Summary: Prevention of Craniofacial Injuries

Health education and injury prevention campaigns addressing the need for protective gear in sports and cycling activities can increase awareness and use. More rapid adoption can occur through legislation or regulation. Greater dissemination of safety measures for home and workplace can similarly lower the risk of falls and other unintentional injuries. With regard to reducing intentional injuries in the United States, current and ongoing policy discussions, legislative proposals, and research efforts are necessary first steps toward appropriate programs.

ORAL HEALTH PROMOTION AND DISEASE PREVENTION KNOWLEDGE AND PRACTICES

To take full advantage of emerging science-based health and health care practices, individuals, health care providers, and policymakers need to be sufficiently informed that they can take appropriate actions for themselves, for those for whom they have responsibility, and for the community at large. For the individual, these actions include brushing with a fluoride-containing dentifrice for caries prevention, brushing and flossing to prevent gingivitis and periodontal diseases, and avoiding tobacco and other substances that are detrimental to health.

Lack of knowledge can affect care. If parents are not familiar with the importance and care of their child's primary teeth or if they do not know that dental sealants exist, they are unlikely to take appropriate action or seek professional services. If the public is not aware of the benefits of community water fluoridation, public referenda and funding for such interventions are not likely to be supported. Similarly, if individuals do not know that an oral cancer examination exists, they may not ask about the need for one. However, it is well established that

BOX 7.2
Sports Injuries and Oral-Facial Trauma

The national concern regarding oral-facial injury is addressed in the Healthy People 2010 objective 15-31, which is to increase the proportion of public and private schools that require use of appropriate head, face, eye, and mouth protection for students participating in school-sponsored physical activities. The National Youth Sports Safety Foundation estimates that more than 3 million teeth will be knocked out in youth sporting activities this year, an injury almost completely preventable by wearing a mouthguard. Even more significant, oral-facial trauma from sports injuries will result in facial bone fractures, concussion, permanent brain injury, temporomandibular dysfunction, blinding eye injuries, and even death.

Currently, no systematic monitoring for oral-facial injuries exists in the United States. Progress toward a more broadly targeted Healthy People 2000 objective proved to be difficult to track because of the data requirements of monitoring all organizations, agencies, and institutions sponsoring sporting and recreational events that pose risk of injury. By focusing on schools, not only should the monitoring of progress be feasible, but healthy habits will be formed early. The hope is that by the time the athletes reach young adulthood they will recognize the hazards posed by their athletic interests and, perhaps, be more comfortable using protective devices than they would be without them.

It is estimated that as many as one third of all dental injuries are sports-related. A particularly high proportion of all baseball injuries (41 percent) is estimated to occur to the head, face, mouth, or eyes. Nowjack-Raymer and Gift (1996) reported that in 1991 more than 14 million U.S. school-aged youngsters participated in at least one sport that was listed on the 1991 National Health Interview Survey questionnaire, with more than 9 million of these children in organized baseball or softball.

Baseball and softball are the most popular organized sports, with nearly one quarter of the school-aged population playing. Unlike football, not all baseball/softball leagues or teams require the use of safety equipment. In many cases, only selected positions such as catchers and batters are covered by rules. Thus only 35 percent of players reported that they wore headgear all or most of the time, and only 7 percent wore mouthguards all or most of the time.

Further analysis of the interview data revealed a variety of socioenvironmental differences in the wearing of headgear and mouthguards. Forty percent of males who played baseball or softball reported wearing protective headgear "all or most of the time," compared with only 25 percent of females. Differences were also found by poverty level, with 36 percent of those at or above poverty level wearing headgear, compared with 24 percent of those below. Better educated parents were somewhat more likely than less educated parents to have responded that their child wore headgear "sometimes" (45 percent versus 38 percent) and non-Hispanics reported occasional use more than Hispanics (43 percent versus 30 percent). Parents of a greater percentage of baseball or softball players of high school age (12 percent) than elementary school-aged players (6 percent) reported that their child wore a mouthguard "all or most of the time." Also, more black (17 percent) than white (6 percent) children reported the use of mouthguards.

These socioeconomic differences might be greater were it not for the safety efforts of school athletic programs. Still, many parents and coaches are not as proactive as they could be and are not aware that facial injuries also occur in sports that are not considered high contact. For example, basketball players typically do not wear mouthguards. Yet approximately 34 percent of all injuries to basketball players involve teeth and/or the oral cavity.

Examples of community-based interventions to prevent sports-related, oral-facial trauma include the development of rules and regulations for the use of headgear and mouthguards in sports where craniofacial injury is a risk; efforts to alert players, parents, sports officials, and organizers to the potential for injury; better product design; and the creation of supportive environments for sports-related equipment and recreation areas.

knowledge alone will not necessarily lead to appropriate practices. For example, even if individuals know that tobacco use is unhealthful and that it contributes to multiple life-threatening illnesses, some continue to smoke. The majority of people who need such information most—those in low-income groups and those with lower levels of education—also are the ones who lack the information and skills (oral health literacy) to ask for and obtain specific preventive services or treatment options. Health professionals are in an ideal position to provide up-to-date health information and care to their patients. They also have an opportunity to enhance their knowledge and practices as well as increase their communication to patients about the procedures they provide and the reasons for these procedures.

Few national studies of public and professional knowledge, attitudes, and practices exist. Highlights from these as well as from state and local studies that evaluated the prevention of dental caries, periodontal diseases, and oral cancers are provided below. Generally, the public is unable to discriminate between methods that prevent dental caries and those that prevent periodontal diseases (Corbin et al. 1985, Gift et al. 1994). This confusion has been attributed to the prevailing marketing message that refers to them as "plaque diseases" preventable by thorough tooth cleaning with a toothbrush and floss. In addition, the general public and health care providers are not fully informed about the relative value of fluoride and the appropriate recommended applications of regimens to prevent dental caries (Corbin et al. 1985, Gallup 1992, Gift et al. 1994, O'Neil 1984). More work is needed to improve knowledge and practices related to oral cancer prevention as well. As with other areas of investigation, additional survey research is needed to better understand findings to date and to develop tailored interventions. Research is ongoing to improve the design of survey instruments and the wording of questions to address cultural and ethnic differences and interpretations.

Dental Caries Prevention

The Public

Most members of the general public, regardless of socioeconomic level, tend to believe that the best way to prevent dental caries is by brushing their teeth (Corbin 1985, Gift et al. 1994, O'Neil 1984). In the 1990 National Health Interview Survey (NHIS), respondents were asked the purpose of adding fluoride to public drinking water. About two thirds of the respondents 25 to 65 years of age knew that water fluoridation helps prevent caries, compared with only 51 percent and 49 percent of those 65 and older and 18 to 24 years of age, respectively. Blacks and Hispanics were less likely to know the value of this preventive procedure than whites. In the same survey, when asked to indicate the one best way to prevent tooth decay from five answers (limiting sugary snacks, using fluorides, chewing sugarless gum, brushing and flossing the teeth, and visiting the dentist every 6 months), only 7 percent of the respondents answered correctly that fluoride was the most effective (Gift et al. 1994). More than two thirds said tooth brushing and flossing were the most effective. These results paralleled those of earlier studies (Gift et al. 1994, O'Neil 1984). A lower perceived value of fluorides by the public in preventing dental caries also was seen in the 1985 NHIS (Corbin et al. 1985). In a survey of knowledge and beliefs of the public, dentists, and dental researchers about the best way to prevent dental caries, the public and the dentists identified tooth brushing, whereas dental researchers unanimously ranked fluorides, as most important (O'Neil 1984). A small study among Latina mothers showed that they believed that brushing with baking soda is a good way to prevent dental caries; they knew little about brushing with a fluoride-containing dentifrice (Watson et al. 1999).

