The Role of Fluoride in Caries Control

A Peer-Reviewed Publication
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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. List and describe the prevalence and incidence of coronal and root caries in different segments of the population.
2. List the primary and contributory risk factors for caries.
3. List and describe available risk assessment tools and what they assess.
4. List and describe the role of fluoride in caries prevention and the available options for different age groups.

Abstract
Caries remains an endemic problem worldwide. A number of primary and contributory factors determine whether or not caries develops as well as a patient’s risk, while risk modifiers mitigate caries risk. Fluoride has played a central role for several decades in caries prevention, with in-office and home-care options available. Performing an individual risk assessment enables the dental professional to determine the level and type of preventive care appropriate for a particular patient.

Introduction
Worldwide, dental caries is an endemic infection and a major public health problem. While caries rates decreased during the 20th century in the United States, they were relatively unchanged during the periods 1988-1994 and 1999-2002 based on NHANES surveys. In children 2-11 years of age, NHANES found that 41% have caries of the primary dentition and 21% present with untreated caries. Minor decreases were observed in caries prevalence in permanent teeth in people up to age 19, with 42% experiencing caries (Figure 1). Among adults aged 20 and older, the NHANES 1999-2002 survey found that 91.3% had coronal caries experience (reduced from 94.6% in the 1988-1994 survey). Root caries experience is found in 18% of people aged 20 and over. The prevalence of root caries increases with age and reaches approximately 32% in those aged 60 and older. As more people are retaining their teeth (and more teeth) into old age, root caries is of increasing concern (Figure 2).

While some modest decreases in dental caries have occurred in the general population, among specific subgroups of the population the caries rate remains higher. It has been estimated that the majority of certain infant populations – including those from families with low socioeconomic status (SES), children who attend Head Start, and infants from immigrant families and ethnic minorities – experience early childhood caries (ECC). Common primary risk factors include the presence of cariogenic bacteria that produce the acid responsible for demineralization. Streptococcus mutans and lactobacilli are implicated in caries, while other low-pH bacteria have also been identified in plaque adjacent to early carious lesions and have been implicated in the caries process. ECC has been found to be significantly correlated with the level of Strep. mutans in young children and mothers (caregivers), with 26 months being the median age of bacterial acquisition during what has been described as a discrete window of infectivity. In children with ECC, the relative levels and interaction of Strep. mutans and Strep. sanguinis have also been found to play a role in the level of caries, with the total amount of Strep. mutans and total Strep. level (including non-mutans Streptococci) corresponding to the severity of ECC and the overall level of cariogenic bacteria in the dental biofilm (plaque).

Sugar consumption is a known risk factor. The consumption of fermentable carbohydrates in foods, snacks and drinks...
- both total amount and frequency of consumption – influences the ability of bacteria to produce acid, since this relies on the bacteria metabolizing the carbohydrates. This is exemplified by one counseling technique that uses a sugar clock to help educate children on their sugar consumption.19 Soda pop consumption can result in rampant caries and erosion. Even if soda pop contains no fermentable carbohydrates (i.e., “diet” soda pop) it is still highly acidic, leading to erosion that subsequently places the enamel at increased risk for further demineralization by acid from cariogenic bacteria. In recent years, soda pop consumption has increased among teenagers and young adults.15 Consumption of energy drinks containing high levels of sugar and caffeine, in addition to the consumption of soda pop, has increased, and their consumption has expanded to include younger and older age groups. Another source that increases subsequent susceptibility to demineralization by acidogenic bacteria is gastric acid, which is prevalent in bulimic patients, during pregnancy, and as a result of gastro-esophageal reflux disease (GERD).16, 17

Xerostomia (dry mouth) is a major factor in caries risk. An absent or reduced salivary flow results in loss of buffering capacity and loss of salivary calcium, phosphate, fluoride and other protective elements.18 The impact of xerostomia can readily be seen in patients following use of xerostomia-inducing medications, in patients with autoimmune disease (Sjögren’s syndrome) and in head and neck radiation patients. There are currently more than 42 drug categories comprising more than 400 drugs that have xerostomia as a side effect, including cardiovascular drugs, antihistamines, antidepressants, diuretics and sedatives. As a result, xerostomia is a major contributing risk factor, particularly in the older adult.19

Figure 3. Recurring and root caries

Contributory risk factors include the inability and/or unwillingness of a patient to perform home care, the presence of restorations that require special care and orthodontic treatment. Home care should include the removal of biofilm as well as use of fluoride dentifrice, and potentially other measures depending on risk. Young children require help and supervision, teenagers are known to be at risk due to (higher) noncompliance and older adults may be unable to perform good home care due to physical handicaps or geriatric mental disorder.

