CURRENT CONCEPTS IN

Fluoride Therapy

Fiona M. Collins, BDS, MBA, MA
Current Concepts in Fluoride Therapy

Current concepts on dental caries as a dynamic process, the mechanisms of action of fluoride, and the use of systemic and topical fluorides are based on a substantial body of research and evidence. Dental caries is a multifactorial bacterial infection, and all factors must be considered. In order to provide a patient with a suitable preventive program, the patient’s risk level must be assessed and the program developed based on this and the age of the patient. Topical and systemic fluorides are safe and effective for caries control when used appropriately and are still considered the most effective method of controlling dental caries.

ABOUT THE AUTHOR

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Dr. Fiona M. Collins has authored and presented CE courses to dental professionals and students in the United States and internationally, and has been an active author, editor, writer, speaker and trainer for several years. Fiona is a member of the American Dental Association, the ADA Standards Committee working groups, Chicago Dental Society, and the Organization for Safety, Asepsis and Prevention (OSAP). She is the ADA external representative to AAMI and a Fellow of the Pierre Fauchard Academy. Dr. Collins earned her dental degree from Glasgow University and holds an MBA and MA from Boston University. AUTHOR DISCLOSURE: Dr. Collins has received honoraria for speaking or writing from oral care companies. She is the CE Editor for Dental Learning. Dr. Collins can be reached at fionacollins@comcast.net.

EDUCATIONAL OBJECTIVES

The overall goal of this article is to provide the reader with current concepts regarding the use of fluoride as a caries preventive. On completion of this article, the reader will be able to:

1. Describe the caries process;
2. Review the mechanisms of action of fluoride for caries prevention;
3. List and describe the types of topical fluorides that are available and their clinical efficacy;
4. Review systemic fluorides, fluorosis and updated dosing recommendations; and
5. Describe factors responsible for orthodontic and xerostomic patients being at-risk for caries and review preventive treatment options.

Introduction

Topical and systemic chemotherapeutics have been used in dentistry for more than one hundred years and are currently used to prevent and/or treat a variety of oral diseases and conditions. Current concepts on dental caries as a dynamic process, the science behind fluoride, and topical and systemic recommendations for use are based on a substantial body of research and evidence.

Dental Caries – The Disease Process

Dental caries is a multifactorial bacterial infection involving primarily mutans streptococci and lactobacilli. These bacteria colonize on the pellicle on the tooth surface, and produce extracellular polysaccharides that aid bacterial adhesion. Although multifactorial, without cariogenic bacteria dental caries cannot exist. It involves a dynamic process with repeated periods of demineralization (an ‘acid attack’).
and remineralization over time, with the balance of these depending on conditions.\(^1\) Demineralization occurs after acid is produced by cariogenic bacteria as they metabolize fermentable carbohydrates. Saliva is supersaturated with calcium and phosphate, preventing demineralization until the critical pH of <5.5 is reached. Subsurface dissolution begins at pH 3.8 – 4.8. Calcium, phosphate and carbonate ions are dissolved out of hydroxyapatite crystals.

Under favorable conditions, demineralization does not occur or is quickly followed by remineralization. Remineralization occurs as the pH rebounds, typically approximately 30 minutes after an acid attack, with calcium and phosphate (as well as fluoride) entering the demineralized sites. The actual timing depends on the availability and quality of saliva, and the depth of plaque present.

Under unfavorable conditions, repeated demineralization occurs either without, or with insufficient, remineralization. As enamel caries progresses, white spots may be visible as the underlying subsurface loses minerals (Figure 1). If oral conditions continue to favor demineralization, larger subsurface lesions will develop, breaching the enamodental junction, progressing into dentin and cavitating. Dentin is less dense than enamel, demineralizing more rapidly. In addition, following demineralization of dentin, the exposed dentin fibrils degrade enzymatically, increasing the rate of caries progression.\(^2,3\)

### Controlling Dental Caries

Caries lesions can be prevented/arrested/reversed by creating favorable conditions that inhibit demineralization and promote remineralization. Options include:

- Reducing or eliminating dental biofilm mechanically or chemotherapeutically
- Altering the biofilm to reduce cariogenic bacteria
- Chemotherapeutically inhibiting demineralization
- Chemotherapeutically promoting remineralization.