Dental sealants and appropriate use of fluoride are critical for caries prevention. In the 1990 NHIS, about 32 percent of the public had heard of dental sealants, but among those only three fourths knew the purpose of this preventive measure (Gift et al. 1994). In 1991 the Gallup Organization conducted a poll for the American Academy of Pediatric Dentistry among a national sample of 1,200 parents of children 16 years and younger. The results indicated that only 58 percent believed fluoride to be very important to a child's oral health; another 36 percent considered it to be somewhat important. Eight of 10 parents did not know when a child should be prescribed fluoride supplements, and virtually no one knew when supplements should be stopped. Only 25 percent of parents in nonfluoridated communities reportedly give their children fluoride supplements (Gallup 1992).

Health Care Providers

In a national survey of U.S. dental hygienists' knowledge, opinions, and practices regarding dental caries etiology and prevention, over 90 percent agreed that "adults benefit from the use of fluorides" and that "root surface caries is an emerging problem." A little

less than one third did not provide fluoride treatments to adults. This same survey found that only 57 percent of the respondents recognized remineralization as fluoride's most important mechanism of action; rather, flossing was selected as the most effective procedure for preventing caries in adults. Also, only 18 percent reported providing the recommended time for acidulated phosphate fluoride (APF) gel treatment (Forrest 1998). A city-based survey of dentists and dental hygienists found that nearly 70 percent of the offices used lower than recommended topical fluoride application times and that some of the fluoride products reportedly used had not been clinically tested (Warren et al. 1996).

Periodontal Disease Prevention

The Public

In the 1990 NHIS the majority of household respondents (79 percent) could identify one common sign of "gum" disease. Level of education was directly related to knowledge of gum disease. Eighty-nine percent of those with more than a high school level of education were able to name a common sign of gum disease, compared with 79 percent of those with a high school education and 60 percent of those with less than a high school education (Gift et al. 1994).

A Roper report on oral health surveyed more than 1,000 adults 18 and older. Eighty percent reported that they did not believe they have had periodontal disease. However, 70 percent reported having experienced at least one symptom of gum disease—bleeding gums; swollen, painful, or receding gums; a change in bite; or loose teeth. Although 41 percent of the respondents said that losing their teeth was their greatest fear regarding oral health, only 38 percent who had bleeding gums said they told their dentists about the problem. Further, only 30 percent of the respondents who had experienced warning signs of gum disease were worried about developing periodontal problems in the future. Fifty-eight percent knew that plaque is the main cause of gum disease and that flossing alone will not prevent gum disease, whereas 77 percent knew that brushing alone would not prevent gum disease. The majority (90 percent) knew that gum disease could strike anyone at any age (Roper Report 1994).

In a recently reported study on the oral hygiene practices of a convenience sample of 34,897 users and nonusers of tobacco products who obtained dental care in 75 dental practices, 74 percent reported brushing twice a day and 36 percent reported flossing once daily (Andrews 1998). Tobacco users brushed and flossed much less frequently than nonusers. Patients with more than a high school education were less likely to use tobacco products and more likely to brush at least 2 times a day and floss daily than were those with less education.

A 1996 study of 1,000 U.S. adults showed that nearly one third (29 percent) of respondents were extremely or very concerned about getting gum disease. Concern was highest among younger respondents 18 to 49 years of age and those who very or somewhat frequently experienced bleeding gums. Only 6 percent said they frequently suffered from bleeding gums (2 percent very frequently and 4 percent somewhat frequently). Only 13 percent said a dental professional had diagnosed them with any kind of periodontal disease (gingivitis, pyorrhea, and periodontitis). Older respondents were somewhat more likely than younger ones to have been diagnosed with gum disease, and 17 percent reported experiencing gingival bleeding occasionally (Andrews 1998).

Health Care Providers

Studies of dental professionals regarding periodontal disease prevention practices are limited. In 1989, Dental Products Report launched a study to determine the involvement of general practitioners in periodontal care. Overall, general dentists and their hygienists have become more involved in the periodontal exam phase of patient treatment. This positive trend suggests that periodontal diagnosis and treatment are well integrated into general practice. For example, when asked "what phases of periodontal treatment are you providing at present?" 100 percent reported gingival exam and evaluation, 97 percent reported pocket probing, and 88 percent reported providing patient education. The majority of dentists (67 percent) used as many as six measurement sites per tooth. Nearly all (93 percent) reported having a referral relationship with a periodontist (Dental Products Report 1996).

Oral Cancer Prevention and Early Detection

The Public

U.S. adults generally are ill-informed regarding risk factors for and signs and symptoms of oral cancers. Further, a 1990 national survey found that only 14 percent of adults 40 and older reported that they had ever had an oral cancer examination. Of those, only 7 percent had had an exam within the last year

Horowitz et al. 1995). In a statewide survey in Maryland, 85 percent of the adults claimed to have heard of oral or mouth cancer, but only 28 percent reported ever having an oral cancer examination (Horowitz et al. 1996). A state-based study of veterans—a population at high risk for oral cancers—found that they were ill-informed and misinformed about these cancers (Canto et al. 1998a). Finally, a study among Latino youths who reported use of tobacco and alcohol found that they, too, were not knowledgeable regarding risk factors for oral cancers (Canto et al. 1998b).

Health Care Providers

A recent national pilot survey of U.S. dentists found that the respondents' knowledge regarding risk factors for and signs and symptoms of oral cancers and their reported practice of examination procedures were limited (Yellowitz et al. 1998). Most respondents believed they were adequately trained to provide oral cancer examinations, and 70 percent provided annual oral cancer exams to patients 40 and older. Seventy-four percent reported their knowledge of oral cancers to be current, yet only 30 percent correctly identified the age cohort most frequently diagnosed with oral cancers. Further, less than 50 percent correctly identified the stage at which most oral cancer lesions are diagnosed, and nearly one third of respondents could not identify the two most common sites of these lesions. Although 86 percent claimed to assess their patients' current tobacco use, only 50 percent assessed current alcohol use; relatively few dentists assessed past alcohol or tobacco use. There was a modest amount of misinformation as well. For example, 65 percent believed, incorrectly, that ill-fitting dentures and partials were a risk factor for oral cancers, and 47 percent believed, also incorrectly, that poor oral hygiene was a risk factor. Further, although the majority of dentists claimed to provide oral cancer examinations to the majority of their patients, a large proportion did not palpate the lymph nodes—part of a comprehensive oral cancer examination. These results confirm an earlier study conducted among a convenience sample of Maryland dentists and physicians in that both groups believed their knowledge and skills related to oral cancer prevention and early detection to be wanting (Yellowitz and Goodman 1995).

A recent national survey among U.S. dental hygienists found that although 98 percent agreed that oral cancer examinations should be provided annually for adults 40 and older, only 64 percent reported performing such an exam 100 percent of the time, and nearly 17 percent reported not performing an exam at any time (Forrest 1998). Further inconsistencies were found between knowledge of risk factors and performance. For example, although 94 percent correctly identified alcohol use as a risk factor for oral cancer, only 49 percent asked about alcohol use. Less than a majority (45 percent) reported their knowledge of oral cancers to be current. A majority (61 percent) believed they were adequately trained to palpate lymph nodes; still, only 24 percent reported routine palpating of lymph nodes, while 51 percent indicated they did not do so at any time.

Summary

Findings from national surveys, together with those from local studies, suggest that there are opportunities for enhanced educational efforts for both the public and health professionals to improve oral health. These studies focus on the public and the dental profession for selected diseases. New research is needed to assess knowledge, attitudes, and practices of all health professionals and for other conditions and risk factors related to oral health as well.

BUILDING UPON SUCCESS

As research and technology advance our understanding of the causes of major craniofacial diseases and disorders and lead to improved methods of diagnosis, treatment, and prevention, opportunities for new community-based prevention programs will grow. Ultimately, the application of any preventive intervention is driven by a combination of individual behaviors, community interventions, and professional practice. Only a few studies have taken into account all three spheres of action in determining health outcomes in a community (Arnljot et al. 1985, Chen et al. 1997). Our knowledge of the effects of multiple interventions is limited because most interventions were developed and tested singly.

