CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care

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Fluoride Use in Caries Prevention in the Primary Care Setting

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Dental caries remains the most common chronic disease of childhood in the United States. Caries is a largely preventable condition, and fluoride has proven effectiveness in caries prevention. This clinical report aims to clarify the use of available fluoride modalities for caries prevention in the primary care setting and to assist pediatricians in using fluoride to achieve maximum protection against dental caries, while minimizing the likelihood of enamel fluorosis. Fluoride varnish application is now considered the standard of care in pediatric primary care. This report highlights administration, billing, and payment information regarding the fluoride varnish procedure.

Dental caries (ie, tooth decay) is an infectious disease caused by bacteria on the tooth surface metabolizing carbohydrates and producing acid, which dissolves tooth enamel. If unchecked, this process continues through the tooth and into the pulp, resulting in pain and tooth loss. This can further progress to local infections (ie, dental alveolar abscess or facial cellulitis), systemic infection, and, in rare cases, death. Dental caries in the United States is responsible for many of the 51 million school hours lost per year as a result of dental-related illness, which translates into lost work hours for the adult caregiver.[1] Early childhood caries is the single greatest risk factor for caries in the permanent dentition. Good oral health is a necessary part of overall health, and studies have demonstrated adverse effects of poor oral health on multiple chronic conditions, including diabetes control.[2] Therefore, failure to prevent caries has health, educational, and financial consequences at both the individual and societal levels.

Dental caries is the most common chronic disease of childhood,[1] with 59% of 12- to 19-year-olds having at least 1 documented cavity.[3] Caries is a "silent epidemic" that disproportionately affects poor, young, minority populations and children living below 100% of the poverty level.[1] In the United States, 25% of 2- to 5-year-old children from low socioeconomic and minority groups experience 80% of dental disease.[4] Among 3- to 5-year-olds, untreated dental decay was significantly greater for non-

abstract

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Drs Clark, Keels, and Slayton participated in the concept and design of the manuscript, analysis and interpretation of data, and drafting and revising of the manuscript; and all authors approved the final manuscript as submitted.This document is copyrighted and is property of the American Academy of Pediatrics and its Board of Directors. All authors have filed conflict of interest statements with the American Academy of Pediatrics. Any conflicts have been resolved through a process approved by the Board of Directors. The American Academy of Pediatrics has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

DOI: https://doi.org/10.1542/peds.2020-034637

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

To cite: Clark MB, Slayton RL, AAP SECTION ON ORAL HEALTH. Fluoride Use in Caries Prevention in the Primary Care Setting. *Pediatrics.* 2020;146(6):e2020034637

Hispanic Black and Hispanic children (19.3% and 19.8%, respectively) than for non-Hispanic white children (11.3%).[4] This disparity persisted among children 6 to 9 years and 13 to 15 years of age.[4] Dental caries is a global problem, with early childhood caries prevalence among socioeconomically disadvantaged groups reported to be as high as 70%.[5] It has been suggested that health beliefs, self-efficacy, access to care, and parents' attitudes and practices related to dietary and oral hygiene behaviors may contribute to this disparity.[6]

Children with special health care needs, including those with developmental delay, complex neurodevelopmental disabilities, or congenital heart disease are also affected disproportionately.[7,8] In a study of Head Start children, those with developmental delays had a caries prevalence ratio that was 1.26 times higher than classmates without developmental delays.[8] This difference may be attributable to challenges with home care routines such as toothbrushing and use of medications with high sugar content, among other factors.[8] Children with special health care needs are frequently considered as a group when determining caries risk. However, some diagnoses place children at greater risk for caries, whereas other children are at decreased or similar risk as children without special health care needs. In a retrospective longitudinal study of children with autism spectrum disorder, Down syndrome, congenital heart disease, and cerebral palsy, Frank et al[7] determined that the caries risk among the group of children with special health care needs was higher than among the control subjects but the risk differed significantly by diagnosis. The caries burden was greatest in children with congenital heart disease, followed by those with autism spectrum disorders.[7] For children with Down syndrome, the risk was close to that of controls and considerably lower than the other 3 groups of children with special health care needs.[7]