Fluoride continues to be considered the most beneficial topical agent.\(^4\)

### Fluoride: Anti-caries Mechanisms of Action

Fluoride exerts a potent anti-caries effect. Traditionally, the incorporation of systemically sourced fluoride into enamel hydroxyapatite crystals was held to be most important for caries prevention. Fluoride is incorporated during tooth development\(^5\) prior to pre-eruptive enamel maturation. However, a higher concentration of fluoride is incorporated in the outer enamel layer compared to the inner layers (1,000–2,000 ppm vs. 20–100 ppm) – the result of being surrounded by fluoride-rich plasma during the pre-eruptive enamel maturation phase.

**Contemporary research has shown that the main effect of fluoride is topical.** Mechanisms by which this occurs are:

- Bathing of erupted teeth in saliva and gingival crevicular fluid that contain fluoride (as a result of ingested fluoride, but a topical effect)
- Bathing of erupted teeth in fluoride as it is ingested/imbibed in foods and drinks
- Bioavailable fluoride from topical fluoride use

Topical fluorides result in bioavailable fluoride reservoirs intra-orally.\(^6\) These reservoirs consist of calcium fluoride-like globules deposited at the tooth surface and in plaque, as well as free fluoride ions in plaque, saliva and on oral mucosa.\(^7\) Higher concentrations of fluoride favor calcium fluoride-like globules. Fluoride is also ‘bonded’ to bacteria
or their fragments by calcium-fluoride bonds. Bioavailable fluoride is also known as non-apatitically bound or loosely-bound fluoride.

When an acid attack occurs, calcium fluoride-like globules release calcium, fluoride and phosphate ions. This is thought to occur as the lower pH breaks down the phosphate coating that otherwise maintains the stability of these globules. Released fluoride increases the concentration of fluoride in plaque and at the tooth surface. Bioavailable fluoride then diffuses into the tooth together with calcium and phosphate ions, where it is incorporated into the hydroxyapatite crystals (becoming firmly bound or apatitically bound fluoride) and resulting in stronger, more acid-resistant crystals (Figure 2). A dose response effect also exists with the use of topical fluorides.

An additional mechanism for topical fluoride involves the inhibition of cariogenic bacterial activity, achieved when fluoride within bacterial cells inhibits enzymes required for the metabolism of fermentable carbohydrates (and acid production). Fluoride has also been shown to inhibit bacterial production of the extracellular polysaccharides that aid bacterial adhesion.

The presence of small quantities of dental biofilm does not reduce the effect of fluoride therapy:
- Calcium fluoride-like globules form at the tooth surface in the presence of plaque
- Fluoride can penetrate through a light layer of plaque and concentrates within it

In summary, the topical effect of fluoride is now held to be key and is largely attributed to the presence of bioavailable fluoride. The use of fluoride agents must consider the risk level of an individual patient, the evidence for a given treatment, and other factors such as safety and convenience. Topical fluorides can be broadly categorized into professionally applied topical fluorides and home-use topical fluorides. Stannous fluoride, sodium fluoride, acidulated phosphate fluoride (APF) and sodium monofluorophosphate are all used in North America in professional and home-use products.

Professionally Applied Topical Fluorides
5% sodium fluoride varnish (22,600 ppm)
This is available in unit doses and tubes, with different flavors and viscosities and in white/clear/yellow-tinted variants. It has been investigated for childhood and adult coronal caries, root caries, secondary/recurrent caries and for use around orthodontic brackets.

Efficacy and safety
Numerous clinical trials and studies support the use of 5% sodium fluoride varnish including:

![Figure 2a. Acquisition of calcium fluoride-like globules and free fluoride ions following use of topical fluoride](image1)

![Figure 2b. Lower pH during acid attack results in de-mineralization and the release of ions from the teeth as well as the release of calcium, fluoride and phosphate from the calcium fluoride-like globules. These, together with the bioavailable free fluoride, remineralize the tooth as the pH rebounds.](image2)
33% caries reduction (range 19% – 48%) in the primary dentition (dmfs) in a meta-analysis of blind and double-blind clinical trials lasting a minimum of one year in the under-17 age group\(^\text{16}\)

- 46% caries reduction (DMFS) (range 30% – 63%)\(^\text{16}\)
- 38% caries reduction in children in a smaller, prior meta-analysis\(^\text{17}\)
- Significant reductions in orthodontic decalcifications\(^\text{18}\)
- Significant reductions in enamel decalcifications related to early childhood caries.\(^\text{19}\)

The total volume of fluoride applied is substantially less than with a gel or foam, and the varnish sets immediately on contact with saliva/water. Fluoride ingestion is substantially lower than that of a 4-minute gel.\(^\text{20}\) Note, however, that the use of varnish for caries prevention/control is off-label in the United States, although globally this is its predominant use. Fluoride varnish is also available as a 0.9% difluorosilane (0.1% fluoride/1,000 ppm in solution).

