

# Treating caries as an infectious disease

**The scientific literature has suggested for many years that a risk-based assessment of an individual patient's caries history and status is an important prerequisite for appropriate preventive or treatment actions.<sup>2-5</sup>**

**W**ith each passing year, the dental profession and the public shift further out of the restorative dentistry dominated era and into the disease prevention and health promotion era. This is occurring because of disease trends, preventive dental practices and broader societal expectations, desires and demands to be protected from disease and to achieve maximum esthetics.

Dental caries has affected human populations since the prehistoric era and various cultures at different times have exhibited wide variation in their susceptibility to dental caries.<sup>1</sup>

The scientific literature has suggested for many years that a risk-based assessment of an individual patient's caries history and status is an important prerequisite for appropriate preventive or treatment actions.<sup>2-5</sup> In dentistry, and more broadly in medicine, when

not to treat is as important a question as when to treat. New information in caries diagnosis and treatment indicates a need to revise the traditional strategies used to manage the disease of dental caries. Accumulating evidence supports the long-term health benefits realized by preserving sound tooth structure with non-invasive interventions. Such interventions include fluorides, sealants, chemotherapeutic agents and conservative restoration techniques. Arresting early lesions, thereby preserving tooth structure, is beneficial for the patient and can be professionally rewarding for the dentist.

The objective of this guide is to examine caries as a chronic, infectious, multifactorial disease process. Minimizing the effects of dental caries on the health of patients requires managing caries as an infectious disease that is affected by certain oral environmental, genetic and behavioral factors.<sup>6,9</sup>

Knowing which patients can

**Numerous clinical studies have associated carious lesions with elevated levels of mutans streptococci in plaque while lactobacilli are implicated in advanced carious lesions.<sup>13,14</sup>**

benefit most from specific preventive approaches instead of restorative treatment is an emerging science.

It should be noted that a clinician's concerns about not providing a treatment service for an observed or suspected carious lesion are always legitimate. At the same time, if restorative services are provided without thoughtfully considering alternatives, patients may be receiving services that may increase their risk for undesirable effects in the future. The most noteworthy example is the long-term compromise in tooth integrity and possibly vitality through a cycle of restoration and reroastoration that begins early and spans a lifetime. This also results in repeated exposures to anesthesia, instrumentation, diagnostic radiographs and dental materials, as well as increasing the costs of care.

Today, the need for reparative treatment would be deemed most appropriate when there is the likelihood that the patient will not benefit from a preventive service; and experience untoward disease progression and health risk in the absence of restorative treatment.

**C**aries management has been a process of serial identification and restoration resulting in the gradual accumulation of restored tooth surfaces by individuals over a lifetime. While this result undeniably is an advance over previous times when many carious teeth were removed as a definitive treatment, improved preventive and therapeutic treatments are available that will:

- control chronic dental caries;
- promote the maintenance of an intact natural dentition; and
- control the bacteria involved in the decay process.

Carious lesions are clearly the clinical manifestation of bacterial infections that progress to a point of irreversibility.

Numerous clinical studies have associated carious lesions with elevated levels of *mutans streptococci* in plaque, while lactobacilli are implicated in advanced carious lesions.<sup>13,14</sup> A carious lesion that is caused by infection by *mutans streptococci* and lactobacilli is detectable microscopically and radiographically before it becomes evident clinically.<sup>15</sup> The early infectious process and associated acid demineralization will either progress, regress or remain essentially unchanged, depending on a variety of preventive interventions. These interventions include, but are not limited to, nutritional and oral health counseling, sealants, managing reduced salivary function, fluoride therapy and the use of antimicrobial agents.<sup>12,16</sup> Fortunately, research clearly demonstrates that many clinically detectable carious lesions can be reversed through a combination of patient behaviors and professional intervention.<sup>12</sup> This will prevent the unnecessary loss of natural tooth structure, reduce exposure to anesthetic agents, reduce pain and inconvenience, and in the long run, preserve esthetics and save dollars.

Research generally has shown that most children acquire *mutans streptococci*, that cause caries, at age 22 to 26 months<sup>17,18</sup> and that the most common source of the transmission of

**The preservation of oral health over a lifetime requires an ongoing partnership between dentist and patient.**

bacteria is from parents or careproviders to the young child. Transmission can be indirect (via eating utensils, cups, glasses, pacifiers and by the tasting of food by the adult that is then given to the child) or directly through kissing. These bacteria, once colonized on tooth surfaces, will remain in the mouth throughout life, as long as there are teeth in the mouth.

A sound tooth is clearly more desirable for the health of the patient than one that has been restored, regardless of how clinically excellent the restoration is that is placed in the tooth. Any restoration, no matter how small or how well-fabricated, compromises the long-term strength of the tooth in some way. Restored teeth are more susceptible to fracture than sound, nondecayed teeth. The fracturing or breakdown of margins of restorations increases the likelihood for additional decay.<sup>19</sup>

Virtually all restorations have a limited clinical lifetime. Small restorations tend to become larger restorations over years and decades, frequently involving more tooth surfaces at the expense of natural tooth structure. Studies have shown that enamel and cementum serve as reservoirs of fluoride.<sup>20</sup> Therefore, it stands to reason that the loss of tooth structure through restoration and tooth loss actually reduces the reservoir potential for fluoride release intraorally. Fluoride is critical for increasing resistance to enamel demineralization by bacterial acids and for reversing (remineralizing) lesions that have not progressed to the stage of frank cavitation.<sup>21</sup>

Because remineralization is possible, a decision by the dentist to surgically remove

tooth structure when a lesion is at a potentially reversible stage is being questioned increasingly in the literature.<sup>22,23</sup>

The preservation of oral health over a lifetime requires an ongoing partnership between dentist and patient. Each plays a unique role critical in producing the desired outcomes. Of course, the best professional intervention cannot succeed without a consistent commitment from the patient.

**PERSONALIZING  
CARIES RISK  
ASSESSMENT AND  
DIAGNOSIS**

Recent epidemiologic studies indicate that caries risk is not evenly distributed in the general population. It has been estimated that one-quarter of the school-aged children experience three-quarters of the dental decay.<sup>10</sup>

Also, it is clear that the type of caries patterns experienced by children and younger adults is different from that of older adults. Dental caries in the permanent dentition of children is found predominantly on surfaces with pits and fissures. As people age and experience gingival recession the prevalence of root caries increases. In addition, certain medically, physically, nutritionally or otherwise compromised individuals may be at risk of different levels and types of decay.

Thus, a "shotgun" approach to caries prevention may well deliver preventive services to a low-risk segment of the population that could be more effectively used on the high-risk segment.