In the past half century, however, advances in our understanding of oral diseases and the application of multiple preventive measures have resulted in continuing declines in the prevalence and severity of both dental caries and periodontal diseases for a sizeable majority of Americans. For dental caries, for example, experts now believe that most people can maintain a low risk of the disease by a combination of drinking fluoridated water and brushing daily with a fluoride dentifrice. They recommend that additional provider- and community-based dental prevention programs be targeted to high-risk individuals and groups.

Many of the studies reviewed in this chapter were conducted when higher rates of caries prevailed, community water fluoridation was less widespread, and use of fluoride dentifrices and supplements was not as common as today. These facts must be taken into consideration in contemporary decision making by public health professionals and policymakers. The validity and reliability of recommendations will benefit from the systematic reviews of the scientific evidence by the Task Force on Community Preventive Services (2000) to be included in a *Guide to Community Preventive Services*. Oral health promotion strategies are among those currently being evaluated.

Future innovations include implementing programs in new settings, such as workplaces, senior centers, and nursing homes, where individuals at high risk can be reached. Even if these programs are more expensive, the yield may be worth it if they reach those at high risk for disease. Similarly, focusing community-based interventions on populations at greatest risk will make optimal use of available resources. However, continued research to understand risk and improve ways to measure it is equally important for the success of these ventures.

A review of progress in reaching the Healthy People 2000 oral health objectives reveals relatively little gain across many of the objectives (Table 7.8). Progress in the next decade will require diligent efforts to identify public health problems, mobilize resources, and ensure that the necessary conditions are in place and crucial services received. Public health agencies will be instrumental in carrying out these functions, and state and local dental directors can perform a leadership role. Box 7.3 describes the public health services that are essential if a community is to realize fully the benefits of available disease prevention and health promotion interventions.

TABLE 7.8
Progress in meeting Healthy People 2000 oral health objectives

		Age	Baseline Data	HP 2000 Goal	Final Data	Summary
13.1	Reduce dental caries in children	6-8	54%	35%	52%	Prog
	Reduce dental caries in adolescents	15	78%	60%	61%	Prog +++
13.2	Reduce untreated dental decay in children	6-8	28%	20%	29%	Reversed
	Reduce untreated dental decay in adolescents	15	24%	15%	20%	Prog ++
13.3	Increase adults who have never lost a permanent tooth	35-44	31%	45%	31%	No Change
13.4	Reduce adults who have lost all their teeth	65+	36%	20%	30%	Prog ++
13.5	Reduce gingivitis among adults	35-44	41%	30%	48%	Reversed
13.6	Reduce destructive periodontal disease	35-44	25%	15%	22%	Prog +
13.7	Reduce oral and pharyngeal deaths in males	45-74	13.6%	10.5%	10.3%	Met
	Reduce oral and pharyngeal deaths in females	45-74	4.8%	4.1%	3.5%	Met
13.8	Increase sealants in children	8	11%	50%	23%	Prog ++
	Increase sealants in adolescents	14	8%	50%	24%	Prog ++
13.9	Increase persons on public water receiving fluoridated water		61%	75%	62%	Prog
13.10	Increase topical/systemic fluorides among nonfluoridated		50%	85%	No data	No data
13.11	Increase caregivers using feeding practices that prevent early childhood caries		55%	75%	No data	No data
13.12	Increase oral health screening, referral, follow-up, first time school attendee		66%	90%	75%	Prog ++
13.13	For long-term care, oral exam and services provided within 90 days		No data	100%	No data	No data
13.14	Increase use of oral health care system (adults)	35+	54%	70%	63%	Prog ++
13.15	Increase states with system for recording and referring orofacial clefts		11 states	40 states	23 states	Prog ++
13.16	Extend use of protective head, face, eye, and mouth equipment		No data	No data	No data	No data
13.17	Reduce smokeless tobacco use among males	12-17	6.6%	4%	3.7%	Met
		18-24	8.9%	4%	6.9%	Prog ++

Source: Adapted from NCHS 1999.

BOX 7.3
Essential Public Health Services for Oral Health

The Association of State and Territorial Dental Directors' *Guidelines for State and Territorial Oral Health Programs* (ASTDD 1997) identifies the following essential public health services to improve oral health:

I. Assessment
   - A. Assess *oral health status and needs* so that problems can be identified and addressed.
   - B. Analyze *determinants* of identified oral health needs, including resources.
   - C. Assess the *fluoridation status* of water systems, and other sources of fluoride.
   - D. Implement an *oral heath surveillance system* to identify, investigate, and monitor oral health problems and health hazards.

II. Policy Development
   - A. Develop *plans and policies* through a collaborative process that support individual and community oral health efforts to address oral health needs.
   - B. Provide *leadership* to address oral health problems by maintaining a strong oral health unit within the health agency.
   - C. Mobilize *community partnerships* between and among policymakers, professionals, organizations, groups, the public, and others to identify and implement solutions to oral health problems.

III. Assurance
   - A. Inform, educate, and empower *the public* regarding oral health problems and solutions.
   - B. Promote and enforce *laws and regulations* that protect and improve oral health, ensure safety, and assure accountability for the public's well-being.
   - C. *Link people* to needed population-based oral health services, personal oral health services, and support services and assure the availability, access, and acceptability of these services by enhancing system capacity, including directly supporting or providing services when necessary.
   - D. Support services and implementation of programs that focus on *primary and secondary prevention.*
   - E. Assure that the *public health and personal health workforce* has the capacity and expertise to effectively address oral health needs.
   - F. Evaluate *effectiveness, accessibility, and quality* of population-based and personal oral health services.
   - G. Conduct *research and support demonstration projects* to gain new insights and applications of innovative solutions to oral health problems.

FINDINGS

- Community water fluoridation, an effective, safe, and ideal public health measure, benefits individuals of all ages and socioeconomic strata. Unfortunately, over one third of the U.S. population (100 million persons) are without this critical public health measure.
- Effective disease prevention measures exist for use by individuals, practitioners, and communities. Most of these focus on dental caries prevention, such as fluorides and dental sealants, where a combination of services is required to achieve optimal disease prevention. Daily oral hygiene practices such as brushing and flossing can prevent gingivitis.
- Community-based approaches for the prevention of other oral diseases and conditions, such as oral and pharyngeal cancers and oral-facial trauma, require intensified developmental efforts.
- Community-based preventive programs are unavailable to substantial portions of the underserved population.
- There is a gap between research findings and the oral disease prevention and health promotion practices and knowledge of the public and the health professions.
- Disease prevention and health promotion approaches, such as tobacco control, appropriate use of fluorides for caries prevention, and folate supplementation for neural tube defect prevention, highlight opportunities for partnerships between community-based programs and practitioners, as well as collaborations among health professionals.
- Many community-based programs require a combined effort among social service, health care, and education services at the local or state level.

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CHAPTER 8

Personal and Provider Approaches to Oral Health

Oral health is not a given. It takes conscious and repeated efforts on the part of the individual, caregivers, health care providers, and the community. For the individual, daily hygiene routines and healthy lifestyle behaviors provide a frontline defense in disease prevention and health promotion. Equally important are periodic professional assessments of the individual's oral health status, which may include diagnostic, preventive, and therapeutic services and counseling. Community activities complement personal and provider approaches to oral health. As discussed in the previous chapter, these include water fluoridation, dental sealant applications for children, tobacco cessation campaigns, the use of mouthguards in sports, and a variety of other school- and community-based oral health promotion and disease prevention activities. The interaction of these components is critical to oral health, as it is to overall health. In particular, there is now a better understanding of the relationship of individual health to the health of the community in which the individual lives, and the importance of this relationship is one of the underlying premises of Healthy People 2010. This chapter discusses actions individuals can take to maintain their oral health and prevent disease, and reviews emerging approaches taken by dentists and other health care providers to promote oral health, assess risks, and prevent disease.