**Neutral sodium fluoride (9,050 ppm) and APF (12,500 ppm) foams/gels**

Gels and foams are applied in trays for 1 or 4 minutes. Compared to gels, foams use less product and total fluoride, with a lower likelihood of ingestion and a more pleasant patient experience. It is important to be sure that the foam being used does not shrink during use leaving surfaces uncovered.

**Efficacy and safety**

The efficacy of gels and foams has been investigated in a number of trials:

- 28% caries reduction (DMFS) with APF gel in a meta-analysis of blind and double-blind clinical trials lasting a minimum of one year in under-17s\(^\text{16}\)
- 21% caries reduction (range 14 – 28%) in a meta-analysis of placebo-controlled clinical trials on gels\(^\text{21}\)
- 22% average caries reduction in a systematic review of APF gel trials\(^\text{22}\)
- Smooth surface caries reductions averaging 41% with APF foam/gel in a 2-year trial in 6-7-year-olds\(^\text{23}\)
- 24% caries reduction (dmfs) with twice-annual application of APF foam in 4-year-olds (efficacy was shown only on approximal surfaces).\(^\text{24}\)

Although there is insufficient evidence to recommend their use, recent *in vitro* and *in situ* studies suggest 1-minute gels/foams may be as effective as 4-minute treatments.\(^\text{25}\)

**pH and topical fluorides**

Low pH formulations were developed with the objective of increasing fluoride uptake. Since demineralized enamel takes up more fluoride than sound enamel,\(^\text{16}\)

<table>
<thead>
<tr>
<th>TABLE 1. Recommendations for professionally-applied topical fluoride based on risk level(^\text{27})</th>
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<tr>
<td><strong>Low Risk</strong></td>
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<tr>
<td><strong>Less than 6 years of age</strong></td>
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<tr>
<td><strong>6 to 18 years of age</strong></td>
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<td><strong>Over 18 years of age</strong></td>
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*In addition to use of OTC fluoride dentifrice and fluoridated water

Low risk: Patients with no risk factors, including no incipient/cavitated/secondary caries lesions in the prior 3 years\(^\text{28}\)

Moderate risk under age 6: Patients with at least one risk factor, but no incipient/cavitated/secondary caries lesions in the prior 3 years\(^\text{28}\)

Moderate risk age 6+: Patients with at least one risk factor and/or 1 or 2 incipient/cavitated/secondary caries lesions in the prior 3 years\(^\text{28}\)

High risk under age 6: Patients with multiple risk factors and/or any incipient/cavitated lesions in the prior 3 years\(^\text{28}\)

High risk age 6+: Patients with multiple risk factors and/or 3 or more incipient/cavitated lesions in the prior 3 years\(^\text{28}\)
using a low-pH fluoride results in greater fluoride uptake. It is, however, bioavailable fluoride that is now recognized as being most important. Low-pH fluorides may be unsuitable for certain patients: high fluoride concentration, low-pH fluoride may alter the titanium surfaces of implants, and may increase bacterial colonization and inhibit epithelial junction development; with ongoing long-term use, home use low-pH fluoride gels may have the potential for surface degradation of some restoratives.

2% sodium fluoride rinses (9,050 ppm) and dual rinses (5,300 ppm)

Limited clinical evidence exists for 2% sodium fluoride.
- Average caries reduction (DMFS) of 29% with sodium fluoride solution use in the under-17 age group
No clinical evidence exists for the use of dual rinses.

Current recommendations for professionally-applied topical fluorides

The recommendations of the ADA Council on Scientific Affairs are presented in Table 1. For low risk patients, a fluoride dentifrice and fluoridated water may offer sufficient protection, although clinical judgment should be used to determine whether an in-office topical fluoride is necessary.

Over-the-counter (OTC) Topical Fluorides

Fluoride dentifrices

Dentifrices in the United States and Canada usually contain 1,000 – 1,100 ppm fluoride, available as 0.23 – 0.24% sodium fluoride, 0.4% stannous fluoride or 0.70% sodium monofluorophosphate. These are all effective and are recommended for twice-daily use.