Targeting interventions has implications for the costs of services to patients, employers

and publicly supported programs. Individualized "risk-based" approaches to caries prevention are scientifically justified given current caries patterns. This philosophical shift has the potential to produce a more effective set of preventive approaches for all patients.<sup>24</sup>

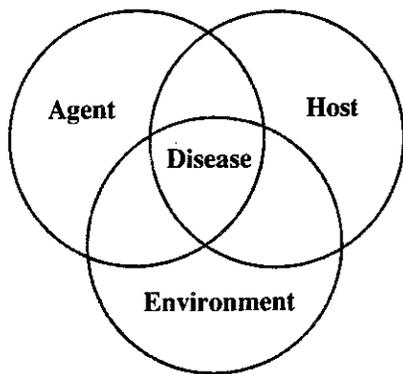
It should also be realized that there is a point of diminishing returns with caries prevention. The combination of various caries prevention approaches can reduce the overall caries risk, but may do so without increasing the caries-prevention benefit greatly. Therefore, assessment of whether a patient's caries risk factors change over time is

orthodontic therapy) or lifestyle changes (for example, a child moving to a non-fluoridated community) can be identified. For a majority of patients, some prevention is good, but more is not always better.

The expansion of water fluoridation in this country, coupled with the widespread consumption of processed beverages and foods prepared with fluoridated water by individuals in non-fluoridated communities, has produced a "diffusion effect." That is, the benefits extend out beyond the technically fluoridated areas. Thus, while the comparative benefits of fluoridation may not be as large today as several decades ago, the benefit to the

*It has been estimated that one-quarter of the school-aged children experience three-quarters of the dental decay.<sup>10</sup>*

**FIGURE 1**



Disease	Agent	Host	Environment
Dental Caries	Cariogenic Bacteria	Tooth	Foods
• Crown	• <i>Strep mutans</i>	• Enamel	• Fermentable
• Root	• Lactobacillus	• Dentin	Carbohydrates
		• Cementum	

Source: International Journal of Technology Assessment in Health Care.

important when considering preventive therapies. Those who have experienced little or no decay do not always realize substantial benefit from multiple preventive approaches, unless additional risk factors (for example, initiation of

overall population may actually be greater. In this regard, the important role of community water fluoridation in caries prevention must be recognized and taken into account when developing personal patient prevention plans. On average,

FIGURE 2

## INITIAL VISIT – QUESTIONS TO CONSIDER.

### IS THERE CURRENT CARIES ACTIVITY?

#### ARE THERE INDICATIONS THAT YIELD POTENTIAL FOR DEVELOPMENT OF CARIES WITHIN THE NEXT YEAR?

- prior DMFS (decayed, missing or filled surfaces)
- tooth morphology
- medications that decrease saliva flow and/or affect viscosity of saliva
- medical condition or treatment(s)

### WHAT IS THE INDIVIDUAL'S CARIES RISK?

- low
- moderate
- high

#### WHAT ARE THE MODIFIABLE RISK FACTORS THAT MAY BE RESPONSIBLE FOR OR MAY CONTRIBUTE TO THIS CARIES ACTIVITY?

- insufficient systemic and topical fluoride
- medications
- poor oral hygiene habits or skills
- deep pits and fissures without sealants
- poor dietary habits

#### WHAT CAN BE DONE TO PREVENT NEW CARIES OR CARIES PROGRESSION WITHIN THE NEXT YEAR?

- sealants
- increase fluoride use
- oral hygiene instruction/education
- dietary counseling
- monitor bacterial count
- antimicrobial agents
- conservative restorative techniques—to minimize removal of tooth structure

#### WHAT IS THE PROGNOSIS FOR SUCCESSFUL INTERVENTION?

- patient compliance
- clinician skill (diagnosis, intervention counseling)
- prevention modalities are accepted/applied
- severity at onset

#### ARE THERE OTHER CONSIDERATIONS THAT MAY AFFECT THE DECISION PROCESS THAT CANNOT BE CHANGED? (EFFECT MODIFIERS, CONFOUNDERS)

- age
- socioeconomic considerations
- medically and/or physically compromising conditions

individuals living in fluoridated communities can expect substantial caries reductions over those not living in fluoridated communities. At the same time, individuals living in non-fluoridated communities, especially if surrounded by fluoridated communities, are better off than their counterparts of several decades ago.<sup>25</sup>

Interestingly, despite an impressive record of effectiveness and safety, only 62 percent of the U.S. population on public water supplies currently receives fluoridated water.<sup>26</sup> This calls for ongoing professional and community efforts to extend the benefits of water fluoridation to a greater percentage of the population, particularly in the Western United States. Further, it is important that fluoridation levels be monitored continuously so that optimal effects can be achieved.

For pediatric patients it is particularly important today to adapt preventive recommendations based on whether or not individuals are drinking fluoridated water. There is evidence that the incidence of mild dental fluorosis is increasing in children who reside in fluoridated areas.<sup>25</sup> Although the reasons for this are varied, the risk for developing mild fluorosis can increase with unintentional ingestion of topical fluoride products, including toothpastes, rinses and gels. Therefore, professionally applied topical fluoride treatments and home fluoride rinse products are not recommended generally for children under 6 years of age or for children and adolescents who are at low risk for developing caries, when those individ-

FIGURE 3

# CARIES RISK CLASSIFICATION GUIDELINES.

RISK CATEGORY	AGE CATEGORY FOR RECALL PATIENTS*	
	CHILD/ ADOLESCENT	ADULT
<b>LOW</b>	No carious lesions in last year Coalesced or sealed pits and fissures Good oral hygiene Appropriate fluoride use Regular dental visits	No carious lesions in last three years Adequately restored surfaces Good oral hygiene Regular dental visits
<b>MODERATE</b>	One carious lesion in last year Deep pits and fissures Fair oral hygiene Inadequate fluoride White spots and/or interproximal radiolucencies Irregular dental visits Orthodontic treatment	One carious lesion in last three years Exposed roots Fair oral hygiene White spots and/or interproximal radiolucencies Irregular dental visits Orthodontic treatment
<b>HIGH</b>	≥2 carious lesions in last year Past smooth surface caries Elevated <i>mutans streptococci</i> count Deep pits and fissures No/little systemic and topical fluoride exposure Poor oral hygiene Frequent sugar intake Irregular dental visits Inadequate saliva flow Inappropriate bottle feeding or nursing (infants)	≥2 carious lesions in last three years Past root caries; or Large number of exposed roots Elevated <i>mutans streptococci</i> count Deep pits and fissures Poor oral hygiene Frequent sugar intake Inadequate use of topical fluoride Irregular dental visits Inadequate saliva flow

\*At initial visit for new patients, if time of last caries experience cannot be determined, a person with no decayed, missing or filled surfaces (DMFS = 0) would be classified as low risk. A person with past caries experience (DMFS > 0) and/or one active lesion would be classified as moderate risk. A person with past caries experience and/or two active caries or one smooth surface lesion would be classified as high risk.

Parents of young children and expectant parents need additional counseling on inappropriate nursing or bottle feeding practices which can lead to the development of baby bottle tooth decay. Parents and caregivers should be advised to introduce children to a cup in an effort to discontinue use of the bottle by the age of 1 year. Also, parents and caregivers should be advised never to place anything other than plain water in a naptime or nighttime bottle. Children should not be allowed to bottle feed at will and should be weaned from the bottle by the age of 1 year.