INDIVIDUAL RESPONSIBILITY: PERSONAL APPROACHES TO ORAL HEALTH

Sound personal hygiene practices and adherence to a healthy lifestyle are the mainstays of personal approaches to oral health. Long before the germ theory of disease, the need for tooth cleaning was recognized—if only to rid the mouth of food debris, eliminate odor, and improve appearance. Tools developed for this purpose have ranged from primitive tooth sticks and picks, still used in parts of the world, to the water irrigators and electronic toothbrushes available in industrialized societies. An impressive array of oral care products greets the shopper in supermarkets and pharmacies today. Beyond the dozens of toothbrush shapes and sizes, there are flavored and textured dental flosses, floss holders, rubber tips, toothpicks, small brushes for cleaning between teeth, scores of dentifrices, and a range of fluoride-containing, antitartar, and antiseptic mouthrinses.

Daily oral hygiene efforts contribute to the prevention of dental caries and periodontal diseases. The biofilm on tooth and root surfaces (dental plaque) can be disrupted to a large extent by the mechanical action of brushing and flossing. Daily efforts are necessary, not only because of food intake, but also because dental plaque is never completely removed. It starts to build up even after the most assiduous cleaning (or prophylaxis) in the dental office and even after the application of a potent antimicrobial mouthrinse. The oral and dental tissues and structures thus require more intensive daily care than do other body areas exposed to the environment.

Daily Hygiene and Dental Caries Prevention

The use of a fluoride-containing dentifrice is critical for dental caries prevention. Even more beneficial than the physical removal of plaque in toothbrushing is the delivery of a small amount of fluoride to the tooth surfaces. Investigators have conducted numerous clinical trials on fluoride dentifrices using rigorous designs and including randomized groups, double-blind designs, and placebo controls. All together, these studies provide strong evidence that using a

fluoride dentifrice is effective (Clarkson et al. 1993, Lewis and Ismail 1995, Stookey et al. 1993). Fluoride dentifrices account for more than 90 percent of the market in the United States, Canada, and other developed countries (Levy 1994).

A fluoride dentifrice is an effective means of reducing the prevalence of dental caries for all persons. Although children's teeth should be cleaned daily from the time they erupt, parents and caregivers should consult a dentist or other health care provider about the use of a fluoride dentifrice for children under the age of 2. For children under 6, fluoride dentifrices should be used in small amounts to minimize swallowing of the product. Mild enamel fluorosis can result from excessive dentifrice use, because children under 6 do not have adequate control of the swallowing reflex or may intentionally swallow a flavored dentifrice. Experts recommend that for children under 6, the parent or caregiver should supervise toothbrushing, apply a pea-sized amount (0.25 gram) of dentifrice to the toothbrush, and encourage the child to spit out the excess (Bawden 1992).

Because the topical benefits of fluoride have been shown to be highly effective, and daily exposure to small amounts of fluoride can reduce the risk of dental caries in all age groups, experts recommend that all persons drink water with an optimal fluoride concentration in addition to brushing daily with a fluoride dentifrice (Bawden 1992, CDC in press). This combination provides a cost-effective and easy way to prevent dental caries and is an excellent example of the individual-community partnership. For persons at low risk of dental caries, these two exposures to fluoride may be the only ones necessary. For persons at moderate or high risk of dental caries, additional fluoride may be helpful and can come from daily use of another fluoride product. These can include mouthrinses, prescribed supplements, and professionally applied topical fluoride products (CDC in press).

Daily Hygiene and the Prevention of Periodontal Diseases

Toothbrushing and flossing also play a critical role in the prevention of periodontal diseases. Unlike dental caries prevention, prevention and control of gingivitis and periodontitis are achieved directly through the mechanical removal and disruption of dental plaque (Genco and Newman 1996). Some dentifrices also contain chemical therapeutics to control the formation of tartar (calculus) (Mandel 1995) and to reduce plaque formation and gingival inflammation (Hancock 1996). Both manual and electric toothbrushing are effective at removing plaque and preventing gingivitis (Walsh et al. 1989, Axelsson et al. 1991). Interproximal (between the teeth) cleaning is also important in maintaining gingival health (Lang et al. 1994). In one short-term evaluation of adults, the addition of flossing to the daily regimen of brushing resulted in an almost twofold reduction in gingival inflammation (Graves et al. 1989). Because preventive measures in periodontics rely mainly on the removal of bacterial plaque and calculus, methods typically include personal oral hygiene measures combined with professional diagnostic and prophylactic measures (i.e., regular exam and cleaning). Periodic professional care for removal of plaque and calculus deposits has also been demonstrated to improve the periodontal health of participants (Cutress et al. 1991, Ronis et al. 1993).

Healthy Lifestyles

There is more to the individual's role in promoting oral health and hygiene than brushing and flossing. Other behaviors that have an influence on oral health include use of tobacco and/or alcohol products, diet, oral habits such as bruxing and clenching the teeth, and use of helmets, mouthguards, or other protective devices. Table 8.1 summarizes selected behaviors that have an effect on oral, dental, and craniofacial health status. These are described more fully in Chapters 3, 7, and 10.

Individuals can obtain credible information regarding oral health from various sources, including health care providers, professional organizations, government agencies, and patient advocacy groups. Increasingly, the World Wide Web is a source for health care information. For example, the National Oral Health Information Clearinghouse offers information on oral health, with an emphasis on special care patients and their health care providers.

Care Seeking

In addition to self-care, individuals also need to seek professional health care—both dental and medical—on a regular basis and whenever a problem manifests. The recall interval is based on the provider's assessment of the individual's dental and medical history and lifestyle behaviors, among other factors. In the case of children and dependent adults, parents and caregivers are responsible for teaching and encouraging healthy behaviors and seeking timely and appropriate care. As noted at the outset, it is only through the combination of individual and professional care, reinforced by community-based health promotion

and disease prevention programs, that optimal oral and general health can be achieved. The remainder of this chapter focuses on the role of the professional in oral health care.

PROVIDER-BASED CARE

The range of conditions and diseases that affect the craniofacial complex is extensive and can provide clinicians with important indications about the patient's general as well as oral health status. Management of the oral health–general health interface calls for interdisciplinary and coordinated care and an enhanced role for primary care providers. Dentists, oncologists, dermatologists, infectious disease specialists, hematologists, endocrinologists, plastic surgeons, and rheumatologists are just a few of the specialists who may be involved in the diagnosis and management of conditions affecting the craniofacial complex.

Dentists, their allied staff, and medical and nursing personnel are in a unique position to incorporate new approaches for prevention,[1] diagnostic, and treatment strategies in their practices. Advances in oral science are providing the basis for a shift in emphasis from the repair and restoration of damaged tissues to earlier diagnoses, control of infections, and remineralization and regeneration of lost tissues. The application of risk assessment strategies and interventions tailored to individuals and groups is

TABLE 8.1
Selected individual behaviors affecting oral, dental, and craniofacial health