Fixed multiunit restorations require additional care to remove biofilm and prevent secondary caries, and removable dentures and appliances provide a surface for dental biofilm to adhere to, requiring care to remove bacteria present on their surfaces. Patients undergoing orthodontic treatment with fixed orthodontic appliances are at extra risk for white spots and subsequent development of frank caries. In addition, the majority of orthodontic treatment continues to be provided to teenagers, who are relatively less compliant and more apt to be involved in destructive habits such as heavy soda pop consumption, which further increases caries risk. It also has been concluded recently that caries progression and severity are genetically influenced in individual hosts.21 Tobacco use is a known risk factor, with an individual smoker’s risk having been shown to vary with the number of cigarettes smoked, an association recognized in the 1950s.22 Drug abuse can also result in rampant caries.23

Periodontal disease and therapy, as well as gingival recession, place patients at increased risk for caries due to exposure of root dentin surfaces. In examining root caries in periodontal maintenance patients, one study found that 82% of the 45 patients had root caries or restorations, with an average of 4.3 lesions (and up to 19 in the most severe case). It was concluded that root caries should be viewed as a complication in periodontal maintenance patients.24

**Caries Progression and Risk Modifiers**

Risk modifiers work by impacting factors that promote the caries process, mitigating or negating their effects. During demineralization, the pH drops to below 5.5, and under these acidic conditions, minerals – primarily calcium and phosphate – are lost from the tooth. As the pH reverses and starts to increase, mineral migration reverses, resulting in remineralization, with uptake of calcium and phosphate present at the tooth surface and in saliva into the apatite crystals and interprismatic fluid. Fluoride present will also enter the tooth to aid remineralization, resulting in the formation of a stronger fluorapatite crystal than the original hydroxyapatite.

Risk modifiers would include interventions that reduce demineralization, enhance remineralization or increase the pH; chemotherapeutics that reduce the bacterial load or prevent the adsorption of oral bacteria and biofilm to the teeth; or modifiers that otherwise reduce the chance of caries progressing. It is worth noting that although dental biofilm harbors cariogenic bacteria, it also retains and contains protective factors, including calcium, phosphate and fluoride of salivary and nonsalivary origin.25

Fluoride is a widely used risk modifier and preventive measure. Fluoride has played an important role in the prevention of dental caries since the introduction of water fluoridation in the 1940s, and is considered to have contributed more to the re-
duction in dental caries seen across the general population than any other single measure.\textsuperscript{26,27,28} Recently, topical agents have also been introduced that increase the amount of bioavailable calcium and phosphate, together with fluoride.\textsuperscript{29,30} Antimicrobials and xylitol are being used to reduce acidogenic bacterial loads,\textsuperscript{31,32} and other modifiers continue to be investigated.

Risk assessment helps the clinician determine the chance of a particular patient developing carious lesions and thereby the level and type of intervention required. Risk assessment considers current risk factors as well as current risk modifiers.

**Risk Assessment**

In order to determine appropriate preventive care, a risk assessment is required. Several methods of performing risk assessments exist, ranging from individualized methods to standardized techniques. Standard risk-assessment protocols include the use of Cariogram, Caries Management By Risk Assessment (CAMBRA) and the Caries-risk Assessment Tool (CAT).

**Cariogram**

Cariogram, developed by researchers in Sweden, is a software program that provides a methodology for risk assessment; the biological risk factors present; and a weighted average of risk, in graphic form, using a pie chart. The “chance of avoiding cavities” is used to determine which patients are at low, moderate or high risk for caries.\textsuperscript{33} This program has been shown to be effective in the management of caries in older adults\textsuperscript{34} and children,\textsuperscript{35} and supports SES as a predictive factor.\textsuperscript{36}

The output provides the relative risk for the different biological factors, enabling the clinician to develop a strategy focused specifically on those factors responsible for increased risk in high-risk patients.\textsuperscript{37} The output also suggests possible preventive protocols for the clinician to select from.\textsuperscript{38} Cariogram is available as a free download from the Web.

