy, systematic review, lip-tie, super labial frenulum, maxillary lip-tie, breastfeeding cessation, frenulum, frenum, tongue-tie, speech articulation, frenuoplasty, midline diastema, lactation, nipple pain, Hazelbaker, IBFAT, LATCH, mandibular labial frenulum, periodontal; fields: all; limits: within the last 15 years, English. One hundred seventeen articles matched these criteria. Papers for review were chosen from this list and from references within selected articles. Expert and/or consensus opinion by experienced researchers and clinicians also was considered.

Background

Frenulum attachments and their impact on oral motor function and development have become a topic of emerging interest among the community as well as various specialties of healthcare providers. Studies have shown differences in treatment recommendations among pediatricians, otolaryngologists, lactation consultants, speech pathologists, surgeons, and dental specialists. [3,4,5,6,7,8,9,10] Clear indications and timing of surgical treatment remain controversial due to lack of consensus regarding accepted anatomical and diagnostic criteria for degree of restriction and relative impact on growth, development, feeding, or oral motor function. [3,4,5,6,7,8,9,10] Although the etiology of this condition remains unknown, there appears to be a higher predilection in male towards anomalies of frenulum attachments, whether it is ankyloglossia or hypertrophic/restrictive maxillary labial frenum.[4,9,11,12,13] There are several frenulum that are usually present in the oral cavity, most notable the maxillary labial frenulum, the mandibular labial frenulum, and the lingual frenulum.[14] Their primary function is to provide stability of the upper lip, lower lip, and tongue, respectively.[15]

Maxillary frenulum

A prominent maxillary frenulum in infants, children, and adolescents, although a common finding, is often a concern to the parents. The maxillary labial frenal attachment can be classified with respect to its anatomical insertion level:

1. Mucosal (frenal fibers are attached up to the mucogingival junction).
2. Gingival (fibers are inserted within the attached gingiva).
3. Papillary (fibers are extending into the interdental papilla).
4. Papilla penetrating (fibers cross the alveolar process and extend up to the palatine papilla).[14]

The most commonly observed types are mucosal and gingival.[9] However, it is also reported that a maxillary frenulum is a dynamic structure that presents changes in position of insertion, structure, and shape during growth and development.[9] Infants have the highest prevalence of papillary penetrating phenotype.[9] In severe instances, a restrictive maxillary frenulum attachment has been associated with breastfeeding difficulties among newborns.[16,17] It has been suggested that a restrictive maxillary frenulum may inhibit an airtight seal on the maternal breast through “flanging” of both lips.[12,17] With the lack of knowledge surrounding the function of the upper frenulum, the ubiquity of its presence, and level of attachment in most infants, the release of the maxillary frenulum based on appearance alone cannot be endorsed at this time.[18] Hyperplastic labial frenulum that inserts into free or marginal gingiva has been suggested to interfere with proper oral hygiene measures and potentially lead to facial-cervical caries as well as initiation and

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progression of gingival/periodontal disease due to interference with adequate oral hygiene. [19] There is no evidence to support this conclusion although antidotal speculation persists. When treatment is considered due to higher caries risk, anticipatory guidance and other preventive measures should be emphasized. However, further research is required to substantiate the cause-and-effect relationship.Surgical removal of maxillary midline frenulum is also related to presence or prevention of midline diastema formation, prevention of post orthodontic relapse, esthetics, and psychological considerations.[7,8,9,20] Treatment options and sequence of care vary with patient age and can include orthodontics, restorative dentistry, surgery, or a combination of these.[20] Treatment is suggested when the attachment exerts a traumatic force on the gingiva causing the papilla to blanch when the upper lip is pulled or if it causes a diastema wider than two millimeters, which is known to rarely close spontaneously during further development.[9.20,21] When a diastema is present, the objectives for treatment involve managing both the diastema of permanent teeth and its etiology.[20] If orthodontic treatment is indicated, the need for frenotomy should be assessed and coordinated with orthodontic closure of the diastema to achieve stable results.[20,21,22] There is general agreement between pediatric dentists and orthodontist that a frenectomy should not be performed before the permanent canines erupt and that the operation should follow orthodontic closure of the space. [23]

Mandibular labial frenulum

A high frenulum sometimes can present on the labial aspect of the mandibular ridge. This is most often seen in the permanent central incisor area and frequently occurs in individuals where the vestibule is shallow.[6] The mandibular anterior frenulum, as it is known, occasionally inserts into the free or marginal gingival tissue.[6] Movements of the lower lip cause the frenulum to pull on the fibers inserting into the free marginal tissue, which creates pocket formation which in turn, can lead to food and plaque accumulation.[6] Early treatment can be considered to prevent subsequent inflammation, recession, pocket formation, and possible loss of the alveolar bone and/or tooth.[6] However, if factors causing gingival/periodontal inflammation are controlled, the degree of recession and need for treatment decreases.[3,6] Again, when treatment is considered due to higher caries risk, anticipatory guidance and other preventive measures should be emphasized.