Unfortunately, dental caries prevalence in young children increased between the previous 2 national surveys, despite improvements among older children.[9] Many children do not receive dental care at young ages, and because the risk of dental caries is heavily influenced by parenting practices, pediatricians have a unique opportunity to participate in the primary prevention of dental caries. The 2007–2016 Medical Expenditure Panel Survey demonstrated that 88.8% of infants and 1-year-olds have office-based physician visits annually, compared with only 3.6% of infants and 1-year-olds having general dental visits (American Academy of Pediatrics [AAP], unpublished analysis of 2007–2016 Medical Expenditure Panel Survey, August 2019). Studies show that health care dollars are saved with simple home and primary care setting prevention measures.[10]

The development of dental caries requires 4 components: teeth, bacteria, carbohydrate exposure, and time. Once teeth emerge, they become colonized with cariogenic bacteria. The bacteria metabolize carbohydrates and create acid as a byproduct. The acid dissolves the mineral content of enamel (demineralization) and, over time, with repeated acid attacks, the enamel surface disintegrates and results in a cavity in the tooth. Protective factors that help to remineralize enamel include exposing the teeth to fluoride, limiting the frequency of carbohydrate consumption (to 3 meals and 2 healthy snacks per day), choosing less cariogenic foods (selecting cheese or raw carrots over candy or crackers; selecting fresh fruit over dried fruit or processed fruit snacks), practicing good oral hygiene (brushing twice a day for 2 minutes and flossing between all teeth that touch), and receiving regular dental assessments and care. If carious lesions are identified early, the process can be halted or reversed by modifying the patient's individual risk and protective factors. The AAP's publications "Maintaining and Improving the Oral Health of Young Children"[11] and *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*[12] discuss these concepts in greater depth and provide targeted anticipatory guidance. For primary prevention to be effective, it is imperative that pediatricians be knowledgeable about the process of dental caries, social determinants of oral health, prevention of the disease, and available interventions, including fluoride.

Fluoride is available from many sources, divided into 3 major categories: tap water (and foods and beverages processed with fluoridated water), home administered, and professionally applied. The widespread decline in dental caries in many developed countries, including the United States, has been largely attributable to the use of fluoride. Fluoride has 3 main mechanisms of action[13]:

1. Fluoride promotes enamel remineralization.
2. Fluoride reduces enamel demineralization.
3. Fluoride inhibits bacterial metabolism and acid production.

The mechanisms of fluoride are both topical and systemic, but the topical effect is the most important, especially over the life span.[14]

There has been substantial public and professional debate about fluoride, and a great deal of information is available, often with confusing or conflicting messages. Excess fluoride ingestion during tooth development can result in subsurface

hypomineralization and porosity between the developing enamel rods, termed enamel fluorosis.[15] Fluorosis of permanent teeth occurs when excessive fluoride is ingested during the time that tooth enamel is being mineralized; therefore, the risk is influenced by both dose and frequency of ingestion. Recent evidence also suggests a genetic susceptibility or resistance to the development of fluorosis.[16] Fluorosis develops in children younger than 8 years, with the most susceptible period for permanent maxillary incisor fluorosis (central teeth) between 15 and 30 months of age.[17–19] The vast majority of enamel fluorosis is mild or very mild and characterized by small white striations or opaque areas not readily noticeable to the casual observer and is of minimal clinical consequence.

Moderate and severe forms of enamel fluorosis are uncommon in the United States but have both an aesthetic concern and, potentially, a structural concern with pitting, brittle incisal edges and weakened groove anatomy in the permanent 6-year molars.[20] After 8 years of age, there is no further risk of fluorosis except for the third molars because all other permanent tooth enamel is fully mineralized.

Dental and governmental organizations (the American Dental Association [ADA], American Academy of Pediatric Dentistry [AAPD], and Centers for Disease Control and Prevention [CDC]) have all published guidelines on the use of fluoride. In 2001, the AAP endorsed the CDC publication "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States."[21]

The 2 intents of this clinical report are as follows:

1. to assist pediatricians in using fluoride to achieve maximum protection against dental caries, while minimizing the likelihood of enamel fluorosis; and
2. to clarify what advice should be given by pediatricians regarding fluoride in the primary care setting.