**CAT**

The American Academy of Pediatric Dentistry (AAPD) recommends use of CAT by six months of age to determine the patient’s relative risk.\textsuperscript{39} CAT is intended for use with infants, young children and adolescents, and it is the intent of the AAPD to review this periodically and reevaluate criteria as indicated. Based on CAT, the AAPD considers low-risk patients to include those with no carious lesions in the previous two years, no enamel demineralization, and no visible plaque or
gingivitis. In addition, the patient must have optimal fluoride exposure and receive regular dental care, have a caregiver with a high SES and have no underlying medical conditions that would predispose the patient to caries. All other patients are categorized as either moderate or high risk.

CAMBRA

CAMBRA involves assessing the risk and then managing the patient’s care to help reduce the risk. CAMBRA is used in the United States for children and adults both in private practice and in public health programs, and assesses the patient’s unique risk for caries by utilizing 25 data points. The principle objectives are to determine, manage and reduce risk; to educate and manage patients; to provide chemotherapeutic intervention to remineralize noncavitated lesions; to help prevent demineralization; and to intervene minimally to restore cavitated lesions.

Other risk assessment tools are also available, such as the CariFree risk assessment form. One prospective study assessed actual caries experience in the three years following risk assessment and then compared the predicted versus actual levels of caries activity. The study found widely varying assessments of risk depending on whether Cariogram, CAMBRA or CAT was used. CAMBRA defined 29% of patients as moderate or high risk, while CAT defined 95% as high risk. This particular study found Cariogram potentially more useful than the other risk assessment methodologies.

Irrespective of the risk assessment tool used, it is important to remember that a patient who was previously at low risk may be at higher risk for caries due to factorial changes – for instance, onset of use of medications that result in dry mouth. It is also acknowledged that risk assessment may not identify all patients at risk. One of the risk assessment factors considered is caries experience within the previous two or three years. In examining prevalence and factors for root caries in periodontal maintenance patients, one study found a relationship between coronal caries experience and root caries.

The Role of Fluoride in Caries Intervention

Fluoride reduces caries by helping to prevent demineralization and by remineralizing early carious lesions. Caries is a dynamic process that can be characterized by mineral transfer, from the tooth to the surrounding environment (demineralization) and vice versa (remineralization). The key is to reduce mineral transfer out of the tooth during acid attacks, and to promote transfer into the tooth following acid attacks. This can be achieved by ensuring the availability of fluoride, calcium and phosphate adjacent to the tooth during the acid attack and by altering the concentration gradient of these minerals. When topical fluoride is applied to the teeth, calcium fluoride-like globules are formed on the tooth surface, as has been observed with scanning electron microscopy. These globules are effective mineral reservoirs that help prevent demineralization and promote remineralization by releasing calcium, phosphate and fluoride following acid attacks. It has been found that both a higher concentration of topical fluoride applied and a more prolonged application independently increase the amount of fluoride released from the agent as well as the deposition and availability of these protective globules. If a higher level of these minerals can be maintained at the tooth surface prior to and during an acid attack, the resulting increased concentration helps prevent migration of calcium and phosphate from the tooth and also reduces the potential for demineralization. Increasing the levels of available calcium and phosphate has also been found to increase available fluoride.

Figure 6. Demineralization and remineralization

Risk Level and Intervention

The appropriate level of intervention depends on the patient’s risk level. Fluoride can be provided in water, salt, over-the-counter products, professional prescriptions and in-office treatments. Optimizing the daily level of fluoride exposure in the general population is recognized as helpful, safe and cost-effective. While water fluoridation has an effect on fluoride content of enamel when provided during tooth development, most of the effect of fluoride has been found to be topical rather than due to fluoride incorporation during tooth development. Evidence-based results in recent years indicate the effectiveness of self-applied and professionally applied fluorides as well as water fluoridation in reducing caries in adults. For low-risk patients, regular twice-daily use of fluoride dentifrice may suffice to help prevent caries. For moderate and higher-risk patients, intervention and a tailored program are required; the program should include the use of in-office topical fluoride as well as home care. In the case of elderly patients who are at high risk for caries, it has been recommended that intervention should focus on antibacterial therapy, high-fluoride therapy, patient education and shorter recall intervals.