Many medically compromised individuals are likely to be assessed in the higher risk categories because of their use of certain medications and possible xerostomia.

uals are living in fluoridated communities and using a fluoridated dentifrice. A "pea-sized" amount of ADA-accepted fluoride toothpaste should be utilized by children under the age of six while parents or caregivers supervise toothbrushing.

Additionally, fluoride supplements should not be prescribed for children without a specific determination of fluoride levels existing in their drinking water. (See Figure 5).

While risk assessment is not a perfect science at this point in time, published models can assist the dentist in assessing caries risk and then making the best possible choices for caries prevention approaches.<sup>7,10,24,27</sup>

Issues to be considered in assessing risk are outlined in Figures 2 and 3.

Recurrent decay should be considered when evaluating an individual's caries risk. However, in the absence of decay, the need to replace restorations due to fractured restorations or adjacent tooth structure is not in and of itself a good indicator of caries risk.<sup>28</sup>

For dental caries to occur, three essential factors must be present at the same time: presence of an adequate number of cariogenic bacteria; a susceptible tooth surface or surfaces (smooth surface, pit, fissure, root surface) to be attacked; and available food-stuffs to support the growth of cariogenic bacteria (Figure 1).

The caries process either will not occur or can be prevented or interrupted if any one of these conditions does not exist or is modified. Therefore, clinicians should recommend to patients those therapies documented as effective in:

reducing the numbers of

FIGURE 4

**CARIES PREVENTION MODALITIES BY RISK STATUS AND AGE GROUP.**

PREVENTIVE OPTIONS FOR RISK CATEGORIES		
	AGE CATEGORY	
RISK CATEGORY	CHILD/ ADOLESCENT	ADULT
<b>LOW</b>	Educational reinforcement re: good oral hygiene and use of fluoride dentifrice One year recall	Educational reinforcement re: good oral hygiene and use of fluoride dentifrice One year recall
<b>MODERATE</b>	<b>Pit and Fissure Caries:</b> Sealants  <b>Smooth Surface, Recurrent and Root Caries:</b> Educational reinforcement Dietary counseling Fluoride mouthrinse* Professional topical fluoride Sealants Brush w/fluoride dentifrice Six month recall Fluoride supplements†	<b>Pit and Fissure Caries:</b> Sealants  <b>Smooth Surface, Recurrent and Root Caries:</b> Educational reinforcement Dietary counseling Fluoride mouthrinse Professional topical fluoride Sealants Brush w/fluoride dentifrice Six month recall
<b>HIGH</b>	<b>Pit and Fissure Caries:</b> Sealants  <b>Smooth Surface, Root and Recurrent Caries:</b> Educational reinforcement Brush w/fluoride dentifrice Sealants Home fluoride (mouthrinse/1.1 percent sodium fluoride gel*) Professional topical fluoride at each visit 3-6 month recall Dietary counseling Monitoring <i>S.mutans</i> count Antimicrobial agents Fluoride supplements†	<b>Pit and Fissure Caries:</b> Sealants  <b>Smooth Surface, Root and Recurrent Caries:</b> Educational reinforcement Brush w/fluoride dentifrice Sealants Home fluoride (mouthrinse/1.1 percent sodium fluoride gel*) Professional topical fluoride each visit 3-6 month recall Monitoring <i>S.mutans</i> count Antimicrobial agents Dietary counseling

\* Not for children under 6 years of age

† Age considerations and fluoride content of primary water supply (refer to section on Interventions, Fluoride Supplementation)

cariogenic bacteria (agent);  
 decreasing the susceptibility of tooth surfaces (host) to infection; and  
 reducing frequent intake of fermentable carbohydrates (environment).

Diagnosis is a critical step in preventing and managing caries and it goes beyond clinical detection of cavitated lesions that can be restored. Diagnosis should include an overall assessment of caries risk and activity in the patient, not just activity at a specific site on a tooth surface. Research indicates that using a combination of diagnostic aids ensures more accuracy in caries diagnosis, including<sup>29,30</sup>:

- visual examination of air-dried teeth (including fiber optic transillumination and magnification);
- adjunctive radiographic methods (including occlusal bitewings and digitalized radiographs);
- knowledge of previous caries history; and
- bacteriologic assessment and monitoring.

The current literature indicates that the diagnosis of caries can be summarized into three general categories<sup>29,31</sup>:

- questionable caries;
- incipient caries (also referred to as enamel, early and white spot lesions); and
- frank caries (also referred to as dentinal caries).

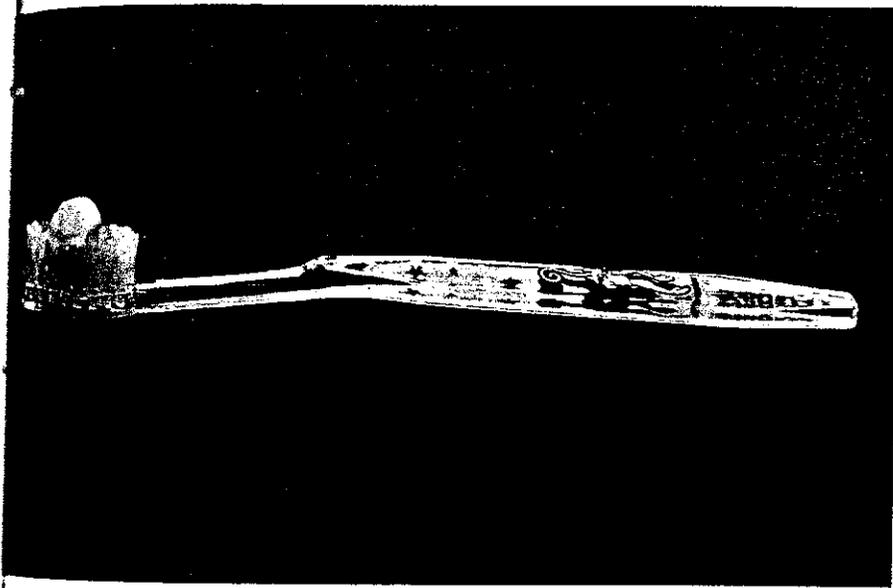
Dental caries typically manifests itself in different ways on different tooth surfaces. Frank lesions are directly observable on occlusal, facial, lingual and often proximal surfaces and pose no problem in diagnosis, while incipient carious lesions are more difficult to identify. White spot lesions typically are

found on smooth surfaces.

Transillumination of interproximal areas can be a useful adjunct in interproximal areas, particularly in the anterior dentition. Fiber optic lights also have been identified as useful for this purpose. Given the current reduced level and severity of caries in the population, restoration of

lesions can become cavitated simply through pressure from the explorer during the typical clinical examination.<sup>30</sup> Thus, penetration by a sharp explorer can actually cause cavitation in areas that are remineralizing or could be remineralized. An explorer can also transfer cariogenic bacteria from one tooth surface to another.<sup>32,33</sup>

**At each subsequent (recall) visit, patients should be re-evaluated for their caries risk status.**



**A "pea-sized" amount of ADA-accepted fluoride toothpaste should be utilized for children under the age of six.**

"sticky fissures" in the absence of other factors such as staining, friable enamel or translucent undermining of enamel may cause many non-carious teeth to be unnecessarily restored.