CURRENT INFORMATION REGARDING FLUORIDE USE IN CARIES PREVENTION

Sources of ingested fluoride include drinking water, infant formula, fluoride toothpaste, prescription fluoride supplements, fluoride mouth rinses, professionally applied topical

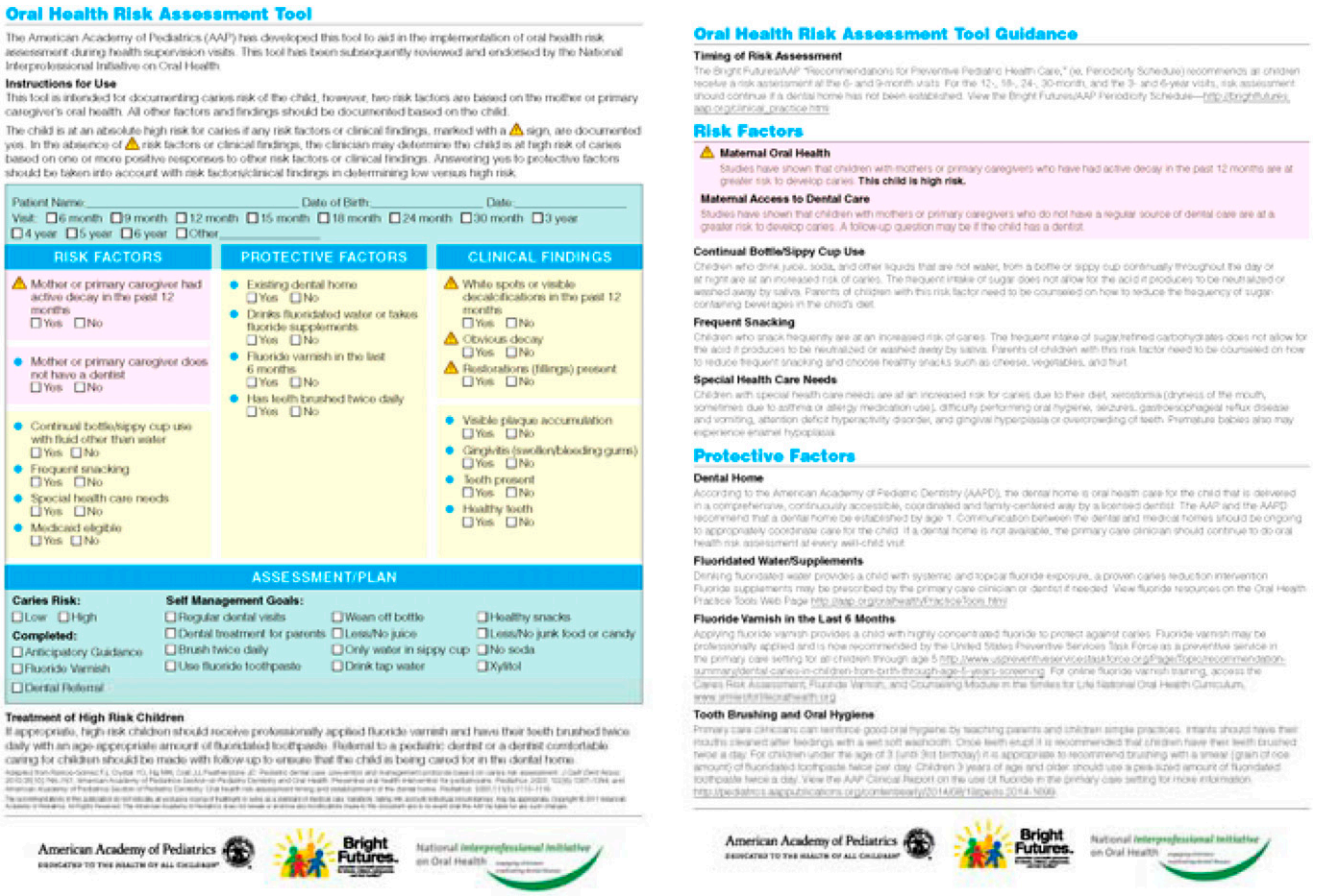

FIGURE 1
AAP Oral Health Risk Assessment Tool.

fluoride, and some foods and beverages.[22] Preventive strategies for caries can be tailored by focusing on key risk factors for dental caries associated with diet, bacteria, saliva, and status of the teeth (both current and previous caries experience).[11] The AAP Oral Health Risk Assessment Tool (Fig 1) is recommended in *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents* and endorsed by the National Interprofessional Initiative on Oral Health. This tool can be found at www.aap.org/en-us/Documents/oralhealth_RiskAssessmentTool.pdf.