In-office treatments

The American Dental Association recently published evidence-based recommendations from the ADA Council on Scientific Affairs on caries risk and the use of professionally applied topical fluorides, derived from a thorough examination of systematic reviews and clinical studies. One conclusion was that low-risk patients may not benefit from topical fluoride applications. For moderate- and high-risk patients, it was determined that topi-
Table 1. ADA Recommendations for topical fluoride application

<table>
<thead>
<tr>
<th></th>
<th>Under age 6</th>
<th>Age 6 to 17</th>
<th>18 years and older</th>
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<tbody>
<tr>
<td><strong>High-risk patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>Fluoride varnish</td>
<td>Fluoride varnish or gel</td>
<td>Fluoride varnish or gel</td>
</tr>
<tr>
<td>Frequency</td>
<td>2-4 times per year</td>
<td>2 times per year</td>
<td>2-4 times per year</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4 times per year may give extra benefit</td>
</tr>
<tr>
<td><strong>Moderate-risk patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>Fluoride varnish</td>
<td>Fluoride varnish or gel</td>
<td>Fluoride varnish or gel</td>
</tr>
<tr>
<td>Frequency</td>
<td>2 times per year</td>
<td>2 times per year</td>
<td>2 times per year</td>
</tr>
<tr>
<td><strong>Low-risk patients</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluoride toothpastes and fluoridated water may be sufficient; potentially no additional benefit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision on applying topical fluorides should consider this, professional judgment, patient preferences</td>
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</table>

Topical fluoride applications are beneficial. Fluoride gel was found to be effective in school-age children and to have clinical data for four-minute applications and laboratory data for one-minute applications; fluoride foam (four-minute) was found to be effective for the primary dentition and newly erupted first permanent molars; and fluoride varnish was found to be effective in preventing caries in children, adolescents and high-risk populations, and to take less time and increase patient comfort compared to use of fluoride gel.\(^{17,57}\) In meta-analyses of 1.23% APF gels and, separately, 5% sodium fluoride varnish using the Cochrane Database, Marinho et al. found gel inferior to varnish in the under-17 age group (a pooled 28% versus 46% reduction in DMFS).\(^{58,59}\) The ADA recommendations can be found in Table 1.

Table 2. Risk and fluoride treatment options

<table>
<thead>
<tr>
<th></th>
<th>In-office topical</th>
<th>Home use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High- and moderate-risk patients</strong></td>
<td>Yes</td>
<td>Yes; fluoride dentifrice plus other option</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Options include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1% sodium fluoride (5000 ppm fluoride)</td>
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<tr>
<td></td>
<td></td>
<td>0.2% sodium fluoride rinse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.044% APF rinse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4% stannous fluoride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.05% sodium fluoride rinse</td>
</tr>
<tr>
<td><strong>Low-risk patients</strong></td>
<td>No/Yes</td>
<td>Yes; dentifrice</td>
</tr>
</tbody>
</table>

It should be noted that while there is substantial data supporting the use of 5% sodium fluoride varnish for caries prevention and that this varnish is endorsed by the American Dental Association and represented in the CDT (D1206)\(^{60}\), at the current time fluoride varnishes do not have FDA approval as caries preventives.

**Home-use treatments**

Depending on caries risk, fluoride mouthrinses and/or high-level prescription home fluoride dentifrices/gels may be advisable. Home-use prescription dentifrices and gels that contain 1.1% (5,000 ppm) sodium fluoride offer greater protection compared to use of regular fluoride dentifrices. 5000 ppm fluoride has been found to be effective in helping to prevent demineralization. In one study on patients with root caries, 5000 ppm fluoride dentifrice remineralized root caries lesions by approximately 57% over six months,\(^{61}\) while an earlier study found that 91% of root caries lesions were arrested with use of 1.1% sodium fluoride for 12 months.\(^{62}\) Dentifrice and gel with 1.1% sodium fluoride have been used in adults with xerostomia, and their use in a regimen including chlorhexidine gluconate rinsing has been recommended for patients who have received head and neck radiation.\(^{63}\) Acidulated phosphate fluoride mouthrinse (0.044%) has been found to be effective in helping prevent the development of white spots and decalcification in patients receiving orthodontic treatment, reducing their occurrence by up to 58%.\(^{64}\) Given that approximately 50% of orthodontic patients experience white spots, preventive care is important during orthodontic therapy.\(^{65}\) Acidulated phosphate fluoride dentifrice containing 5000 ppm fluoride is also available. Regular use of lower-level fluoride mouthrinses in young children, adolescents and adults has also been found to be effective in helping to prevent caries. 900 ppm fluoride mouthrinse was found in one study to result in a caries reduction of up to 55% in schoolchildren with weekly rinsing over 30 months of use.\(^{66}\)