Traditional probing with a sharp explorer has come into question as the ultimate determinant of caries activity.<sup>32</sup> The exclusive use of a "catch" by the sharp explorer to diagnose caries in pit and fissure sites should be discontinued and clinicians are being called upon to use "sharp eyes and a blunt explorer."<sup>11</sup> Also, non-cavitated

Less aggressive carious lesions apparent these days may also lead to underdiagnosis of occlusal caries. In this regard, "occlusal bitewing" radiographs have been suggested as helpful.<sup>29</sup>

Clinical studies published over the past several years have confirmed that caries will not progress under a properly placed and intact dental sealant.<sup>34-39</sup> Therefore, practitioners could choose to apply a sealant and continue to observe the area if the presence or extent of pit or fissure caries is uncertain.

FIGURE 5

## QUESTIONS FOR ASSESSING FLUORIDE EXPOSURE.

### A. PATIENT EXPOSURE TO SYSTEMIC FLUORIDE

1. Currently living in a fluoridated area?  yes  no  
(If yes, skip to section on topical fluorides. If no, continue with question 2.)
2. What is the source of the home water supply? Non-fluoridated water system or well water\*  
Natural fluoride level currently in drinking water =  ppm
3. Currently taking a dietary fluoride supplement?  yes  no  
(Need for fluoride supplements is determined by age and existing natural level of fluoride in drinking water)
4. Other residences or known exposures to community and/or school water fluoridation between 6 months to 16 years of age? (for example, exposure to fluoridated water at school or day care site.)

### B. PATIENT EXPOSURE TO TOPICAL FLUORIDE PRODUCTS

1. Which fluoride-containing products are currently used? Determine names of products, if possible:

Name of product(s) used:	How often is each product used?
toothpaste _____	_____
over-the-counter rinse _____	_____
prescription rinse _____	_____
prescription gel _____	_____

2. Has the patient received topical fluoride treatments at dentists' office(s)? If yes, how often? \_\_\_\_\_
3. Is (or has) the patient participated in any school fluoride programs? (fluoride rinse, tablets?)

(\*Contact state department of health for testing service to test/determine natural level of fluoride, if not known.)

In instances where the presence of pit or fissure caries is suspected, the minimal exploration of the surface with a small round bur can open up the fissure pattern so that a more definitive determination can be made. A sealant or preventive resin restoration can then be placed.<sup>40</sup>

Bitewing radiographs also are important for detecting incipient proximal lesions that have the potential for reversal.<sup>41</sup> Good quality bitewings, standardized as much as possible using alignment devices and consistent exposure settings over time for individual pa-

tients, aid in detecting such lesions and monitoring their status over time.

While the patient's overall caries experience is important, the more recent caries experience, particularly as it relates to specific surface types, can provide useful information for predicting risk and recommending interventions to reduce risk. Enamel lesions (including white spot lesions) are indicative of the need to intervene to prevent these early lesions from progressing to frank cavities that require restoration.

Microbiological monitoring

measures salivary levels of cariogenic organisms (*mutans streptococci* and *lactobacilli*) and can assist in identifying individuals at high risk for caries. For individual patients, especially when based on a single sample, the levels of cariogenic bacteria may not be any more predictive for caries risk as is the patient's previous caries history.<sup>42</sup> Tests can be performed in microbiological laboratories where the bacteria are grown on selective culture media<sup>43,44</sup> or an in-office system may be used.<sup>45</sup> Levels of microorganisms (that is, colony-forming units [CFU] per

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FIGURE 6

## RECALL VISIT — QUESTIONS TO CONSIDER.

- How long has it been since the last dental visit?
- During this time, has there been new caries activity or progression of disease?
- Have previous interventions been implemented?
- Have they been successful?
- If no, what other interventions are available?
- If yes, continue intervention and/or monitor until have sufficient evidence to re-classify risk status (reassessment of risk).
- Are there changes in caries risk based upon changed physical status or habits?

milliliter of saliva) indicate relative levels of caries risk or activity. More than 1 million *mutans streptococci* or 100,000 lactobacilli per mL of saliva could be considered high counts, while less than 100,000 *mutans streptococci* or 1,000 lactobacilli could be considered low. These general guidelines are helpful for recommending appropriate preventive interventions (for example, antimicrobial rinses) for patients with high caries risk.

### PERSONALIZING CARIES PREVENTION

After causal factors for possible future caries activity have been assessed, the clinician should analyze all possible factors affecting the individual patient's caries pattern before selecting an intervention or

treatment. The rationale for careful analysis is that many of the factors that may be responsible for or contribute to disease activity or the likelihood of future disease, can be modified. The issues discussed in this section are fully outlined in Figures 3 and 4 as well as in the Intervention section, starting on page 16.

The current diagnosis, indications of recent past caries experience and the presence of modifiable risk factors can be used to classify each patient according to their "caries risk." That is, the likelihood of developing new lesions or progression of existing lesions within the next year. Figure 3 presents low-, moderate- and high-risk categorizations.

For example, if the person has not been exposed to sufficient levels of systemic and/or topical fluoride, they may be at moderate or high risk for caries and appropriate fluoride therapy should be recommended. The best method for determining the amount and types of fluoride to recommend is through an individualized fluoride assessment which should be completed with all patients. Figure 5 includes items that may be used as a stand-alone questionnaire, or the questions may be integrated into the existing medical and dental history form.

For individuals who have not received pit and fissure sealants, placement of sealants is appropriate as both a preventive and therapeutic treatment. Sealant use is outlined in the Intervention section.

In general, microbiological diagnostic methods and pharmacotherapeutic products may be used to<sup>46</sup>:

- prevent primary infection with *mutans streptococci*;
- assess caries-risk status;
- suppress the caries process;
- arrest presurgical lesions; and
- pretreat lesions before restoration.