Efficacy

Fluoride dentifrice efficacy in the primary and permanent dentition has been demonstrated worldwide:
- 23% average caries reduction (DMFS) in a meta-analysis of 74 controlled trials at the concentration of 1,000 – 1,250 ppm in the 16-and-under age group
- 24% (range 21 – 28%) average caries reduction (DMFS) in a meta-analysis of 70 controlled, blinded trials in the 16-and-under age group with the higher caries reductions in high-risk patients
- 67% root caries reduction (DFS) in a 1-year study
- No statistically significant caries reduction with use of dentifrices containing 450 – 550 ppm

Current recommendations: 1,000 – 1,100 ppm fluoride dentifrices

- As soon as the first tooth erupts, until age 3: Use a smear of toothpaste (the size of a grain of rice) twice-daily to brush teeth; brushing under supervision for children brushing their own teeth
- Children age 3 until age 6: Use of a pea-sized amount twice daily, brushing under supervision to minimize swallowing of toothpaste
- Age 6 onward: Twice-daily brushing with toothpaste; (may require supervision until age 10 or 11)

Fluoride rinses

Over-the-counter fluoride rinses are available as sodium fluoride and as acidulated phosphate fluoride/sodium fluoride (pH ~4). Options include 0.05% or 0.02% sodium fluoride and 0.044% or 0.021% APF. These concentrations fall under the FDA caries monograph. A recent meta-analysis confirmed that rinsing with fluoride resulted in a reduction in dental caries. Clinical trials have been published using 0.05% sodium fluoride and 0.044% APF rinses.

Efficacy of 0.05% sodium fluoride rinse

- 84% caries arrestment rate for noncavitated smooth surface caries lesions with daily rinsing in the 11 – 15 age group
- Reductions in orthodontic white spot lesions with daily rinsing
- Substantial reductions in root caries in geriatric patients
in a 4-year study\textsuperscript{40}
- 31\% caries reduction with daily rinsing in non-fluoridated communities\textsuperscript{41}

\textbf{Efficacy of 0.044\% acidulated phosphate fluoride rinse}
- Up to a 58\% reduction in orthodontic white spots\textsuperscript{42}

\textbf{Current directions for OTC fluoride rinses}
- Fluoride rinses are not recommended for the under-6 age group, due to the risk of swallowing (see below)
- 0.05\% sodium fluoride and 0.044\% acidulated phosphate fluoride are recommended for daily use
- 0.02 – 0.021\% fluoride rinses must be used twice daily
- Plaque and salivary fluoride levels are higher with the use of higher-ppm fluoride rinses\textsuperscript{43}
- Nighttime use results in prolonged fluoride retention in whole saliva compared to daytime use\textsuperscript{44}

Recent investigations suggest a role for fluoride rinsing post-brushing. Rinsing with water after brushing lowers the level of bioavailable fluoride and fluoride rinsing has been proposed.\textsuperscript{45-48} A small study found that rinsing post-brushing with water/100 ppm fluoride reduced salivary fluoride (‘wash-out’) whether 5,000 ppm or 1,450 ppm fluoride dentifrice had been used. 0.05\% sodium fluoride rinse resulted in a significantly greater level of salivary fluoride than just brushing, and 900 ppm (0.2\% prescription level rinse) even more so.\textsuperscript{49}

\textbf{Prescription Home-use Pastes, Gels and Rinses}
\textit{1.1\% sodium fluoride (5,000 ppm) pastes/gels}

These confer additional protection due to a dose-response effect. Gels/pastes can be used in fluoride mouthtrays; however, they are now mainly used during brushing, which is preferable for patient compliance. Pastes offer the additional advantage of including an abrasive for gentle cleaning while brushing with them (instead of a dentifrice).

\textbf{Efficacy of 1.1\% sodium fluoride paste/gel}
- 57\% remineralization of root caries lesions over a 6-month period with twice-daily brushing\textsuperscript{50}
- 91\% root caries arrestment rate over a 1-year period when used in trays\textsuperscript{51}
- Effective in helping to prevent caries lesions following head and neck radiation\textsuperscript{52}

\textbf{Current recommendations for 1.1\% sodium fluoride}
- Not recommended for children under age 6
- For patients age 6 and older: Use of 1.1\% sodium fluoride twice-daily as an option instead of professional topical fluoride\textsuperscript{26}
- Recommended for twice-daily use in patients at high risk for caries\textsuperscript{53}

\textbf{0.2\% sodium fluoride rinse (920 ppm)}
0.2\% sodium fluoride rinse has been used in school programs on a weekly basis. It is not intended for use in children under age 6 (due to the risk of fluorosis).