Behavior	Effect
Diet and nutrition	Nutrition and diet contribute to oral and craniofacial development and to the maintenance of these tissues throughout life. Nutritional deficiencies during pregnancy can affect tooth size, enamel solubility, time of tooth eruption, salivary gland function, saliva composition, epithelial tissue, and susceptibility to dental caries. Deleterious effects specific to the dentition include protein-calorie malnutrition, deficiencies of vitamin A, ascorbic acid, vitamin D, calcium, phosphorus, iron, and iodine, and excessive fluoride. Linear enamel hypoplasia and hypomineralization during the first year of life increase susceptibility to dental caries in both deciduous and permanent teeth. The physical consistency, sequence, and frequency of carbohydrate intake (primarily refined sugars) have been linked to the development of caries. Reduced calcium intake is associated with greater levels of periodontal disease. Early clinical signs of nutritional deficiencies and eating disorders are often seen in and around the mouth. Oral lesions may also affect systemic nutrition. (See Chapter 10, Box 10.1.)
Oral hygiene and home care practices	Regular toothbrushing with a fluoride-containing dentifrice prevents dental caries. Rinsing with fluoride mouthrinse can aid in reducing caries and in the remineralization of tooth structure. Regular toothbrushing and proper flossing can prevent gingivitis.
Care seeking	Seeking health care—both dental and medical—on a regular basis and whenever a problem manifests is important. In the case of children or dependent adults, it calls for the caregivers to teach and encourage healthy behaviors and to seek appropriate care from a variety of care providers. Prenatal care, as well as oral health care prior to major treatments such as chemotherapy, is critical to overall oral and craniofacial health.
Parafunctional habits	Habitual grinding (bruxism) and/or clenching teeth are forms of abnormal motor behavior. These habits often occur during sleep. As with clenching and other oral habits such as frequent gum-chewing, bruxism can cause tooth wear and affect muscles of mastication. Treatment may begin with making the individual aware of the problem, providing an occlusal splint to prevent tooth wear, and using behavioral strategies.
Tobacco use	The use of tobacco in all forms increases the risk for oral and pharyngeal cancers, and smoking is a leading risk factor for periodontal diseases. Increased risk for dental caries has been associated with spit tobacco use. In HIV-infected individuals, tobacco use is a risk factor contributing to increased risk of the development of oral candidiasis. (See Chapter 10, Box 10.2.)
Alcohol use	Alcohol alone, as well as acting synergistically with tobacco, greatly increases the risk for oral and pharyngeal cancers. Independently, alcohol in excess is associated with circulatory and neurological problems, liver disease, and other organ-specific diseases and disorders. Alcohol use in pregnancy can lead to birth defects, such as fetal alcohol syndrome and its associated craniofacial defects and mental retardation.
Injury control practices	Proper use of helmets, mouthguards, safety belts, and other protective devices helps prevent injuries to the head, neck, and mouth.

[1]The term *prevention*, as used in this chapter, includes interventions aimed at reducing the incidence of disease in relatively healthy patients. It includes both health promotion and specific protection to control one or more risk factors. Some strategies, such as the prevention of tobacco use, are applicable to many oral diseases, including oral cancer, oral candidiasis, and periodontal diseases, whereas other strategies are specific, such as the use of dental sealants and fluorides for caries prevention.

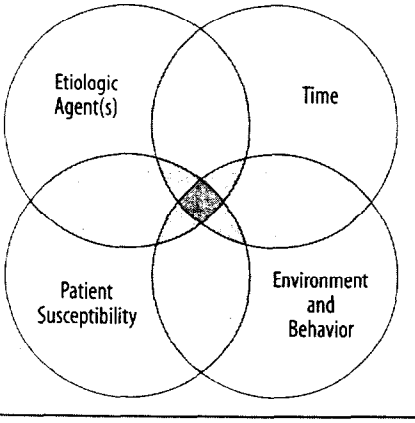
expanding with the increased understanding of risk factors and the development of biomarkers that signal host resistance, susceptibility, and the presence and progression of disease.

The changing demographics of the U.S. population and a greater understanding of the relationship between oral health and general health are presenting new challenges. Making clinical decisions for patients requires integrating a range of interacting biological, psychological, social, cultural, and environmental factors. In order for disease to manifest, the etiologic agent(s) must be present, the host must be susceptible, the environment conducive, and sufficient time available for the factors to interact (Figure 8.1). Early diagnosis and prompt treatment require an understanding of the pathology and of the diagnostic, prevention, and treatment modalities available. As genetic information accumulates, clinical judgments will increasingly be informed by knowledge of an individual's genetic susceptibility or resistance to particular diseases and disorders. The development of tailored treatment plans will require incorporating all these factors together with input from the patient's health providers, taking into consideration the patient's interests and needs. The following sections provide an overview of emerging approaches to clinical management and highlight selected diseases as examples.

Risk Assessment

Given the greater understanding of disease etiology, epidemiology, patient characteristics, and genetic information, it is becoming increasingly possible to determine an individual's risk of disease and tailor treatments accordingly. Risk assessment for dentistry has been defined as "the use of knowledge of factors that are associated with dental disease to determine which patients are more or less likely to prevent or control their dental disease" (Douglass 1998). The factors can include co-morbidities, medications used, and patient characteristics such as sex, age, and lifestyle behaviors, among others. By compiling such factors and sorting them by risk category, patients can be classified into high- or low-risk groups, enabling providers to make more comprehensive diagnoses and identify patients who would benefit from more aggressive prevention strategies. Such analyses conducted during the early stages of disease can result in treatments that reverse or contain the disease process (Douglass 1998). Knowledge of risk factors for oral and craniofacial diseases and disorders allows other health care providers to screen for these risk factors and contribute to improving oral health.

FIGURE 8.1
Factors involved in disease



Risk assessment and disease prediction studies have focused primarily on dental caries and periodontal diseases (Genco 1996, Page and Beck 1997, Pitts 1998, Powell 1998). In addition, risk factors for oral and pharyngeal cancers have been explored (Johnson 1991). The evidence base for risk assessment is developing from population-based studies. It involves a research process in which a suspected risk factor is related in a multivariate model to other factors and confounders (Beck 1990). The resulting model is tested in a second group of subjects, and a targeted intervention study is conducted to confirm the predictive validity of the risk factor.

Although the application of research findings of risk assessment has begun in some practices, the prediction of future disease at the individual patient level has not yet been extensively studied. Douglass (1998) has posed six clinically oriented questions that need to be addressed if risk assessment is to be adopted into routine clinical practice:

1. Does the scientific theory or biologic logic of the risk factor fit with our current body of knowledge about the disease in question?
2. Has the technical merit of identifying the risk factor (such as imaging technologies and bacterial assays) been evaluated?
3. Has the efficacy of the risk factor in predicting disease been evaluated in terms of sensitivity, specificity, and positive and negative predictive values?[2]
4. Has the potential effect of the risk factor on the disease management decision been explored? Can knowledge of the presence of a particular risk factor or pattern of risk factors alter the treatment plan?

5. Has the influence of the risk factor on oral health outcomes been assessed?

6. Has the cost-effectiveness of collecting risk factor data from each patient been evaluated? Is the added expense justified either by increased effectiveness or by avoiding other expenses?

Diagnostic Tests

Whereas risk assessment aims to predict future disease and disease progression, diagnostic tests evaluate a patient's current status with regard to a specific disease or disorder. They enable the provider to formulate, in cooperation with the patient, a treatment plan. In relation to dental caries and periodontal diseases, the diagnosis ideally should not only detect the presence of disease, but also distinguish between active and arrested disease.

Today, most diagnostic tests for oral conditions are based primarily on anatomic clinical evidence. However, microbiological, pathological, immunological, genetic, and tissue metabolite tests are increasingly available and valuable. Table 8.2 cross-references diseases with categories of diagnostic tests available. The following sections describe elements of a general health assessment and highlight risk assessment, diagnosis, and prevention of selected diseases and conditions.

Oral Health Assessment

An oral health assessment involves an evaluation of an individual's overall health status, including any risk factors and personal needs that can affect health and treatment options. For the majority of craniofacial conditions, this assessment and subsequent care are coordinated with a range of health care providers, with the intent of enhancing the patient's overall health and well-being.

The information gathered for the assessment is derived from patient information, extraoral and intraoral clinical examinations, and imaging and other diagnostic tests as needed. The patient provides demographic and lifestyle behavior information and a medical and dental history, including current complaints, if any. Symptom analysis entails an additional series of questions that explore symptom onset, characteristics, and course. Figure 8.2 provides an example of a medical history form used in dental practice.

The clinician will take into consideration the patient's general appearance and ability to function, as noted by characteristics of facial symmetry or asymmetry and speech. In addition, the patient's vital signs may be assessed, and a thorough examination of the head, neck, temporomandibular joints, and other structures will be conducted. The intraoral portion of the examination involves an extensive assessment of the tissues: the lips and labial mucosa, buccal mucosa and mucobuccal fold, the floor of the mouth, tongue, hard and soft palate, oropharynx, muscles of mastication, salivary glands and saliva, gingiva, periodontium, and teeth.