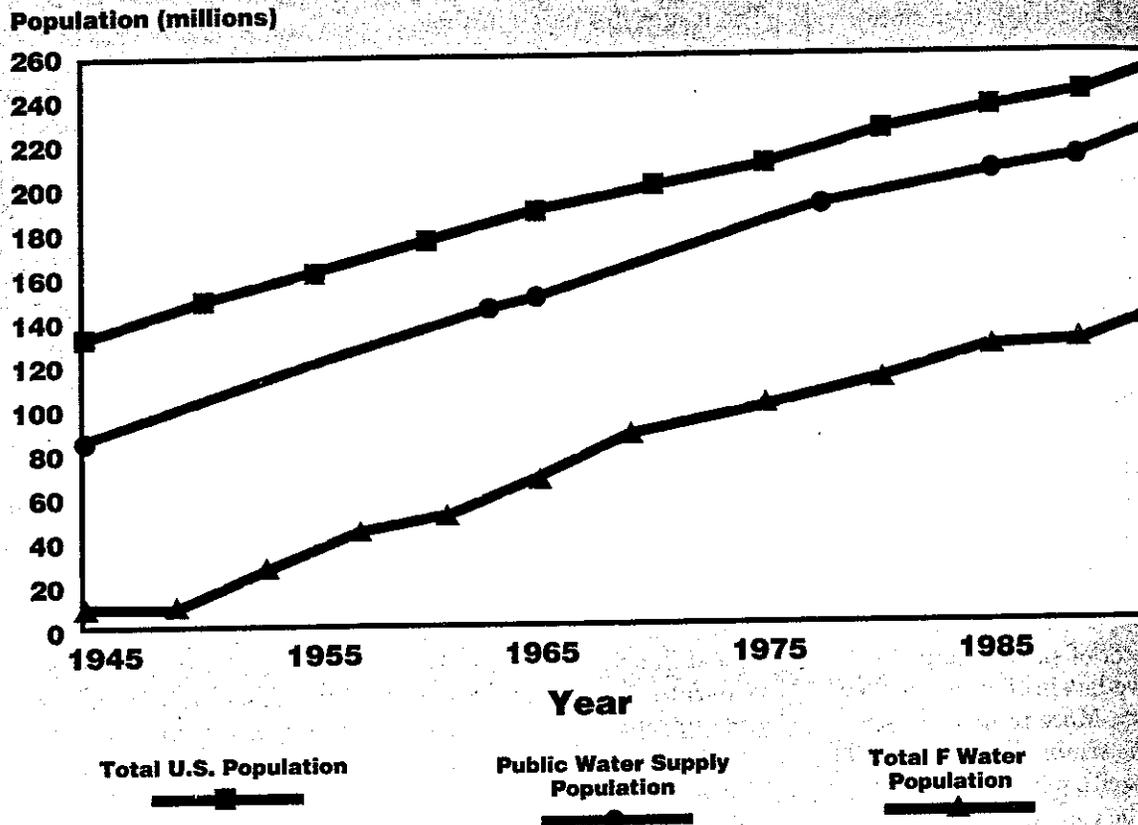
As noted before, individuals presenting with consistently high levels of *mutans streptococci* (greater than 1 million per mL of saliva) should be considered at high risk for dental caries and will benefit from many preventive interventions, including short-term antimicrobial rinses.

If poor oral hygiene habits and skills are apparent, then educational and motivational efforts to improve self-care skills are in order. A history of inappropriate dietary practices indicates a need for dietary counseling.

Risk for dental caries also increases in individuals who have xerostomia. A variety of individuals may be affected with xerostomia including: individuals taking certain medications, individuals receiving radiation therapy for head and neck cancer, persons with Sjogren's syndrome and individuals with dehydration due to specific conditions (for example, diabetes, leukemia or pernicious anemia).<sup>47,48</sup> A sample of drugs that have been shown to cause or contribute to dry mouth include: amphetamines, anticholinergics, antidepressants, antihistamines, antihypertensives, antiparkinsonians, narcotic analgesics, sedatives and tranquilizers.

For individuals who prefer to chew gum or who present with xerostomia, recommending xylitol gum may be considered. Gum chewing stimulates saliva

## Fluoridation growth, by population, United States, 1945-1992



Source: 1992 Fluoridation Census, Centers for Disease Control and Prevention.

and neutralizes plaque acids; xylitol does not increase and may actually reduce caries risk.<sup>49-52</sup>

As the caries rate has decreased, many dentists are advocating more conservative cavity preparations<sup>53</sup> that do not follow traditional G.V. Black guidelines established in the early 1900s.<sup>54</sup> Such restorative techniques include<sup>28</sup>:

- preventive resin restorations
- proximal slot restorations
- tunnel restorations
- conservative class 2 resin restorations

Utilizing conservative restorative procedures will do much to preserve tooth structure in many individuals.

There are additional factors that should be taken into consideration and that may affect the caries risk of individuals. These issues are not amenable to change and include the patient's age, genetic factors, and presence of medically or physically compromising conditions.

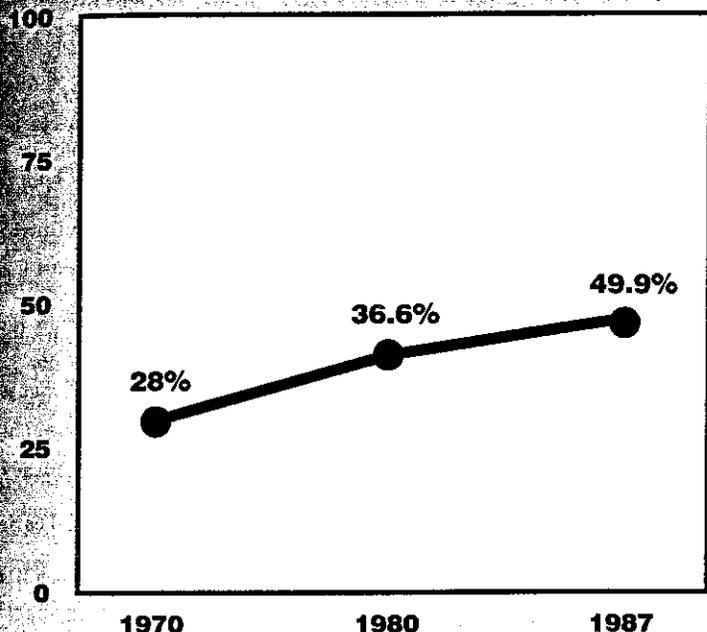
Finally, before an intervention is selected, the clinician should consider the prognosis for successful intervention. Will

the intervention work? Success will depend on both the patient and the clinician. Factors on the part of the patient include: severity of caries and number of lesions at the time of diagnosis; acceptance and compliance with prevention modalities. Factors on the part of the clinician include: skill with diagnosis of early signs of caries; and selection of effective counseling and interventions.

Questions to consider regarding risk assessment are listed in Figure 2. These provide a useful guide in data gathering and even may be incorporated into

## Percent of U.S. school children who are caries free early 70s to late '80s

% Of Caries free U.S. children



documentation already used by care providers.

Various caries risk factors are summarized in Figure 3 for children, adolescents and adults. This reference can be used as a guide each time the diagnosis and assessment process occurs; that is, upon initial diagnosis and upon subsequent visits.

Figure 4 describes intervention strategies that are recommended by the authors based on the literature for patients with different caries risk levels. As explained in this document, the type and location of the caries activity, and the caries risk status of the individual, based on both clinical

and modifiable risk factors, are considered. Each of the preventive therapies listed in the table are described in detail in the Intervention section of this document.