In determining which fluoride agent to use, the type of fluoride is an important consideration alongside efficacy. Neutral sodium fluoride does not etch ceramics or sealants, is nonstaining and is safe for ceramic restorations. It is available in mouthrinses, gels, foams, varnishes, high-fluoride-level prescription dentifrices and gels. An acidic topical fluoride, acidulated phosphate fluoride (APF), has been used as a 1.23% APF in-office gel and foam. APF for home use has been formulated for orthodontic patients in both a mouthrinse and as a 5000 ppm dentifrice for home use. Acidulated formulations are capable of etching ceramics, so patient selection should take this into consideration. In addition, acidic rinses and gels would be relatively contraindicated in patients suffering from erosion. Stannous fluoride is also available for home use, as a gel and rinse, and in-office as a rinse and combination topical. Stannous fluoride use over
time can result in staining of the teeth and aesthetic restorations, a consideration in its selection. Some patients also find the taste unacceptable.

Table 3. Types of fluoride

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>pH</th>
</tr>
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<tbody>
<tr>
<td><strong>In-office topical fluoride</strong></td>
<td></td>
</tr>
<tr>
<td>2% sodium fluoride Gel, foam</td>
<td>Neutral; non-etching</td>
</tr>
<tr>
<td>5% sodium fluoride varnish Varnish</td>
<td>Neutral; non-etching</td>
</tr>
<tr>
<td>1.23% acidulated phosphate fluoride (APF)</td>
<td>Acidic; potential for etching</td>
</tr>
<tr>
<td>0.63% stannous fluoride Rinse</td>
<td>Slightly acidic</td>
</tr>
<tr>
<td>Combination rinses Rinse</td>
<td>Acidic; potential for etching</td>
</tr>
<tr>
<td><strong>Home-use topical fluoride</strong></td>
<td></td>
</tr>
<tr>
<td>1000 - 1100 ppm Dentifrice</td>
<td>Neutral</td>
</tr>
<tr>
<td>5000 ppm prescription strength</td>
<td></td>
</tr>
<tr>
<td>Sodium fluoride</td>
<td>Neutral</td>
</tr>
<tr>
<td>APF</td>
<td>Acidic</td>
</tr>
<tr>
<td>900 ppm fluoride</td>
<td>Rinse</td>
</tr>
<tr>
<td>250 ppm fluoride</td>
<td>Rinse</td>
</tr>
<tr>
<td>250 ppm fluoride</td>
<td>Rinse</td>
</tr>
</tbody>
</table>

In patients suffering from root sensitivity and post-periodontal surgery, both neutral sodium fluoride and stannous fluoride have been shown to relieve sensitivity as well as to provide fluoride at the tooth surface to aid hard-tissue preservation.

Consideration of the type and combinations of fluoride to be provided and recommended to a patient requires an assessment of the patient’s risk level, condition and required prevention. The cases presented below illustrate patients with different conditions and levels of risk and potential fluoride intervention therapies.

**Case presentations**

**Case 1.**

History and presentation: This 45-year-old patient presented for examination. On examination, a number of carious lesions were found cervically and interstitially. The patient had been examined eighteen months earlier, and had no active carious lesions or restorative work in the previous three years of attending the same office. As a result, the patient had previously been categorized as low risk. On questioning, it was discovered that the patient was taking antidepressants and suffering from dry mouth. To relieve the dry mouth, she had been sucking sour candies and sipping on sodas during the day.