Table 1 provides condensed recommendations for use of fluoride modalities in patients at low and high risk of caries as described in the following sections.

Fluoride Toothpaste

Fluoride toothpaste has consistently been proven to provide a caries-preventive effect for individuals of all ages.[21,23] In the United States, the fluoride concentration of over-the-counter (OTC) toothpaste ranges from 1000 to 1100 ppm. This translates into 1 mg of fluoride in a 1-inch (1 g) strip of paste. A pea-sized amount of toothpaste is approximately one-quarter of an inch. Therefore, a pea-sized amount of toothpaste containing 1000 to 1100 ppm fluoride would have approximately 0.25 mg of fluoride. Most fluoride toothpastes in the United States contain sodium fluoride, sodium monofluorophosphate, or stannous fluoride as the active ingredient.

Children younger than 6 years are more likely to ingest toothpaste and increase the risk of fluorosis. Fluorosis risk can be minimized by using the recommended amounts of toothpaste and storing toothpaste where young children cannot access it without parental help. Parents should supervise children younger than 8 years to ensure the proper amount of toothpaste and effective brushing technique.

Recommendations and Dosing

The use of fluoride toothpaste should begin with the eruption of the first tooth. For children younger than 3 years, the recommended amount is a smear or grain of rice size (approximately 0.1 mg of fluoride). Once the child has turned 3 years of age and is more able to consistently expectorate, a pea-sized amount of toothpaste (approximately 0.25 mg of fluoride) should be used.[24,25] It is preferable to spit, but not rinse, after brushing. Expectorating without rinsing reduces the amount of fluoride swallowed and leaves some fluoride available in the saliva for uptake by the dental plaque. Parents should be strongly advised to supervise their child's use of fluoride toothpaste to avoid overuse or ingestion, especially with children who have complex neurodevelopmental disabilities and cannot consistently expectorate.

High-concentration toothpaste (5000 ppm) is available by prescription only, and this decision is usually made by a dental health professional. The active ingredient in this toothpaste is sodium fluoride. This agent can be recommended for children 6 years and older and adolescents who are at high risk of caries and who are able to expectorate after brushing. Examples of children for whom high-concentration fluoride toothpaste might be indicated are those with history of dental caries and new lesions, children with xerostomia, and those with gastroesophageal reflux causing dental erosion. Dental health professionals may also prescribe this agent for adolescents who are undergoing orthodontic treatment because they are at increased risk of caries during this time.[26]

Fluoride Varnish

Fluoride varnish is a concentrated topical fluoride applied to the teeth that sets on contact with saliva. Advantages of this modality are that it is well tolerated by infants and young children, has a prolonged therapeutic effect, and can be applied by both dental and nondental health professionals in a variety of settings.[27] The concentration of fluoride varnish is 22 600 ppm (2.26% fluoride ion), and the active ingredient is sodium fluoride. The unit dose packaging from most manufacturers provides a specific measured amount (0.25 mL, providing 5 mg of fluoride ion). The application of fluoride varnish during an oral screening is of benefit to children, especially those with limited access to dental care. The current AAPD recommendation for children at high risk of caries is that fluoride varnish be applied to the teeth every 3 to 6 months.[28] The 2013 ADA

TABLE 1 Summary of Fluoride Modalities for Low- and High-Risk Patients

Fluoride Modality	Low Caries Risk	High Caries Risk
Toothpaste	Starting at tooth emergence (smear of paste until age 3, then pea-sized)	Starting at tooth emergence (smear of paste until age 3, then pea-sized)
Fluoride varnish	Every 3–6 mo starting at tooth emergence	Every 3 mo starting at tooth emergence
Mouth rinse OTC	Do not use	Starting at age 6 y if the child can reliably swish and spit
Community water fluoridation	Yes	Yes
Dietary fluoride supplements	Yes, if drinking water supply is not fluoridated	Yes, if drinking water supply is not fluoridated

guideline recommends application of fluoride varnish at least every 6 months to both primary and permanent teeth of those at elevated caries risk.[29] Medicaid pays both physicians and dentists for the application of fluoride varnish in all 50 states.