For patients age 6 and older, the current recommendations include the use of prescription-strength rinse containing 0.9\% fluoride ion, at least weekly, as an alternative to professional topical fluoride applications.\textsuperscript{26}

\textbf{Efficacy of 0.2\% sodium fluoride rinse}
- Up to 55\% caries reduction in schoolchildren with once-
weekly rinsing over 30 months\textsuperscript{54}

- 57.8\% caries reduction (DMFS) over 7 years with weekly rinsing (it was concluded, however, that other factors also contributed to this)\textsuperscript{55}

0.63\% stannous fluoride rinse

These are diluted for use, rendering a concentration of 0.1\%. This rinse is less frequently used. It has demonstrated caries reductions and inhibition of bacterial metabolism.\textsuperscript{56}

Fluorosis

Fluorosis results from the ingestion of excessive cumulative amounts of fluoride during tooth development prior to pre-eruptive enamel maturation (Figure 3).

Sources of fluoride include fluoridated water, supplemental fluorides, infant formulas, infused tea, foods, and some medications. Fluoride is also ingested unintentionally during toothpaste and rinse use.\textsuperscript{57} Topical fluorides may be associated with fluorosis only if they are swallowed over a period of time, prior to pre-eruptive enamel maturation. There is no evidence that in-office topical fluorides – which are infrequently used – play a role in fluorosis.\textsuperscript{58}

Fluorosis can present in the following ways:\textsuperscript{59}

- Mild fluorosis that appears as white lacy striae
- Moderate fluorosis with mottled areas of hypomineralization over >50\% of the enamel
- Severe fluorosis with abnormal tooth morphology, brittle enamel, severe brown staining and pitting. This is typically due to well water with an extremely high fluoride level (e.g., 9–10 ppm and higher), and was observed by this author in the Middle East
- In all cases, hypomineralization is present.

The risk of fluorosis is mainly of concern up to age 6, by which time most of the dentition has undergone pre-eruptive enamel maturation, and after age 8 is of no concern. Appropriate use and dosing of systemic fluorides helps to reduce the risk of fluorosis associated with excessive cumulative ingestion from all sources of fluoride.

Infant formula

A recent study of infant formulas determined that:\textsuperscript{60}

1) most infants up to 12 months of age will receive excess fluoride (above the recommended level) if formula is reconstituted with water at 0.7–1.2 ppm fluoride; and 2) for some formulas, a water level of 0.5 ppm will result in excess fluoride ingestion. It was also determined that excessive fluoride concentration was unlikely to be reached if 1) ready-to-use infant formula was given; and 2) infant formula was reconstituted with water <0.4 ppm fluoride.

Systemic Fluorides

Fluoridated water supply

An intentionally fluoridated water supply was first introduced in the mid-1940s in the United States and Canada.\textsuperscript{61,62}

As discussed above, current concepts hold that the effect of systemic fluorides is mainly topical – in communities where the public water supply was no longer fluoridated, increases

| TABLE 2. Recommended fluoride supplement dosing\textsuperscript{69} |
|------------------|-----------------|-----------------|-----------------|-----------------|
|                  | Birth to 6 months | 6 months - 3 yrs | 3 yrs to 6 yrs | 6 yrs to at least 16 yrs |
| Water fluoride level | 0 mg (none) | 0.25 mg | 0.50 mg | 1 mg |
| < 0.3 ppm |                |                |                |                |
| 0.3 - 0.6 ppm | 0 mg (none) | 0 mg (none) | 0.25 mg | 0.50 mg |
| > 0.6 ppm | 0 mg (none) | 0 mg (none) | 0 mg (none) | 0 mg (none) |

Fluoride supplements are not recommended, regardless of age or risk level, if the water fluoride level is > 0.6 ppm.
Fluoride supplements are not recommended from birth to 6 months of age.
in caries were observed – including in the dentition of patients who had always lived in that community. Water fluoridation is considered the most effective caries preventive at the community level.

**Other systemic fluorides**

Fluoridated milk, drinks and salt have also been used in some regions. One 3-year study demonstrated a statistically significant caries reduction in children drinking fluoridated milk. A meta-analysis of salt fluoridation studies found caries reductions in children. Supplemental fluoride drops, lozenges and tablets may also be used. It is then recommended to suck lozenges or crunch tablets so that the maximum topical benefit is obtained. A recent review of 11 studies found limited evidence for childhood caries prevention using fluoride supplements, although caries reductions were observed in the permanent dentition in children under 16 years of age.

**Updated recommendations for systemic fluoride use**

Due to an increased overall availability of fluoride, mild to moderate fluorosis has become more prevalent. Revised recommended doses have been introduced to balance the benefits of fluoride use with the risk of fluorosis:

- The recommended concentration of fluoride in public water supplies is now 0.7 ppm fluoride.
- Fluoride supplements are recommended by the American Academy of Pediatric Dentistry (AAPD), the ADA and the American Academy of Pediatrics only for at-risk children. If thus indicated, fluoride supplements should commence only at 6 months or 3 years of age, depending on the water fluoride concentration. Their use is not indicated if the water fluoride level is >0.6 ppm.