Depending on the needs of the patient, the initial physical examination is usually augmented by supplementary data from radiographs and sometimes by other diagnostic tests, including tissue biopsies and samples of oral cells and fluids. Such samples can be used to type specific bacteria, viruses, or fungi or to detect elevated levels of tissue metabolites or

TABLE 8.2
Categories of diagnostic methods for selected oral, dental, and craniofacial diseases and disorders

	Diagnostic Procedure	Caries	Periodontal Diseases	Oral Infections	Mucosal Diseases	Temporomandibular Disorders	Craniofacial Defects	Oral Cancers
Interview	Patient history	◆	◆	◆	◆	◆	◆	◆
Physical	Clinical examination	◆	◆	◆	◆	◆	◆	◆
	Probing/caries	◆						
	Probing/periodontal		◆					
Imaging		◆	◆			◆	◆	◆
Biologic	Histology/cytology			◆	◆			◆
	Microbiology	◆	◆	◆	◆			◆
	Genetics/DNA		◆		◆		◆	◆

[2]*Sensitivity* is a measure of how often the test is positive when applied to patients known to have a particular disease or condition; *specificity* is a measure of how successful the test is in judging the absence of a disease or condition.

FIGURE 8.2
Medical history form for use in dental practice

Medical History Form Date _____

Name _____ Home Phone (____) _____

Address _____ Business Phone (____) _____

City _____ State _____ Zip Code _____

Occupation _____ Social Security No. _____

Date of Birth _____/_____/_____ Sex M F Height _____ Weight _____ Single _____ Married _____

Name of Spouse _____ Closest Relative _____ Phone (____) _____

If you are completing this form for another person, what is your relationship to that person? _____

Referred by _____

For the following questions, *circle yes or no,* whichever applies. Your answers are for our records only and will be considered confidential. Please note that during your initial visit you will be asked some questions about your responses to this questionnaire and there may be additional questions concerning your health.

1.	Are you in good health?	Yes	No
2.	Has there been any change in your general health within the past year?	Yes	No
3.	My last physical examination was on _____		
4.	Are you now under the care of a physician?	Yes	No
	If so, what is the condition being treated? _____		
5.	The name and address of my physician(s) is _____		
6.	Have you had any serious illness, operation, or been hospitalized in the past 5 years?	Yes	No
	If so, what was the illness or problem? _____		
7.	Are you taking any medicine(s) including non-prescription medicine?	Yes	No
	If so, what medicine(s) are you taking? _____		
8.	Do you have or have you had any of the following diseases or problems?		
	a. Damaged heart valves or artificial heart valves, including heart murmur or rheumatic heart disease	Yes	No
	b. Cardiovascular disease (heart trouble, heart attack, angina, coronary insufficiency, coronary occlusion, high blood pressure, arteriosclerosis, stroke)	Yes	No
	1. Do you have chest pain upon exertion?	Yes	No
	2. Are you ever short of breath after mild exercise or when lying down?	Yes	No
	3. Do your ankles swell?	Yes	No
	4. Do you have inborn heart defects?	Yes	No
	5. Do you have a cardiac pacemaker?	Yes	No
	c. Allergy	Yes	No
	d. Sinus trouble	Yes	No
	e. Asthma or hay fever	Yes	No
	f. Fainting spells or seizures	Yes	No
	g. Persistent diarrhea or recent weight loss	Yes	No
	h. Diabetes	Yes	No
	i. Hepatitis, jaundice, or liver disease	Yes	No
	j. AIDS or HIV infection	Yes	No
	k. Thyroid problems	Yes	No
	l. Respiratory problems, emphysema, bronchitis, etc.	Yes	No
	m. Arthritis or painful swollen joints	Yes	No
	n. Stomach ulcer or hyperacidity	Yes	No
	o. Kidney trouble	Yes	No
	p. Tuberculosis	Yes	No
	q. Persistent cough or cough that produces blood	Yes	No
	r. Persistent swollen glands in neck	Yes	No
	s. Low blood pressure	Yes	No
	t. Sexually transmitted disease	Yes	No
	u. Epilepsy or other neurological disease	Yes	No
	v. Problems with mental health	Yes	No
	w. Cancer	Yes	No
	x. Problems of the immune system	Yes	No
9.	Have you had abnormal bleeding?	Yes	No
	a. Have you ever required a blood transfusion?	Yes	No

10. Do you have any blood disorder such as anemia? ..... Yes No
11. Have you ever had any treatment for a tumor or growth? ..... Yes No
12. Are you allergic or have you had a reaction to:
    a. Local anesthetics ..... Yes No
    b. Penicillin or other antibiotics ..... Yes No
    c. Sulfa drugs ..... Yes No
    d. Barbiturates, sedatives, or sleeping pills ..... Yes No
    e. Aspirin ..... Yes No
    f. Iodine ..... Yes No
    g. Codeine or other narcotics ..... Yes No
    h. Other _____
13. Have you had any serious trouble associated with any previous dental treatment? ..... Yes No
    If so, explain _____
14. Do you have any disease, condition, or problem not listed above that you think I should know about? ..... Yes No
    If so, explain _____
15. Are you wearing contact lenses? ..... Yes No
16. Are you wearing removable dental appliances? ..... Yes No
17. Do you currently use tobacco of any type? ..... Yes No
    If so, which type? _____
18. Are you a former tobacco user? ..... Yes No
    If so, which type of tobacco? _____
19. How many years have/did you use tobacco? _____
20. How much tobacco do/did you use a day? _____
21. If you have stopped using tobacco products, how long ago did you stop? _____
22. Have you ever used alcoholic beverages? ..... Yes No
23. How long ago did you stop using alcoholic beverages? _____
24. Do you currently use alcoholic beverages? ..... Yes No
    If so, which type? _____
25. How many times a week do you use alcoholic beverages? _____

Women

26. Are you pregnant? ..... Yes No
27. Do you have any problems associated with your menstrual period? ..... Yes No
28. Are you nursing? ..... Yes No
29. Are you taking birth control pills? ..... Yes No

Chief Dental Complaint _____

I certify that I have read and understand the above. I acknowledge that my questions, if any, about the inquiries set forth above have been answered to my satisfaction. I will not hold my dentist, or any other member of his/her staff, responsible for any errors or omissions that I may have made in the completion of this form.

Signature of Patient _____

For completion by the dentist.

Comments on patient interview concerning medical history: _____

Significant findings from questionnaire or oral interview: _____

Dental management considerations: _____

Date _____ Signature of Dentist _____

Medical history update:

Date	Comments	Signature

Source: Adapted from American Dental Association, as reproduced in Rose and Steinberg 2000.

immune system factors associated with disease. The number of such tests is increasing and will be supplemented by genetic tests to indicate an individual's susceptibility to specific diseases.

Currently, the assessment of oral and craniofacial health and disease involves intraoral radiographs as well as radiographic imaging, including arthrography, motion-based tomography, and computed tomography (Jeffcoat 1992). Intraoral radiographs permit detection of lesions between teeth and are the only widely available clinical test that can assess periodontal bone support in situ (Jeffcoat et al. 1995). Radiographs are an essential tool for treatment planning of complex prosthetic reconstructions as well as a diagnostic method to assess periodontal progression. However, the mere presence of bone loss on a radiograph does not imply progressive osseous destruction, although it does increase the patient's risk of future bone loss (Armitage 1996, Genco 2000). Radiographs have high specificity for disease progression, and low sensitivity. Because all radiographic examinations expose the patient to some, albeit small, level of ionizing radiation, current guidelines indicate that radiographs should not be taken routinely (FDA 1987), but should be prescribed after an initial assessment by the dentist.

Image processing techniques, such as digital radiography, enhance the clinician's ability to detect small intraoral osseous changes over time and aid in the detection of small changes in skeletal tissues between examinations. Direct digital radiography uses an intraoral detector to capture a radiographic image of the diagnostic area of interest (Ellwood et al. 1997, Matsuda et al. 1997). Several proposed methods for quantitative estimation of lesion mass or volumetry using digital subtraction radiography exist (Armitage 1996). A recent multicenter validation study has indicated that simulated lesions as small as 1 mg in mass may be detected with better than 90 percent sensitivity and specificity (Jeffcoat et al. 1996). These techniques are currently in use in clinical trials.