Under the Patient Protection and Affordable Care Act,[30] payers are required to cover, without cost-sharing, preventive services recommended by the US Preventive Services Task Force (USPSTF) and *Bright Futures* guidelines. The USPSTF recommended in 2014 that primary care clinicians apply fluoride varnish to the primary teeth of all infants and children starting at the age of primary tooth eruption (B recommendation).[31] All children 5 years and younger deserve to have application of fluoride varnish fully covered, as per USPSTF recommendations, as part of health maintenance and preventive care and for fluoride varnish application to be a covered benefit and separately paid service (ie, not considered incidental to the office visit). All practices should be paid separately and appropriately according to the definition of the *Current Procedural Terminology* (CPT) code, which defines fluoride application as a separately identifiable procedure. Fluoride varnish payment should not be bundled with routine preventive evaluation and management services because definitions of preventive care under those specific CPT codes do not include fluoride varnish application. Information regarding coding, billing, and payment for fluoride varnish application can be found on the AAP Web site (www.aap.org/oralhealth) and the Pew Center on the States Web site (www.pewstates.org/research/analysis/reimbursing-physicians-for-fluoride-varnish-85899377335). Many AAP Chapters have chapter oral health advocates who promote and advocate for pediatric oral health within their community. Contact information for these chapter oral health advocates can be found at www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/Oral-Health/Pages/Chapter-Oral-Health-Advocates.aspx.

Indications for Use

In the primary care setting, fluoride varnish should be applied at least once every 6 months for all children and every 3 months for children at high risk for caries, starting when the first tooth erupts and until the establishment of a dental home. Medical and dental professionals are encouraged to work in collaboration to ensure that fluoride varnish is being applied.

Instructions for Use

Fluoride varnish must be applied by a dentist, dental auxiliary professional, physician, nurse, or other health care professional on the basis of individual state practice acts. It should not be dispensed to families to apply at home. Application of fluoride varnish is most commonly performed in the context of a well-child visit. Teeth are dried with a 2-inch gauze square, and then the varnish is painted onto all surfaces of the teeth with a brush. The dose recommended for young children is 0.25 mL, which is available in single-dose applicator kits. Children can eat and drink immediately after application and are instructed to eat soft foods and not to brush their teeth on the evening after the varnish application to maximize the contact time of varnish on the teeth. Children should resume brushing twice daily with fluoridated toothpaste the following morning.

OTC Fluoride Rinse

OTC fluoride rinse provides a lower concentration of sodium fluoride than toothpaste or varnish. The concentration is most commonly 230 ppm (0.05% sodium fluoride). Expert panels on this topic have concluded that OTC fluoride rinses should not be recommended for children younger than 6 years because of their limited ability to rinse and spit and increased risk of swallowing higher than recommended amounts of fluoride.[32] A teaspoon (5 mL) of OTC fluoride rinse contains approximately 1 mg of fluoride. For children older than 6 years, OTC rinses provide additional topical fluoride that may assist in the prevention of enamel demineralization. However, the evidence for an anticaries effect is limited, and decisions to recommend OTC fluoride rinses should be made in consultation with the child's dental health care provider.[33,34]

Dietary Fluoride Supplements

The USPSTF recommended in 2014 that primary care clinicians prescribe dietary fluoride supplements for children living in communities with nonfluoridated water or who drink well water that does not contain fluoride.[31] Because there are many sources of fluoride in water supplies and processed food and drinks, it is essential that all potential sources of fluoride be assessed before prescribing a dietary supplement, including consideration of differing environmental exposures (dual homes and child care). As a general guideline, if the source of drinking water in the primary home is fluoridated tap or well water, children will not require fluoride supplementation, even if they primarily drink bottled water because the teeth are exposed to fluoride through food preparation and brushing. The risk of fluorosis is high if fluoride supplements are given to a child consuming fluoridated water.[35] Information about the fluoridation levels in many community water systems can be found on the CDC Web site "My Water's Fluoride" (https://nccd.cdc.gov/doh_mwf/default/default.aspx). Not all communities report this information to the CDC, so it may be necessary to contact the local water department to determine the level of

fluoride in the community water. Well water must be tested for fluoride content before prescribing supplements, and this testing is available in most areas through the state or county public health laboratory. Challenges with dietary fluoride supplementation include determining the child's fluoride exposures and proper administration of the medication.