### ONGOING REASSESSMENT OF CARIES RISK

At each subsequent (recall) visit, patients should be re-evaluated for their caries risk status using information gathered about the incidence or onset of new caries, and the progression of lesions during a defined period of time since the last visit. If a year has passed without progression of caries or

new caries activity, the patient can be considered to be in the low risk category, regardless of previous classification, unless new or other risk factors have been identified (for example, a patient who has been caries-free for a year but who is undergoing orthodontic therapy may well continue in the moderate risk category).

If caries activity has continued, reasons for this continuation should be assessed. The previous interventions should be reviewed to determine if they have been implemented appropriately, what changes can be made, or whether other interventions are available and appropriate. Interventions should be continued and outcomes monitored until there is sufficient evidence to justify a lower classification of caries risk status. The thought process that comprises the continuum of diagnosis, assessment, choice of intervention and reassessment can be summarized by a series of questions that the clinician can pose during each appointment. These questions are presented in Figure 6.

### SUMMARY

The scientific basis for caries risk assessment, prevention and treatment on an individual patient basis requires further development, specification and continuing validation. Still, current technologies and techniques, taken together, can provide enhanced capabilities over those that have been employed traditionally. Undoubtedly, the clinical tools for carrying out these responsibilities will be refined and expanded in the future in response to the changing

clinical profile of caries in the population. For example, bacteriologic testing methods have become easier and more reliable, and will become more widely used. Other effective methods to detect the early, pre-cavitation stage of caries also should become more available in the future.

Practitioners will be continually challenged and responsible for evaluating the effectiveness and value of emerging technologies in their practices and in light of their patients' needs. But how can this be accomplished best? Effectiveness claims will be made for new drugs and devices that come onto the market. There are several sources of information to assist the practitioner in making such decisions. The American Dental Association acceptance programs (voluntary) and the U.S. Food and Drug Administration compliance programs (law) provide standards and guidance as to product safety and effectiveness.<sup>55</sup>

Without such determinations, the practitioner must judge independently product claims and clinical studies. Marketing materials by themselves (advertisements, videos, pamphlets) may not be sufficient evidence of effectiveness particularly when scientific references supporting claims either are not provided or are inadequate. Peer-reviewed scientific literature in publications of the major scientific and professional associations can be viewed as generally reliable.

Changing the way dental caries is managed in clinical practice will require integrating new scientific information and

technology into workable clinical procedures. Dental education and third-party reimbursement issues must be addressed also but are beyond the scope of this document. Given that disease patterns are always changing in the population, dentists need to modify practice decisions using risk assessment. Ultimately, the goal for dentistry is that adult patients also will enjoy the same low level of caries experience that many children enjoy today. ■

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# INTERVENTION: EDUCATIONAL REINFORCEMENT AND RECALL

**INDICATIONS:** Candidates for educational reinforcement include all patients at moderate or high risk for dental caries, and parents/caregivers of children at moderate or high caries risk.

Special educational reinforcement related to plaque control is indicated for individuals with fair or poor oral hygiene and/or physical limitations. Parents/caregivers of infants and toddlers should be counseled about the direct and indirect transferability of *mutans streptococci* from themselves to their children. (Children acquire *mutans streptococci* soon after the first deciduous molars appear.)

Educational reinforcement related to dietary counseling is indicated for parents and other caregivers of infants and young children (to prevent baby bottle tooth decay), individuals with eating disorders, systemic diseases (for example, Crohn's disease), xerostomia and patients undergoing radiation and/or chemotherapy.

Recall interval should be evaluated and modified depending on the success of interventions in slowing the decay process.

**ADVANTAGES:** Educational reinforcement and dietary counseling assist patients in assuming appropriate responsibility for their oral health and provide knowledge and skills needed to maintain health and prevent disease.

Recall visits allow for frequent delivery of professional preventive services, assessment of home interventions and reassessment of risk category. The goal is to move patients to the low risk category and lengthen the recall interval.

**LIMITATIONS:** Educational reinforcement requires behavior modification on the part of the patient and a significant time commitment and special counseling skills on the part of dental care professionals. Dentists may encounter difficulty in obtaining an objective report of plaque removal and dietary assessment. Frequent recall requires patient compliance regarding dental visits and a willingness to reimburse providers for services not covered by their dental benefit policies.

## **CONSIDERATIONS:**

**PATIENT:** Efficient methods of removing/reducing cariogenic bacteria are important in caries prevention. Frequent recall allows for the risk assessment categorization to be updated and the success of interventions to be monitored. The amount, frequency and duration of exposure to sugar(s) in foods and beverages can also be monitored and modified. Recall visits provide for frequent clinical examination which can prevent early carious lesions from progressing and to ensure that remineralization is occurring.

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**RESOURCES:** American Dental Association Catalog. Call the Department of Salable Materials (1-800-947-4746) to order catalog with educational pamphlets, videos, etc.

# INTERVENTION: PIT AND FISSURE SEALANTS

**INDICATIONS:** Caries risk, regardless of the age of the patient, should be a major criterion for selecting teeth for sealant application.

Patients who are at moderate or high risk for developing caries and have teeth with pits and fissures that have morphological characteristics further increasing caries risk should receive *preventive* sealants.

Patients having incipient caries (limited to enamel) of pits and fissures are candidates for *therapeutic* sealants.

[Note: Post-eruptive age alone should not be a major criterion for selecting teeth for sealant application. Although the majority of sealants have been placed in children, recent studies suggest that the risk for pit and fissure caries extends beyond adolescence. See Figure 7.]

**ADVANTAGES:** Sealants are minimally invasive and require no patient compliance after they have been applied. Sealants can be applied by auxiliary personnel. Long-term sealant retention rates are high; fully retained sealants are 100 percent effective and have been proven to halt the caries process.

**LIMITATIONS:** Adequate isolation and correct application technique are essential for sealant retention. Sealant success is positively associated with eruption status of teeth because the more fully erupted a tooth is, the greater the ability to maintain a dry field. Whenever possible, therefore, sealant placement should be delayed until the tooth is sufficiently erupted for all susceptible pits and fissures to be isolated.

**CONSIDERATIONS:**

**TOOTH:** Sealants are very useful as a conservative therapy for any tooth with pits and fissures that have questionable carious lesions or caries limited to the enamel. Permanent molars are at greatest risk for pit and fissure caries and, therefore, the most logical recipients of preventive sealants. Primary molars, premolars and permanent maxillary incisors that are at high risk also may be sealed preventively. Teeth with well-coalesced pits and fissures and wide, easily cleaned grooves usually do not require sealing.