Treatment: Cavitated lesions were treated using bonded composite resins after caries removal. Dietary advice and counseling were provided and preventive care instituted to help remineralize early lesions and to help prevent new lesions from developing. This included in-office topical application of neutral sodium fluoride, twice-daily use of 5000 ppm fluoride dentifrice, twice-daily chlorhexidine rinsing (30 minutes apart from use of fluoride), brushing with an ultra-soft toothbrush and flossing. Since the patient was now at high-risk for caries due to xerostomia and related dietary changes, she was advised to return in three months.

**Case 2.**

History and presentation: This child presented with his mother at the pediatric dental office to which they were referred by the pediatrician. Upon examination, it was found that the patient, 2 years of age, was suffering from early childhood caries with several lesions present. The mother confirmed that her child slept with a bottle filled with juice, and also confirmed that both she and the infant’s siblings had a lot of dental decay and fillings. Frank carious lesions were treated. Given the age of the patient, 5% sodium fluoride varnish was provided as an in-office topical fluoride, and the mother was provided with dietary advice and counseling and instructed on how to care for her child’s teeth using an ultra-soft toothbrush and fluoride dentifrice. She was advised to bring her son back in three months for reevaluation and fluoride treatment.
certain segments of the population. Nonetheless, caries remains a common disease, with disadvantaged segments of the population disproportionately suffering caries. Risk assessments can be performed for individual patients using one of several available tools or a self-developed form in-office. With a completed risk assessment, the need for preventive care can be assessed. Since the advent of the fluoridation of water, fluoride has remained the therapeutic mainstay in the prevention of carious lesions and their early remineralization. In addition to fluoride, other available agents that assist with prevention include antimicrobial agents such as chlorhexidine gluconate and xylitol, and calcium- and phosphate-containing agents. The risk assessment helps the clinician decide whether preventive care is required beyond use of fluoride dentifrice, and if so, whether in-office and/or higherrlevel fluoride or other preventive therapy is required.

References
1 Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/ ss5403a1.htm#top. Accessed October 16, 2008.
19 Ibid.
1. Among adults aged 20 and older, the NHANES 1999–2002 survey found that ________ had coronal caries experience.
   a. 81.3%
   b. 87.3%
   c. 91.3%
   d. 95.3%

2. It has been estimated that the _______ infant population(s) experience(s) early childhood caries.
   a. majority of
   b. majority of certain
   c. whole
   d. none of the above

3. A sugar clock can be used to
   a. check sugar levels in the blood
   b. check whether it is time to give a child a sugary snack
   c. help educate children on their sugar consumption
   d. all of the above

4. Diet soda pop ________.
   a. contains no acid
   b. contains no fermentable carbohydrates
   c. is safe for teeth
   d. b and c

5. Xerostomia (dry mouth) results in
   a. loss of buffering capacity
   b. loss of salivary calcium, phosphate and fluoride
   c. loss of other protective elements
   d. all of the above

6. There are currently more than 42 drug categories with ________ as a side effect.
   a. dysesthesia
   b. bulimia
   c. xerostomia
   d. b and c

7. Patients at risk for caries include those
   a. undergoing periodontal therapy
   b. undergoing orthodontic treatment
   c. with erosive lesions
   d. all of the above

8. Risk modifiers work by impacting factors that promote the caries process, ________ their effects.
   a. mitigating
   b. negating
   c. absolving
   d. a or b

9. Risk modifiers include ________.
   a. interventions that reduce demineralization and enhance remineralization
   b. chemotherapeutics that reduce bacterial loads
   c. chemotherapeutics that increase bacterial loads
   d. a and b

10. ________ is considered to have contributed more to the reduction in dental caries seen across the general population than any other single measure.
    a. Calcium
    b. Fluoride
    c. Hydroxyapatite cream
    d. none of the above

11. ________ being used as risk modifiers.
    a. Antimicrobials are
    b. Xylitol is
    c. Calcium and phosphate are
    d. all of the above

12. Risk assessment ________.
    a. helps the clinician determine the chance of a particular patient developing carious lesions
    b. considers current risk factors and modifiers
    c. helps the clinician determine the appropriate intervention
    d. all of the above

13. Standard caries risk-assessment protocols include ________.
    a. Cariogram
    b. CAMBRÁ
    c. CARA
    d. a and b

14. When topically fluoride is applied to the teeth, ________ are formed on the tooth surface as has been observed with scanning electron microscopy.
    a. sodium fluoride-like globules
    b. calcium fluoride-like globules
    c. calcium iodide-like globules
    d. none of the above