It is important to note that the USPSTF recommendations vary from the ADA and AAPD guidelines, which both recommend fluoride supplementation only be considered for children who drink fluoride-deficient water and are also at high risk for dental caries.[36,37] No caries risk assessment tool has been validated for pediatricians to use, but the AAP Oral Health Risk Assessment Tool was piloted through the Quality Improvement Innovation Network, and more than 80% of practices found the tool easy to implement because clinicians did not need to significantly alter current practice to incorporate risk assessment. Identification of high-risk patients for oral health referral increased from 11% to more than 87% with the use of this tool (Brightening Oral Health Workgroup and Quality Improvement Innovation Networks, AAP, Brightening Oral Health: Teaching and Implementing Oral Health Risk Assessments in Pediatric Care project, unpublished data, 2009).

Guidelines for Use

The CDC-recommended fluoride supplementation dosage schedule is provided in Table 2. Supplements can be prescribed in liquid, tablet, or lozenge form. Tablets are preferable for children who can chew because they gain an additional topical benefit to the teeth during the chewing process. Liquid supplements are recommended for younger children and should ideally be added to water or put directly into the child's mouth. Addition of the fluoride supplement to milk or formula is not recommended because absorption of fluoride is reduced in the presence of calcium.[38] The risk of fluorosis can be minimized by health care providers verifying that there are no other sources of fluoride exposure before prescribing systemic fluoride supplements.

TABLE 2 Fluoride Supplementation Schedule for Children

Age	Fluoride Ion Level in Drinking Water, ppm[a]		
	<0.3	0.3–0.6	>0.6
Birth to 6 mo	None	None	None
6 mo to 3 y	0.25 mg/d[b]	None	None
3–6 y	0.50 mg/d	0.25 mg/d	None
6–16 y	1.0 mg/d	0.50 mg/d	None

Source: Centers for Disease Control and Prevention.[21]
[a] 1.0 ppm = 1 mg/L.
[b] 2.2 mg of sodium fluoride contains 1 mg of fluoride ion.

Other Sources of Fluoride

Fluoride is present in processed foods and beverages and may be naturally occurring in some areas of the country. The presence of fluoride in juices and carbonated beverages does not counteract the cariogenic nature of these beverages.

Breastfeeding and Reconstitution of Infant Formula

The AAP recommends exclusive breastfeeding for the first 6 months of life, and there is no need during this period of time to supplement with fluoride or water that is fluoridated. A study of infant feeding practices revealed that 70% to 75% of mothers who fed their infants formula used tap water to reconstitute the powdered formula.[39] According to 2014 CDC data,[40] approximately 74% of US households using a community public water supply received optimally fluoridated water.[41] Before the emergence of the primary teeth, tap water can be used to reconstitute formula. There is a small risk of fluorosis in the permanent dentition if a fluoridated water source is used to reconstitute formula.[22] If families elect to purchase water, it is appropriate to buy water with no added fluoride before tooth emergence. After tooth emergence, formula should be mixed with optimally fluoridated tap water or nursery water with fluoride, or fluoride supplements should be prescribed. It should be noted that most bottled water has suboptimal concentrations of fluoride and that fluoride content is not listed unless fluoride is added by the manufacturer. Fluoride is often added to "nursery" water, and this must be declared on the packaging. Dietary fluoride supplements should not be prescribed for children drinking infant formula reconstituted with fluoridated water.

Community Water Fluoridation

Community water fluoridation is the practice of adding a small amount of fluoride to the water supply to achieve a fluoride concentration of 0.7 ppm. Community water fluoridation was heralded by the CDC as 1 of the top 10 public health achievements of the 20th century.[42] Community water fluoridation is a safe, efficient, and cost-effective way to prevent tooth decay and has been shown to reduce tooth decay by 25%.[43] It prevents tooth decay by providing both topical and systemic exposure of low levels of fluoride to the teeth over time. Although more than 210 million Americans live in communities with optimally fluoridated water, more than 70 million others do not have access to fluoridated water in their public water system.[41] The fluoridation status of a community water supply can be determined by contacting the local water department or accessing the CDC Web site "My Water's Fluoride" (https://nccd.cdc.gov/doh_mwf/default/default.aspx).