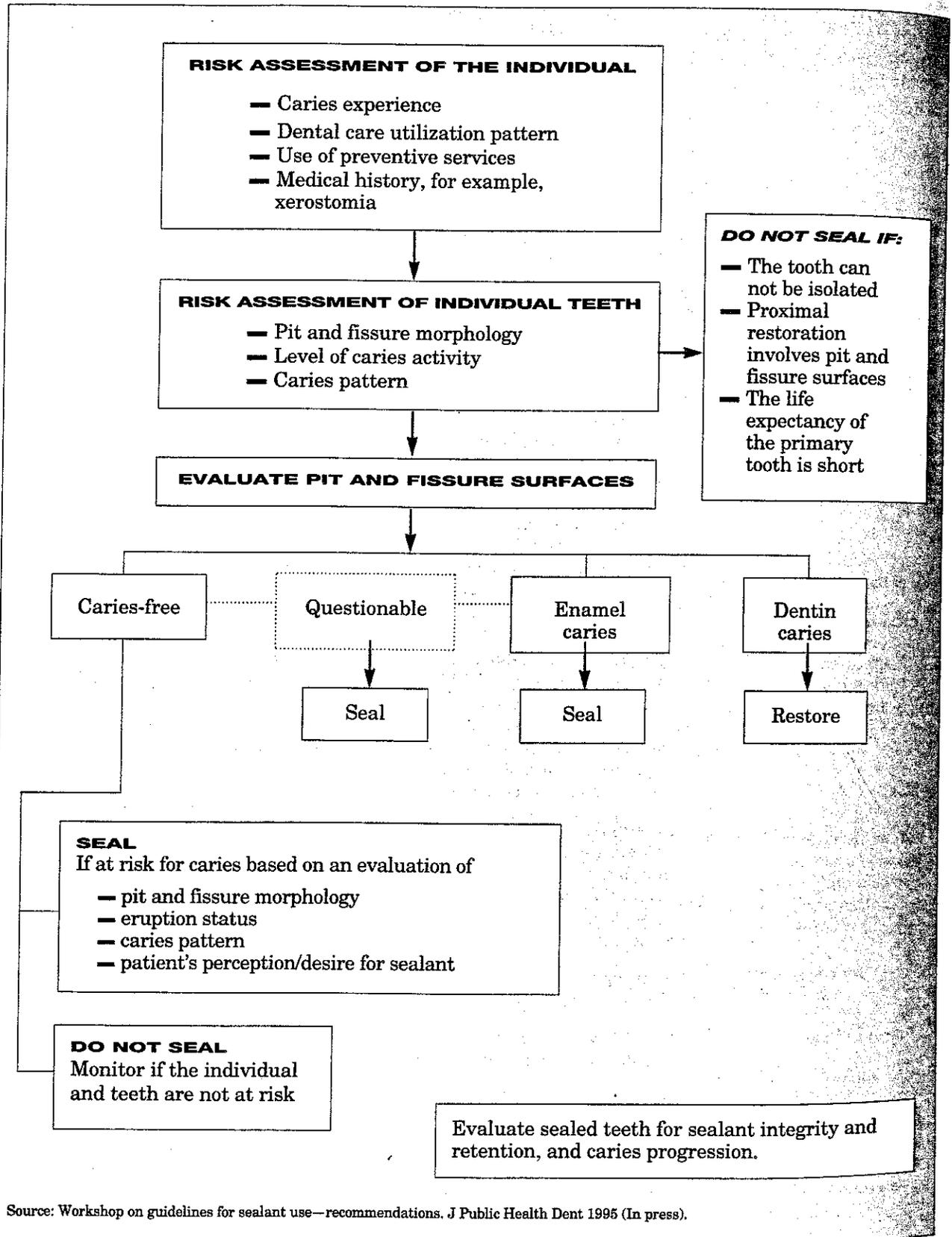
**PATIENT:** Cost-effectiveness of sealant use will be maximized by selecting those patients and teeth who are at risk for pit and fissure caries. Patient reliability may be a factor in deciding whether or not to wait for further eruption before placing a sealant. Waiting for full eruption, therefore, may be sacrificed in order to assure that sealants are placed on susceptible areas of a patient who does not have regular dental visits.

**REFERENCES:** Workshop on guidelines for sealant use—recommendations. J Public Health Dent 1995 (In press).

Ripa LW. Sealants revisited: an update of the effectiveness of pit-and-fissure sealants. Caries Res 1993;27(Supplement 1):77-82.

**RESOURCES:** The ADA Council on Access, Prevention and Interprofessional Relations offers a sealant information packet.

**FIGURE 7**



Source: Workshop on guidelines for sealant use—recommendations. J Public Health Dent 1995 (In press).

# INTERVENTION: FLUORIDE SUPPLEMENTATION

**INDICATIONS:** Children 6 months to 16 years of age living in areas with less than optimally fluoridated water, for example, home or "primary" water supply is fluoride deficient.

ADA Council on Scientific Affairs Recommendations, new dosage schedule approved April 1994:

AGE	FLUORIDE ION LEVEL IN DRINKING WATER (ppm)*		
	<0.3 ppm	0.3-0.6 ppm	>0.6 ppm
Birth-6 months	None	None	None
6 months-3 years	0.25 mg/day†	None	None
3-6 years	0.50 mg/day	0.25 mg/day	None
6-16 years	1.0 mg/day	0.50 mg/day	None

\* 1.0 ppm = 1 mg/liter

† 2.2 mg sodium fluoride contains 1 mg fluoride ion.

**ADVANTAGES:** Permits early exposure, which maximizes protection. Fluoride supplements are sold in two forms: drops for infants age 6 months and up, and chewable tablets for children and adolescents. Systemic and topical benefits when chewed, swished and swallowed. Caries protection from 6 months of age when used as recommended.

**LIMITATIONS:** All sources of fluoride must be evaluated with a thorough fluoride history. If fluoride level is unknown, drinking water must be tested for fluoride content before supplements are prescribed. For testing of fluoride content, contact the local or state health department. Requires long-term compliance on a daily basis. Ingestion of higher than recommended levels of fluoride by children has been associated with an increase in mild dental fluorosis in developing, unerupted teeth. Patient exposure to multiple water sources can make proper prescribing complex.

**CONSIDERATIONS:**

**TOOTH:** Caries reduction benefits must be balanced with risk for mild and very mild fluorosis.

**PATIENT:** Home water filtration systems may remove fluoride, therefore, treated water should be tested. Other sources of fluoride need to be determined, including fluoride prescribed by a physician. (Refer to Figure 5.)

**REFERENCES:** American Dental Association, Council on Scientific Affairs, Association Report on Dietary Fluoride Supplements. JADA 1995 (In press).

# INTERVENTION: PROFESSIONALLY APPLIED ACIDULATED PHOSPHATE FLUORIDE AND SODIUM FLUORIDE PRODUCTS

**INDICATIONS:** All patients with moderate or high caries risk due to smooth (or root) surface caries activity. Special groups, for example, orthodontic patients, patients undergoing head and neck irradiation, patients with decreased salivary flow (usually due to systemic conditions or side effects of medications). Not recommended for individuals with low caries risk who reside in optimally fluoridated areas.

**APPLICATION:** For professionally applied gels and foams, the following schedule may be followed:  
(There are also data to indicate that professionally-applied fluoride varnishes, applied every 3-6 months, may be beneficial. One fluoride varnish gained FDA approval in 1994 for marketing in the United States.)