New diagnostic methods are also becoming available as adjuncts to existing methods for caries diagnosis. Comparing data between bite-wing radiographs of potential occlusal fissure lesions, Lussi et al. (1995) found that electrical resistance measurement may provide a substantial improvement in caries diagnosis.

Other imaging approaches are used to assess craniofacial anatomy, temporomandibular joints, maxillary sinuses, and other associated tissues, and in the assessment of the size and quality of bone to receive dental implants. Magnetic resonance imaging (MRI) is also receiving increased attention for craniofacial applications, such as for the assessment of the temporomandibular joints. Finally, light-based imaging of teeth and associated structures, using a small intraoral camera, gives both the patient and the provider a wide-screen view of the oral cavity, aiding in patient education.

In the course of conducting a general assessment, the clinician notes disease-specific signs and symptoms. While examining the teeth, the clinician may detect signs of relatively rare hereditary diseases such as ectodermal dyplasias, or more common destructive habits such as bruxism, where the enamel and at times the dentin may be abraded. Examinations of the face and oral cavity may reveal the effects of intentional and unintentional injuries. With the results of the general assessment in hand, the clinician will classify the patient's general and oral health status and make treatment and/or referral recommendations.

A classification system adopted in 1962 by the American Society of Anesthesiologists, used to categorize a patient's risk on the basis of physical status, also has been applied, along with the patient's general and oral health risk assessment, to determine the need for coordinated multidisciplinary referral and whether care in a hospital is indicated rather than in the dental office (Bricker et al. 1994) (Table 8.3).

Changing Approaches to Selected Diseases and Conditions

The science and technology base is providing new approaches to risk assessment, diagnosis, prevention, and treatment. Highlights of selected diseases and conditions follow.

Dental Caries

Dental caries is caused by a transmissible microbial infection that affects tooth mineral. A number of factors play a role in the initiation and progression of the disease, including bacterial biofilm, specifically the presence of mutans streptococci and species of lactobacilli; the frequency of simple sugars in the diet; the flow and composition of saliva; the availability of fluoride; the structure of tooth mineral in a given individual; and oral hygiene behaviors. Sound caries management takes all these factors into account (Figure 8.3) (Burt and Ismail 1986). Today there is the prospect that clinicians will be able to balance protective and pathologic factors and work with the patient to control disease (Anderson et al. 1993, Edelstein 1994, Featherstone 1996).

Risk Assessment. Reviews of caries risk prediction models conclude that clinical variables, especially past caries experience, are the best predictors of new caries experience (Newbrun and Leverett 1990, Powell 1998). Table 8.4 shows a timeline summarizing the strongest predictors of caries incidence based on a review of the modeling literature. At the time of initial tooth eruption, the presence of mutans streptococci appears to be the primary predictor of future caries. With continued tooth eruption, this variable disappears as a primary predictor and is replaced by the status of the most recently exposed or erupted tooth surface. For example, the presence of carious lesions in the primary incisors has been found to be the best predictor of caries in the later-erupting primary molars (Powell 1998).

Despite recent declines, dental caries is a prevalent disease, with some age and population groups particularly vulnerable (see Chapter 4). A guide for the identification of vulnerable patients and the treatment of caries as an infectious disease has been developed (ADA 1995). Figure 8.4, from that guide, proposes questions to be considered at an initial examination. These questions, together with information gathered at recall examinations, allow classification of child and adult patients into high-, moderate-, and low-risk disease categories (Table 8.5). This approach has been incorporated in a variety of caries risk assessment forms adopted by some dental schools and managed care programs (C.W. Douglass, personal communication, 1999). Studies are needed to determine the validity and reliability of such approaches for different patient populations and practice settings.

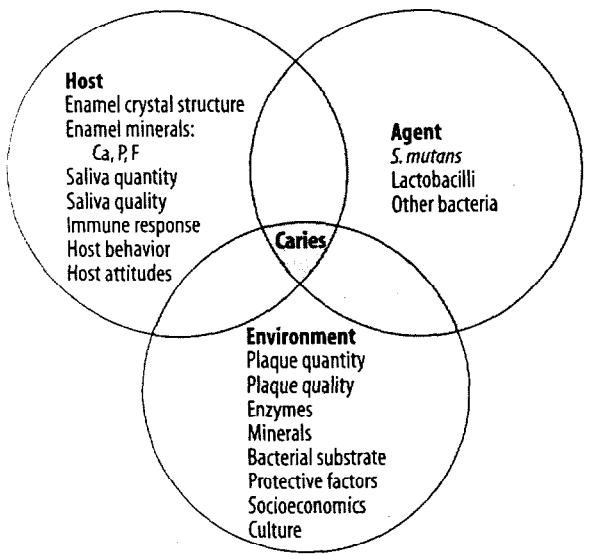
The use of tests to assess caries risk to determine the activity status of preclinical disease is becoming more widespread. A range of diagnostic aids for caries activity testing are available. Microbial tests can detect the presence and quantify the levels of lactobacilli and mutans streptococci. The development and use of these tests are based on studies that have associated these microbes individually and together with different types of carious lesion development. Measurements of plaque and salivary pH have been used to evaluate the oral environment overall and to note the changes in pH that occur after eating various foods. Salivary flow and composition analyses add another dimension. Decreased flow has been related to caries susceptibility, as have increases in viscosity. These factors warrant further study to determine their sensitivity and specificity.

TABLE 8.3
American Society of Anesthesiologists—medical risk categories and associated dental considerations

ASA Classification	Dental Consideration
Physical status 1 A patient without systemic disease; a normal, healthy patient	Routine dental therapy without modification
Physical status 2 A patient with mild systemic disease	Routine dental therapy with possible treatment limitations or special considerations (e.g., duration of therapy, stress of therapy, prophylactic consideration, possible sedation, and medical consultation)
Physical status 3 A patient with severe systemic disease that limits activity but is not incapacitating	Dental therapy with possible strict limitations or special considerations
Physical status 4 A patient with incapacitating systemic disease that is a constant threat to life	Emergency dental therapy only, with severe limitations or special considerations

Source: Genco 2000. Risk factors for periodontal disease. In Rose LF, Genco RJ, Cohen DW, Mealey BL. Periodontal medicine. Hamilton: B.C. Decker Inc. 2000:35-43. Copyright 2000 by B.C. Decker Inc. Reprinted by permission of B.C. Decker Inc. (2000).

FIGURE 8.3
Multifactorial model of dental caries



Source: Burt and Ismail 1986. Copyright 1986 by *Journal of Dental Research*. Reprinted by permission of *Journal of Dental Research* (2000).

Diagnosis. Clinical signs, patient-derived history, and radiographic images remain the primary means of dental caries diagnosis. Tooth surface pitting and cavitation, white and/or brown spots, areas soft to tactile probing, and radiolucencies are used to detect the effects of this disease. The most common diagnostic approaches include visual inspection, the use of an explorer (a probelike instrument) to determine the integrity of the tooth surface, the use of a light source to detect difference in reflectance across tooth structure (transillumination), and radiographs. Table 8.6 compares the reported sensitivity and specificity of selected methods. No single method stands out as superior with regard to both sensitivity and specificity for all tooth surfaces.

The most basic diagnostic methods—visual alone and visual examination with an explorer—have limited sensitivity, but excellent specificity. The visual examination may be combined with a radiographic series for the initial assessment. Bite-wing radiographs are frequently used to diagnose interproximal caries (between teeth) and for these surfaces provide excellent sensitivity and specificity. Radiographic examination allows examination of otherwise inaccessible areas. Specifically, the depth of a lesion and its relationship to the pulp chamber can be evaluated for interproximal lesions. However, radiographs are of little value in detecting caries on the occlusal surfaces of the teeth. For these surfaces, a negative radiographic diagnosis does not imply lack of a carious lesion in enamel.