Recommended Concentration

Community water fluoridation was initiated in the United States in the 1940s. In 2015, the US Department of Health and Human Services finalized

a recommendation to lower the optimal fluoride concentration in drinking water to 0.7 mg/L.[44] This fluoride concentration replaced the previous recommendation, which was based on climate and ranged from 0.7 mg/L in warmest climates to 1.2 mg/L in coldest climates.[44] The change was recommended because recent studies revealed no variation in water consumption by young children on the basis of climate and to adjust for an overall increase in fluoride intake through foods and beverages processed with fluoridated water, fluoridated mouth rinses, and fluoride toothpastes.

Evidence Supporting Community Water Fluoridation

Despite overwhelming evidence supporting the safety and preventive benefits of fluoridated water, community water fluoridation continues to be a controversial and highly emotional issue. Opponents express a number of concerns that have been addressed or disproven by validated research. The only scientifically documented adverse effect of excess (nontoxic) exposure to fluoride is fluorosis. An increase in the incidence of mild enamel fluorosis among teenagers has been cited as a reason to discontinue fluoridation, although this is a cosmetic condition with no detrimental health outcomes. Recent opposition has sometimes centered on the question of who decides whether to fluoridate: elected and/or public officials or the voters. Some opponents believe fluoridation to be mass medication and call into question the ethics of community water fluoridation, but courts have consistently upheld that it is legal and appropriate for a community to adopt a fluoridation program.[45] Opponents express concern about the quality and source of fluoride, claiming that the additives (fluorosilicic acid, sodium fluoride, or sodium fluorosilicate), in their concentrated form, are highly toxic byproducts of the production of phosphate fertilizer and may include other contaminants, such as arsenic. The quality and safety of fluoride additives are ensured by Standard 60 of the National Sanitation Foundation/American National Standards Institute, a program commissioned by the US Environmental Protection Agency (EPA), and testing is conducted to confirm that the concentrations of arsenic or other substances are below those allowed by the EPA.[46] Finally, there have been many unsubstantiated or disproven claims that fluoride leads to kidney disease, bone cancer, and compromised IQ. More than 3000 studies or research articles have been published on the subject of fluoride or fluoridation.[47] Few topics have been as thoroughly researched as community water fluoridation, and the overwhelming weight of the evidence (along with over 75 years of experience) supports the safety and effectiveness of this public health practice.

Naturally Occurring Fluoride in Drinking Water

The optimal fluoride concentration in drinking water is 0.7 ppm, an amount proven beneficial in reducing tooth decay.[44] Naturally occurring fluoride may be below or above these levels in some areas. Under the Safe Drinking Water Act,[48] the EPA requires notification by the water supplier if the fluoride concentration exceeds 2 ppm. In areas where naturally occurring fluoride concentrations in drinking water exceed 2 ppm, people should consider an alternative water source or home water treatments to reduce the risk of fluorosis in young children.[49] Well water should be tested for the concentration of fluoride, and this testing is most commonly performed through the local health department.

Fluoride Toxicity

Toxic levels of fluoride are possible, particularly in children, resulting from ingesting large quantities of fluoride supplements, fluoridated toothpaste, or fluoride mouth rinse. The toxic dose of elemental fluoride is 5 to 10 mg of fluoride/kg of body weight.[50] Lethal doses in children have been calculated to be between 8 and 16 mg/kg. When prescribing sodium fluoride supplements, it is recommended to limit the quantity prescribed at one time to no more than a 4-month supply. Parents should be advised to keep fluoride products out of the reach of young children and to supervise their use.

Fluoride-Removal Systems

A number of water treatment systems are effective in removing fluoride from water,[51] including reverse osmosis and distillation. Parents should be counseled on the use of these and activated alumina filters in the home and, should they choose to use one that removes fluoride, the potential adverse effects on the family's oral health. Commonly used home carbon filters (eg, Brita or PUR) do not remove fluoride.[51] Families concerned about heavy metals or other impurities in their home water supply can use an activated carbon filter and still retain the benefits of fluoridated water.