Lingual Frenum

World Health Organization (WHO) has recommended mothers worldwide to exclusively breastfeed infants for the child's first six months to achieve optimum growth, development and health. Thereafter, they should be given complementary foods and continue breastfeeding up to the age of two years or beyond. [24] American Academy of Pediatrics (AAP), in 2018, reaffirmed its recommendation of exclusive breastfeeding for about six months, followed by continued breastfeeding as complementary foods are introduced, with continuation of breastfeeding for one year or longer as mutually desired by mother and child. [25] Maxillary and lingual frenulum have been associated by some practitioners as impedance to successful breastfeeding leading to recommendations for frenotomy.

Ankyloglossia

Ankyloglossia is a developmental anomaly of the tongue characterized by a short, thick lingual frenulum resulting in limitation of tongue movement (partial ankyloglossia) or by the tongue appearing to be fused to the floor of the mouth (total ankyloglossia).[6,26] Studies with different diagnostic criteria report prevalence of ankyloglossia between four and 10.7 percent of the population.[3,5] Several diagnostic classifications have been proposed based on anatomical and functional criteria, but none has been universally accepted.[3]

Ankyloglossia has been associated with breastfeeding difficulties among neonates, limited tongue mobility and speech difficulties, malocclusion, and gingival recession.[3,4,5,6,7,8,9,10,21] A short frenulum can inhibit tongue movement and create deglutition problems .[3,27,28] During breastfeeding, a restrictive frenulum can cause ineffective latch, inadequate milk transfer and intake, and persistent maternal nipple pain, all of which can affect feeding adversely.[3,4,5,6,7,8,9,10,11,21,26,27,28,29,30] Systematic literature review articles acknowledge the role of frenotomy procedure when there is clear evidence of frenal constriction in reduction in maternal nipple pain when provided in conjunction with support of other allied healthcare professionals.[3,4,5,6,8,31]

Limitations in tongue mobility and speech pathology have been associated with ankyloglossia.[3, 32, 33] Speech articulation is largely perceptual in nature, and differences in pronunciation are often evaluated subjectively. There is very high variability in the speech assessment outcomes among individuals and specialists from different medical backgrounds.[4] The difficulties in articulation are evident for consonants and sounds like /s/, /z/, /t/, /d/, /l/, /j/, /she/, /chi/, /the/, /dg/, and it is especially difficult to roll an r [4,32] Speech therapy in conjunction with frenuloplasty or frenotomy can be a treatment option to improve tongue mobility and speech.[32,33] There has been varied opinion among health care professionals regarding the correlation between ankyloglossia and speech disorders. Further evidence is needed to determine the benefit of surgical correction of ankyloglossia and its relation to speech pathology as there are many children and individuals with ankyloglossia who do not suffer from speech difficulty.[3, 8, 34]

There is limited evidence to show that ankyloglossia and abnormal tongue position may affect skeletal development and be associated with Class III malocclusion.[28, 35] A complete orthodontic evaluation, diagnosis, and treatment plan are necessary prior to any surgical intervention.[35]

Localized gingival recession on the lingual aspect of the mandibular incisors has been associated with ankyloglossia in some cases where frenal attachment causes gingival retraction.[3, 6] As with most periodontal conditions, elimination of plaque-induced gingival inflammation can minimize gingival recession without any surgical intervention.[3] When recession continues even after oral hygiene management, surgical intervention may be indicated.[3,6]

Frenotomy procedure

Although there is limited evidence in the literature to promote the timing, indication, and type of surgical intervention, frenotomy for functional limitations should be considered on an individual basis. [3,4,28,30,33,36] When indicated, frenuloplasty (various methods to release the frenulum and correct the anatomic situation) or frenectomy/frenotomy (simple cutting of the frenulum) may be a successful approach to alleviate the problem.[3,4,9,37] Each of these procedures involves surgical incision, establishing hemostasis, and wound management.[38] Dressing placement or the use of antibiotics is not necessary.[38] Post-operative recommendations include maintaining a soft diet, regular oral hygiene, and analgesics as needed. The use of electrosurgery or laser technology for frenotomies has demonstrated a shorter operative working time, a better ability to control bleeding, reduced intra- and post-operative pain and discomfort, fewer postoperative complications (e.g., swelling, infection), no need for suture removal, and increased patient acceptance [39] These procedures require extensive training as well as skillful technique and patient

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management.[3,4,9,33,37,40,41,42,43] As with all surgical procedures, an informed consent should be obtained.

Policy statement

Recognizing there is limited evidence; AAPD supports additional research on the causative association between ankyloglossia and breast feeding difficulties or speech articulation problems. Further randomized controlled trails of high methodological quality are necessary to determine the effects of frenotomy. With all surgical procedures an informed consent is necessary, which includes relevant information regarding diagnosis, nature and purpose of proposed treatment, potential benefits and risks, and professionally-recognized or evidence-based alternative treatment–including no treatment–to recommended therapy and risk(s).[44] When treatment is considered due to higher caries risk, anticipatory guidance and other preventive measures should be emphasized.

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