15. The amount of fluoride released from an agent is influenced by ________.
    a. concentration
    b. length of application
    c. color
    d. a and b

16. Evidence-based results in recent years indicate the effectiveness of ________ in reducing caries in adults.
    a. self-applied fluorides
    b. professionally applied fluorides
    c. water fluoridation
    d. all of the above

17. Regular ________ use of fluoride dentifrice may suffice to help prevent caries in a low-risk patient.
    a. once-daily
    b. twice-daily
    c. nightly
    d. none of the above

18. It has been recommended that intervention for elderly patients who are at high risk for caries should focus on ________.
    a. patient education and shorter recall intervals
    b. antibacterial therapy
    c. high-level fluoride therapy
    d. all of the above

19. The ADA Council on Scientific Affairs recently concluded in a report that low-risk patients ________ benefit from topical fluoride applications.
    a. may not
    b. never
    c. always
    d. none of the above

20. The ADA Council on Scientific Affairs has recommended the use of professionally applied fluoride gel for children ________.
    a. under age 6
    b. under age 3
    c. age 6 and over
    d. none of the above

21. In one study on patients with root caries, 5,000 ppm fluoride dentifrice remineralized root caries lesions by approximately ________ over six months.
    a. 37%
    b. 47%
    c. 57%
    d. 67%

22. For patients who have received head and neck radiation, ________ sodium fluoride has been used in a regimen including chlorhexidine gluconate rinsing.
    a. 500 ppm
    b. 250 ppm
    c. 5,000 ppm
    d. none of the above

23. Acidulated phosphate fluoride mouthrinse (0.044%) has been found to be effective in helping to prevent decalcification in patients receiving ________ treatment.
    a. endodontic
    b. periodontal
    c. orthodontic
    d. all of the above

24. Mouthrinse containing 900 ppm fluoride reduced caries by up to ________ in schoolchildren with weekly rinsing over 30 months of use.
    a. 45%
    b. 55%
    c. 65%
    d. none of the above

25. Neutral sodium fluoride ________.
    a. does not etch ceramics
    b. does not etch sealants
    c. is nonstaining
    d. none of the above

26. Acidulated fluoride formulations are capable of ________ ceramics.
    a. polishing
    b. etching
    c. preserving
    d. none of the above

27. ________ use over time can result in staining.
    a. APF
    b. Varnish
    c. Stannous fluoride
    d. none of the above

28. ________ has been shown to relieve dentinal hypersensitivity.
    a. Sodium fluoride
    b. Stannous fluoride
    c. APF gel
    d. a and b

29. The maximum level of fluoride available for home use is ________.
    a. 1,000 ppm
    b. 2,500 ppm
    c. 5,000 ppm
    d. 7,500 ppm

30. Consideration of the type and combinations of fluoride to be provided and recommended to a patient requires an assessment of the patient’s ________.
    a. risk level
    b. condition
    c. required prevention
    d. all of the above
The Role of Fluoride in Caries Control

Educational Objectives

1. List and describe the prevalence and incidence of coronal and root caries in different segments of the population.
2. List the primary and contributory risk factors for caries.
3. List and describe available risk assessment tools and what they assess.
4. List and describe the role of fluoride in caries prevention and the available options for different age groups.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent (5) to Poor (0).

1. Were the individual course objectives met?  
   Objective #1: Yes  No
   Objective #2: Yes  No
   Objective #3: Yes  No
   Objective #4: Yes  No

2. To what extent were the course objectives accomplished overall?  
   5  4  3  2  1  0

3. Please rate your personal mastery of the course objectives.  
   5  4  3  2  1  0

4. How would you rate the objectives and educational methods?  
   5  4  3  2  1  0

5. How do you rate the author's grasp of the topic?  
   5  4  3  2  1  0

6. Please rate the instructor's effectiveness.  
   5  4  3  2  1  0

7. Was the overall administration of the course effective?  
   5  4  3  2  1  0

8. Do you feel that the references were adequate?  
   Yes  oN

9. Would you participate in a similar program on a different topic?  
   Yes  oN

10. If any of the continuing education questions were unclear or ambiguous, please list them.

11. Was there any subject matter you found confusing? Please describe.

12. What additional continuing dental education topics would you like to see?