Silver Diamine Fluoride

Silver diamine fluoride (SDF) is a minimally invasive, low-cost liquid solution that is painted on cavitated lesions. In young children, SDF provides a nonsurgical technique to manage carious lesions until the child can cope with traditional restorative dental care and, potentially, avoid sedation or a general anesthetic.[52] SDF has been used in Japan for more than 40 years and was cleared by the US Food and Drug Administration in 2014 to treat tooth sensitivity in adults.[53,54] Similar to fluoride varnish, SDF (38% solution) has been used off-label in children and adults to stabilize dental caries and reduce dental sensitivity. At present, the use

of SDF in the United States is largely limited to the dental profession because there are no formal professional guidelines for use outside of dentistry. SDF is indicated for the arrest of cavitated carious lesions in primary teeth as part of a comprehensive caries management program.[52] Information about SDF is included in this report in expectation of questions to pediatricians about this increasingly publicized intervention and increasing numbers of SDF-treated teeth seen in pediatric practices. The mechanism of SDF action is poorly understood, but silver ions are known to be antimicrobial, and the fluoride prevents further enamel demineralization. After SDF application, the lesions must be followed to assess their hardness state. Additional treatments can be applied to obtain sufficient hardness. The only known contraindication to SDF is silver allergy, but SDF is not indicated for carious lesions involving the pulp. The only significant adverse effect of SDF is that the carious lesion turns black (Figs 2 and 3), which can be esthetically problematic for some. SDF can also temporarily stain the skin black if it accidentally comes into contact with the epithelium, and SDF can cause mucosal irritation for approximately 48 hours after mucosal contact. Care must be taken when applying SDF to a cavitated lesion to avoid contact with the child's mucosa or skin. Details of SDF application technique for dental health professionals are delineated in the AAPD Chairside Guide.[54]

FIGURE 2
Permanent staining of carious lesions after SDF application. Photograph courtesy of Martha Ann Keels, DDS, PhD.

FIGURE 3
Three-year stabilization of a carious lesion on 1 primary molar after SDF application. Photograph courtesy of Martha Ann Keels, DDS, PhD.

SUGGESTIONS FOR PEDIATRICIANS

1. Know how to assess caries risk. As recommended by the AAP in "Maintaining and Improving the Oral Health of Young Children" and the fourth edition of Bright Futures, pediatricians should perform oral health risk assessments on all children at every routine well-child visit beginning at 6 months of age. The Oral Health Risk Assessment Tool has been developed by the AAP and Bright Futures and endorsed by the National Interprofessional Initiative on Oral Health. This tool can be accessed at www.aap.org/en-us/Documents/oralhealth_RiskAssessmentTool.pdf. The tool is a guide to help clinicians counsel patients about oral health and counsel in reducing risk.
2. Recommend use of fluoridated toothpaste starting at the eruption of the first tooth. A smear or grain of rice sized amount is recommended for children younger than 3 years, and a pea-sized amount of toothpaste is appropriate for most children starting at 3 years of age (see Fig 4).

FIGURE 4
Diagram of smear versus pea-sized amount of fluoride toothpaste.

3. Apply fluoride varnish according to the periodicity schedule and bill using the CPT code 99188. Fluoride varnish is a proven tool in early childhood caries prevention. Additional training on oral screenings, fluoride varnish indications and application, and office implementation can be found in the Smiles for Life Curriculum Course: Caries Risk Assessment, Fluoride Varnish and Counseling[55] at www.smilesforlifeoralhealth.org. Additionally, the AAP Children's oral health Web site is a resource for oral health practice tools at https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/Oral-Health/Pages/Oral-Health-Practice-Tools.aspx.
4. Know how to determine the concentration of fluoride in a child's primary drinking water and determine the need for systemic supplements.[21]
5. Advocate for water fluoridation in your local community. Public water fluoridation is an effective and safe method of protecting the most vulnerable members of our population from dental caries. Pediatricians are encouraged to advocate on behalf of public water fluoridation in their communities and states. For additional information and water fluoridation facts and detailed questions and answers, see the following:
   - o http://www.ilikemyteeth.org;
   - o www.ada.org/en/public-programs/advocating-for-the-public/fluoride-and-fluoridation/fluoridation-facts; and

o http://www.cdc.gov/fluoridation/.

6. Understand indications for SDF and be able to recognize the clinical appearance of SDF-treated teeth.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
AAPD: American Academy of Pediatric Dentistry
ADA: American Dental Association
CDC: Centers for Disease Control and Prevention
CPT: *Current Procedural Terminology*
EPA: US Environmental Protection Agency
OTC: over-the-counter
SDF: silver diamine fluoride
USPSTF: US Preventive Services Task Force

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

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