WATER F LEVEL	CARIES STATUS		
	Caries-free	Active caries*	Rampant caries†
Deficient (<0.7 ppm)	Apply topical 2 x per year	Apply topical 2 x per year	Apply topical 4 x per year
Optimal	0	Apply topical 2 x per year	Apply topical 4 x per year

\*Active caries means the patient has one or more lesions. †Rampant caries means the patient has caries involving tooth surfaces not usually involved with caries, or patient has lesions that are rapidly progressing.

Source: Ripa LW. An evaluation of the use of professional (operator-applied) topical fluoride. J. Dent Res 1990;69 (Spec Issue):786-96.

**ADVANTAGES:** Applications require no patient compliance beyond keeping their dental appointment. Promotes remineralization and prevents caries initiation. Replaces fluoride-rich surface layer of enamel that may have been removed during prophylaxis. Can be applied by trained auxiliaries.

**LIMITATIONS:** Products contain large and potentially harmful amounts of fluoride if swallowed. These products should be used appropriately and kept out of reach of the patient. Frequent application of Acidulated Phosphate Fluoride (APF) may etch porcelain and some composite restorations. Therefore, use of neutral sodium fluoride gel or judicious use of APF is suggested for patients with such restorations. Some patients do not tolerate the procedure well. Fluoride varnishes gained FDA approval in 1994 but there are currently no fluoride varnish products accepted by the ADA Council on Scientific Affairs.

**CONSIDERATIONS:**

**TOOTH:** A four-minute application by tray is recommended with an ADA-accepted professional topical fluoride product (gel or foam). When contact time is reduced to one minute, the enamel fluoride uptake is significantly less. (Note: A professional prophylaxis is not needed prior to application of professional products because fluoride intake and caries inhibition are not improved by a prophylaxis. In addition, use of a fluoride prophylaxis paste does not constitute a professionally applied fluoride application.)

*Continued from Page 20*

Fluoride varnish preparations are reportedly effective for children and adolescents with high caries activity or adults with root caries.

**PATIENT:** Need to minimize unintentional ingestion of fluoride product, particularly in young children.

**REFERENCES:** Wei SHY, Yiu CKY. Evaluation of the use of topical fluoride gel. *Caries Res* 1993;27(Supplement 1):29-34.

Ripa LW. An evaluation of the use of professional (operator applied) topical fluoride. *J Dent Res* 1990;69(Spec Issue):786-96.

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Mandel ID. Fluoride varnishes—a welcome addition (Editorial). *J Public Health Dent* 1994;54(2):67.

American Dental Association, Council on Scientific Affairs. *Clinical products in dentistry—a desktop reference*. Chicago:ADA;1993.

## INTERVENTION: FLUORIDE DENTIFRICES

**INDICATIONS:** All patients, regardless of risk category, should floss daily and brush with an ADA-accepted fluoride dentifrice.

Recommending that patients purchase fluoride dentifrices that are accepted by the ADA is important because the ADA Seal of Acceptance ensures that the fluoride will be bioavailable when the dentifrice is used.

**ADVANTAGES:** Daily use of a fluoride dentifrice inhibits demineralization.

**LIMITATIONS:** Inadvertent swallowing of fluoride dentifrices by young children can lead to mild dental fluorosis.

**CONSIDERATIONS:**

**PATIENT:** Appropriate for all patients regardless of risk category. Young children (under 6 years of age) should be supervised while dispensing fluoride toothpaste so that only a pea-sized amount is used. Young children should be supervised while brushing to diminish inadvertent swallowing of fluoride dentifrice.

**REFERENCES:** American Dental Association, Council on Scientific Affairs. Clinical products in dentistry—a desktop reference. Chicago:ADA;1993. Published yearly.

## INTERVENTION: HOME FLUORIDE GELS OR RINSES

**INDICATIONS:** Adults and adolescents at moderate or high risk for caries.

Especially indicated for individuals undergoing head and neck radiation, undergoing orthodontic treatment, taking medications that decrease salivary flow or persons with Sjögren's syndrome.

**ADVANTAGES:** Can remineralize lost enamel crystals and inhibit demineralization.

Some of these products (for example, 0.05 percent sodium fluoride mouthrinses and 1.1 percent sodium fluoride gels) have been shown to help arrest early root caries lesions.

**LIMITATIONS:** Compliance may be difficult to achieve in some patients.

**CONSIDERATIONS:**

**TOOTH:** Neutral sodium fluoride preparations are preferred for patients with a large number of porcelain and/or composite restorations. APF rinses have been shown to enhance enamel fluoride uptake in vitro.

**PATIENT:** Fluoride products available over-the-counter:  
0.05 percent neutral sodium fluoride mouthrinse (225 ppm)  
0.1 percent stannous fluoride rinse (244 ppm)

Fluoride products available by prescription:  
0.05 percent APF mouthrinse (225 ppm)  
0.05 percent NaF mouthrinse (225 ppm)  
0.2 percent NaF mouthrinse (900 ppm, weekly rinse)  
0.4 percent stannous fluoride gel (1,000 ppm)  
\*1.1 percent acidulated sodium fluoride gel (5,000 ppm)  
\*1.1 percent neutral sodium fluoride gel (5,000 ppm)

\*Preferred product for individuals at high risk for dental caries

**REFERENCES:** Wei SHY, Yiu CKY. Evaluation of the use of topical fluoride gel. *Caries Res* 1993;27(Supplement 1):29-34.

Ripa LW. An evaluation of the use of professional (operator applied) topical fluoride. *J Dent Res* 1990;69(Spec Issue):786-96.

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American Dental Association, Council on Scientific Affairs. *Clinical products in dentistry—a desktop reference*. Chicago:ADA; 1993. Published yearly.

## INTERVENTION: ANTIMICROBIAL MOUTHRINSES

**INDICATIONS:** For high-risk individuals (with high cariogenic bacterial count and/or recent caries experience), the use of antimicrobial mouthrinses should be part of a multi-stage treatment sequence that also includes: restoration of frank carious lesions; sealing of appropriate pits and fissures and sealing or repair of fractured, non-carious margins of amalgam restorations.

**ADVANTAGES:** Alleviates unnecessary surgical treatment of caries. Antimicrobial agents can:

- reduce existing plaque;
- prevent formation of new plaque;
- selectively inhibit only those bacteria associated with disease;
- inhibit acid production, glucan synthesis, etc. Chlorhexidine gluconate (CHX) is a broad-spectrum antimicrobial agent with proven antiplaque effect.

**LIMITATIONS:** Must remove the nidi of infection (carious lesions) first. Need to regularly monitor bacterial counts and repeat treatment if count increases. CHX should be reserved for short-term use because of possible local side effects (for example, staining of teeth).

**CONSIDERATIONS:** Short-term use of CHX rinse: 1/2 oz, 30 second rinse, twice a day, for 30 days. Allow at least 30 minutes between toothbrushing and CHX rinse to avoid inactivation of CHX by toothpaste.

**REFERENCES:** Anderson MH, Bales DJ, Omness KA. Modern management of dental caries. *JADA* 1993;124(6):37-44.

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