**Identifying At-risk Patients**

The strongest predictor of future caries is past caries experience. Disease indicators include white spots (associated with caries) on smooth surface enamel, recent restorations (within the last 3 years) as a result of dental caries, enamel lesions mesially and distally (Figure 4) and cavitated caries lesions (radiographically evident). Dental caries will progress if the influence of pathologic factors is
greater over time than that of protective factors. Risk factors relate to the level of cariogenic bacteria, the ability to inhibit demineralization and to promote remineralization, lifestyle/habits, systemic factors and local environmental factors (Table 3). Severe early childhood caries (Figure 5) is now thought to be a distinct entity presenting with an early, less diverse bacterial colonization and with enamel hypoplasia (due to prenatal colonization) that provides surface defects for colonization.  

Protective factors include saliva, exposure to fluoride and

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<th>TABLE 3. Destructive/pathologic risk factors.</th>
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<tr>
<td>Factor</td>
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<tr>
<td>Poor oral hygiene</td>
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<td>High level and frequency of fermentable carbohydrates</td>
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<tr>
<td>Familial high caries rate</td>
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<tr>
<td>Xerostomia</td>
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<td>Suboptimal fluoride exposure</td>
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<tr>
<td>Enamel defects</td>
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<tr>
<td>Defective restorations</td>
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<tr>
<td>Exposed roots</td>
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<tr>
<td>Orthodontic appliances</td>
</tr>
<tr>
<td>Tobacco use/drug or alcohol use</td>
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<tr>
<td>Low SES</td>
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<td>Genetics</td>
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<table>
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<th>TABLE 4. Protective factors</th>
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<tr>
<td>Factor</td>
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<tr>
<td>Saliva</td>
</tr>
<tr>
<td>Fluoride exposure</td>
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<tr>
<td>Use of xylitol</td>
</tr>
<tr>
<td>Antimicrobial agents (incl. xylitol)</td>
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<tr>
<td>Sealants</td>
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<td>Healthy lifestyles</td>
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other anti-caries agents, and a favorable lifestyle (Table 4).

Saliva washes fermentable carbohydrates from the teeth and oral cavity, and buffers the pH, thereby neutralizing bacterial acid. In addition, saliva contains statherin, lactoferrin, immunoglobulins and other agents that are protective. Ductal saliva carries small quantities of fluoride and calcium, while whole intra-oral saliva acts as a substantial fluoride reservoir. This fluoride is then available for incorporation into dental plaque.

In order to recognize and appropriately treat patients, a caries risk assessment should be performed. Numerous standardized caries risk assessment tools are available, including the following: (1) CAMBRA (CAries Management By Risk Assessment), which includes a form to determine the risk level along with recommendations based on an individual’s risk level and age; (2) Cariogram, a downloadable program; (3) ADA forms for 0 to 6 years of age and for ages 6 and over; and (4) AAPD forms.

Risk assessment forms include a list of specific destructive and protective factors from which the clinician selects the status for an individual patient, and also address caries experience. Depending on the tool, a numeric score may be generated based on the individual’s risk factors. Since a patient’s risk level is not static, a risk assessment must be repeated at regular intervals. The AAPD recommends that the first risk assessment be performed by 6 months of age.

Several categories of patients are by definition at-risk patients, including orthodontic and xerostomic patients. These two examples are discussed below.

**Young children**

Young children under age 6 who are at risk can develop early childhood caries (at least one lesion present under age 6) or severe early childhood caries that is rampant and destructive.

**Topical fluoride therapy for young children under age 6**

Recommendations for at-risk patients under age 6 are as follows:
- Age-appropriate OTC fluoride dentifrice use
- Topical fluoride rinses and 5,000 ppm fluoride pastes/gels are not recommended due to the risk of swallowing and fluorosis.

**Orthodontic patients**

Greater bacterial colonization occurs on orthodontic appliances and teeth with brackets and ligatures/bands compared to other teeth. Fixed orthodontic appliances (FOAs) make oral hygiene more complex. Orthodontic decalcifications ('white spots') occur with frequency adjacent to brackets and may present within 1 month of the onset of treatment. It was previously estimated that up to 50% of patients could develop white spots in the absence of a preventive program. In a more recent study using quantitative light-induced fluorescence 97% of subjects had lesions and an average of 30% of buccal surfaces were affected by caries.

In a 2012 survey, 69% of general dentists had treated orthodontic white spots, and 37% of orthodontists had removed FOA due to poor patient compliance with oral hygiene (Figure 6). The researchers recommended fluoride therapy, and low-concentration topical fluorides post-treatment.

**Topical fluoride therapy for orthodontic patients**

Options for at-risk patients (includes orthodontic patients), are as follows for age 6 and over:
- Professionally applied topical fluoride:
  - 5% sodium fluoride varnish or 1.23% 4-minute APF gel at least every 3 to 6 months
- Home-use topical fluoride:
  - Twice-daily use of 5,000 ppm fluoride paste/gel or at least weekly use of 0.2% fluoride rinse instead of professionally applied topical fluoride
  - Twice-daily OTC dentifrice use and daily use of 0.05% sodium fluoride rinse, which inhibits enamel lesions adjacent to FOA

**Xerostomic patients**

Xerostomic patients are considered high-risk (extreme high
risk). Etiologies include prescription drug use and autoimmune diseases as well as head and neck radiation. The importance of xerostomia in the progression of dental caries can easily be understood considering the functions of saliva.55

Patients with xerostomia experience a longer dip in pH than other patients, with the pH remaining below the critical level for demineralization for extended periods of time. Greater accumulation of biofilm and bacteria occurs, calcium and phosphate that help prevent demineralization are absent or reduced, buffering capacity is lost and other protective factors are either reduced or absent.

**Topical fluoride therapy for patients with xerostomia**

For age 6 and over:
- In-office 5% sodium fluoride varnish or 4-minute gel at least every 3 to 6 months
- Home-use topical fluoride:
  - 5,000 ppm fluoride paste/gel once- or twice-daily (if once daily, fluoride dentifrice should be used the second time daily) and use of a 0.05% sodium fluoride rinse when the mouth feels dry or after eating/drinking.53

Twice-daily use of 5,000 ppm paste/gel, or at least weekly use of 0.2% sodium fluoride rinse, may be used as an alternative to professionally applied topical fluoride. Under age-6 should receive 5% sodium fluoride varnish treatments. In-office topical gels, 5,000 ppm fluoride pastes/gels and fluoride rinses are not recommended for children under age 6 years.

**Summary**

Fluorides are the first line of defense in the chemotherapeutic control of dental caries. The efficacy and safety of, in particular, professional and home-use topical fluorides is well-established based on the evidence. Fluoride use for an individual patient should be evidence-based and must consider his/her level of risk, as determined by disease indicators and risk factors, and the age of the patient. Other factors to consider include patient compliance, convenience and ease of use.

**References**


CE Quiz

1. Current concepts on dental caries and recommendations for the use of fluoride are based on __________.
   a. learned opinions
   b. a substantial body of research and evidence
   c. the FDA
   d. none of the above

2. Bacteria that colonize the tooth surface produce extracellular polysaccharides that __________.
   a. produce acid
   b. aid bacterial migration
   c. aid bacterial adhesion
   d. a and b

3. During the caries process, subsurface dissolution begins at a pH of __________.
   a. 2.5 – 3.5
   b. 2.8 – 3.8
   c. 3.5 – 4.5
   d. 3.8 – 4.8

4. As enamel caries progresses, white spots may be visible as the __________ loses minerals.
   a. surface
   b. underlying subsurface
   c. cementum
   d. dentin

5. In one meta-analysis of blind and double-blind clinical trials, a __________ caries reduction in the primary dentition and a __________ caries reduction in the permanent dentition was found.
   a. 23%; 36%
   b. 25%; 33%
   c. 33%; 46%
   d. 38%; 42%

6. During tooth development, fluoride is incorporated into the hydroxyapatite crystals prior to __________.
   a. pre-eruptive enamel maturation
   b. post-eruptive enamel maturation
   c. surface solidification
   d. all of the above

7. Topical fluoride use results in bioavailable fluoride reservoirs intra-orally that consist of __________.
   a. calcium fluoride-like globules deposited at the tooth surface and in plaque
   b. free fluoride ions in plaque, saliva and oral mucosa
   c. apatitically bound fluoride
   d. a and b

8. Contemporary research has shown that the main effect of fluoride is __________.
   a. systemic
   b. topical
   c. negligible
   d. all of the above

9. When an acid attack occurs, calcium fluoride-like globules release __________ ions.
   a. calcium
   b. phosphate
   c. fluoride
   d. all of the above

10. Fluoride incorporated into hydroxyapatite crystals is also known as __________.
    a. firmly bound
    b. apatitically bound
    c. reserve
    d. a and b

11. Fluoride __________.
    a. can concentrate within light plaque
    b. is deflected by plaque
    c. must be used before brushing
    d. cannot penetrate through light plaque

12. Five percent sodium fluoride varnish has been investigated for the prevention of __________.
    a. coronal caries
    b. root caries
    c. secondary/recurrent caries
    d. all of the above

13. Dentin __________.
    a. is less dense than enamel
    b. contains dentin fibrils that degrade enzymatically
    c. is more rapidly demineralized than enamel
    d. all of the above

14. Fluoride varnish is available as __________.
    a. 0.3% fluoroxane
    b. 0.9% difluorosilane
    c. 5% sodium fluoride
    d. b and c

15. Compared to gels, foams __________.
    a. use less product
    b. offer a more pleasant patient experience
    c. use less total fluoride
    d. all of the above
16. A caries reduction (DMFS) of ________ was found in a meta-analysis of trials where APF gel was used.
   a. 18%
   b. 28%
   c. 38%
   d. 48%

17. Low pH fluoride formulations were developed with the objective of ________.
   a. increasing application time
   b. increasing fluoride uptake
   c. increasing fluoride concentration in the product
   d. all of the above

18. For low risk patients, ________.
   a. a fluoride dentifrice may offer sufficient protection
   b. clinical judgment should be used to determine whether an in-office topical fluoride is necessary
   c. supplemental fluoride is required
   d. a and b

19. Clinical trials have been published using ________ over-the-counter rinses.
   a. 0.2% sodium fluoride and 0.05% sodium fluoride
   b. 0.2% sodium fluoride and 0.044% APF
   c. 0.05% sodium fluoride and 0.044% APF
   d. 0.05% sodium fluoride and 0.01% APF

20. Fluoride rinses ________.
   a. are recommended for all age groups
   b. are not recommended for the under-6 age group
   c. should only be used in low-risk patients
   d. none of the above

21. ________ acts as a substantial fluoride reservoir.
   a. Ductal saliva
   b. Whole intra-oral saliva
   c. Gingival crevicular fluid
   d. all of the above

22. Fluorosis results from the ingestion of excessive cumulative amounts of fluoride ________.
   a. during tooth development prior to the pre-eruptive enamel maturation phase
   b. from supplemental fluorides only
   c. during office visits
   d. all of the above

23. The risk of fluorosis is mainly of concern up to age ________ and after age ________ is of no concern.
   a. four; six
   b. five; seven
   c. six; eight
   d. seven; nine

24. 1.1% sodium fluoride (5,000 ppm) pastes and gels confer additional protection compared to lower level fluoride products due to ________.
   a. their uptake mechanism
   b. a dose response effect
   c. their viscosity
   d. all of the above

25. The recommended concentration of fluoride in public water supplies is now ________.
   a. 0.7 ppm
   b. 0.9 ppm
   c. 1 ppm
   d. 1.2 ppm

26. Caries risk factors relate to ________.
   a. the level of cariogenic bacteria
   b. the ability to inhibit demineralization and to promote remineralization
   c. systemic, local and environmental factors
   d. all of the above

27. Fixed orthodontic appliances make oral hygiene more complex, and orthodontic decalcifications may present within ________ of the onset of treatment.
   a. one day
   b. one week
   c. one month
   d. none of the above

28. Recommendations for at-risk patients age 6 and over include ________.
   a. application of 5% sodium fluoride varnish or a 4-minute 1.23% APF gel at least every 3 to 6 months
   b. twice-daily OTC dentifrice use and daily use of 0.05% sodium fluoride rinse for patients with no cavitated lesions
   c. 1.1% sodium fluoride paste/gel use for patients with cavitated lesions
   d. all of the above

29. Patients with xerostomia ________.
   a. are at high risk for caries
   b. experience a longer period of time during which demineralization can occur following an acid attack
   c. do not have, or have reduced, buffering capacity and protective factors
   d. all of the above

30. Fluoride use for an individual patient ________.
   a. should be evidence-based
   b. must consider his/her caries risk level
   c. must consider the age of the patient
   d. all of the above
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EDUCATIONAL OBJECTIVES
• Describe the caries process;
• Review the mechanisms of action of fluoride for caries prevention;
• List and describe the types of topical fluorides that are available and their clinical efficacy;
• Review systemic fluorides, fluorosis and updated dosing recommendations, and
• Describe factors responsible for orthodontic and xerostomic patients being at-risk for caries and review preventive treatment options.

COURSE SUBMISSION:
1. Read the entire course.
2. Complete this entire answer sheet in either pen or pencil.
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