Precavitated carious lesions and caries in restored teeth pose an additional diagnostic challenge. A review of the literature on the clinical diagnosis of precavitated carious lesions concluded that visual detection of these lesions has low sensitivity and moderate specificity (Ismail 1997). It is difficult with these lesions to determine whether there is no caries or whether only the enamel or outer layer of dentin is involved. Carious lesions forming around restorations are seen more frequently at the approximal and cervical margins of these restorations (Mjör 1985). Distinctive color changes around a restoration alone are not diagnostic of active caries (Kidd 1990).

Currently, the progression of carious lesions is the most definitive diagnostic parameter for disease activity. Progression can be determined over specific time intervals only by professional assessment.

Prevention. The primary prevention of dental caries starts with adequate prenatal and perinatal nutrition to ensure normal development of the teeth and supporting structures. It continues with interventions aimed at preventing transmission of cariogenic microbes from caregivers to infants, and proceeds with specific strategies employed across the life span. These approaches include the provision of sufficient fluoride, the use of dental sealants, the adoption of healthy behaviors, including avoiding unhealthy dietary practices and practicing appropriate oral hygiene, and the timely use of care services. Although many factors are brought to bear on the primary prevention of dental caries, the combination of fluoride in its multiple forms and dental sealants is the foundation (as described in Chapter 7).

Fluoride is available in a variety of products that can be used by health professionals, individuals, and public programs. Topical solutions and gels, mouthrinses, and dentifrices are available for daily, weekly, or as-prescribed frequency. In addition,

TABLE 8.4
Timeline of strongest clinical predictors of caries incidence

Age (years)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14-21	22-45	>45
Dentition	Primary						Mixed								Early permanent	Mature permanent	
Event	Eruption primary molars						Eruption first permanent molar				Eruption second permanent molar					Progression of gingival recession	
Predictor	Mutans streptococci		dmfs, especially primary incisors Mutans streptococci and lactobacilli				dmfs, especially primary molars First molar occlusal morphology DMFS				DMFS, especially first permanent molars First molar occlusal morphology Incipient smooth surface lesions				Incipient smooth surface lesions DMFS	Not studied	Coronal and root DMFS Number of teeth Periodontal disease

Note: dmfs = decayed, missing, or filled primary tooth surfaces; DMFS = decayed, missing, or filled permanent tooth surfaces.

Source: Powell 1998. Caries prediction: a review of the literature. *Community Dentistry and Oral Epidemiology* 1998; 26:361-71. Copyright 1998 by Munksgaard International Publishers Ltd., Copenhagen, Denmark. Reprinted by permission of Munksgaard International Publishers Ltd., Copenhagen, Denmark (2000).

FIGURE 8.4
Caries risk questions for initial examination

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

Source: American Dental Association Council on Access, Prevention and Interprofessional Relations 1995. Caries diagnosis and risk assessment. A review of preventive strategies and management. JADA; 126: 15-245. Copyright 1995 by American Dental Association. Reprinted by permission of ADA Publishing Co. Inc. (2000).

fluoride-containing prophylactic pastes are available for professional application (see Chapter 7). Clinical judgment of risk factors determines the type and frequency of interventions needed.

Although there is general agreement on the overall value of topical fluorides in reducing dental caries (ADA 1986, 1994, Moss 1976, Stookey et al. 1993), comparative clinical trials are needed to determine which of the existing fluoride formulations (acidulated phosphate fluoride, stannous fluoride, amine fluoride, or sodium fluoride) and which delivery system (gel, varnish, dentifrice, or solution) are most efficacious.

A second line of defense is through control of the etiologic agent. Chemotherapeutic agents (including the antimicrobial mouthrinse agent chlorhexidine and fluoride) can be used to reduce plaque. Dietary measures aimed at reducing the frequency and quantity of sugars and the substitution of sugars by sugar-free sweeteners may effectively starve the bacteria.

The process of tooth demineralization and remineralization has received significant attention over the past four decades (Geiger et al. 1992, Koulourides et al. 1961, Larsen and Fejerskov 1987, Linton 1996, Silverstone et al. 1981, White 1988), although the concept was documented in the early 1900s (Head 1912) (see Chapter 3). Investigators are studying the effectiveness of therapeutic agents for arresting carious lesions and remineralizing enamel in populations at high risk for dental caries. For example, a combined chlorhexidine-fluoride solution can enhance remineralization of incipient lesions and arrest caries in patients who suffer from radiation-induced caries (Katz 1982). The use of a twice-daily rinse with 0.05 percent sodium fluoride to prevent demineralization and induce remineralization in subjects with radiation-induced hyposalivation has also been found to be effective (Meyerowitz et al. 1991). This study also addressed the effects of chlorhexidine use alone, which has been associated with tooth staining, alterations in taste, and potential hypersensitivity reactions (Ohtoshi et al. 1986, Okano et al. 1989). Schaeken et al. (1991) showed that the application of 40 percent by weight chlorhexidine varnish every 3 months enhanced remineralization of root caries more than fluoride varnish, although both treatments were associated with fewer filled root surfaces than the control group after 1 year. A chlorhexidine varnish has not yet been approved in the United States, and large-scale, double-blind, placebo-controlled clinical trials are not yet available to test the effects of specific regimens in relation to caries risk.

Studies also are evaluating interventions to prevent mutans streptococci transmission. Findings from cross-sectional studies indicate that infants are initially infected by their parents, specifically mothers, around the time the teeth erupt (Berkowitz et al. 1975, Caufield et al. 1993, Kohler and Bratthall 1978). A longitudinal study using DNA fingerprinting demonstrated that mothers were the source of the

TABLE 8.5
Caries risk classification guidelines

Risk Category	Age Category for Recall Patients[a]	
	Child/Adolescent	Adult
Low	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 3 years Adequately restored surfaces Good oral hygiene Regular dental visits
Moderate	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 3 years Exposed roots Fair oral hygiene White spots and/or interproximal radiolucencies Irregular dental visits Orthodontic treatment
High	≥2 carious lesions in last year Past smooth surface caries Elevated mutans streptococci 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 3 years Past root caries; or large number of exposed roots Elevated mutans streptococci count Deep pits and fissures Poor oral hygiene Frequent sugar intake Inadequate use of topical fluoride Irregular dental visits Inadequate saliva flow

[a]At initial visit for new patient, 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 that can lead to the development of early childhood caries. 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.

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TABLE 8.6
Sensitivity and specificity of selected dental caries diagnostic procedures

	Sensitivity (percentage)	Specificity (percentage)	References
Visual examination of noncavitated fissures	12-31	70-99	Lussi 1993, Ketley and Holt 1993
Examination using explorer	14-24	70-99	Penning et al. 1992, Lussi 1993
Radiographs of approximal lesions	50-90	85+	Gröndahl 1989, Benn and Watson 1989

bacteria in their infants and the degree of matching to maternal strains was higher for female infants than for males (Li and Caufield 1995). Based on a study of child-mother pairs (with the child initially at 1 year of age), the application of a 1.0 percent chlorhexidine rinse alternated with a 0.2 percent sodium fluoride gel to the mother's teeth (3 times per day on 2 consecutive days, twice per year for 3 years) delayed, and in some cases prevented, the colonization of their children's teeth by mutans streptococci (Tenovuo et al. 1992). Timing of colonization has been shown to be correlated with caries prevalence. In a longitudinal study that followed children in 4-month intervals from 15 months to 4 years of age, children who were infected earlier had a higher caries prevalence than those in whom the infection was detected at later ages. Studies also have been aimed at reducing the levels of cariogenic bacteria in the infants themselves.

Work continues on the development of a caries vaccine. One approach focuses on the production and release of antibodies against cariogenic bacteria antigens (Russell et al. 1995). Specific antigens have been purified and synthesized. Another approach involves biological replacement therapy, where nonpathogenic bacteria, instilled in the mouth, prevent pathogenic bacteria from colonizing (Hillman et al. 2000). Yet another approach employs passive immunization in which antibodies, produced outside the body (in cultures, animals, eggs, or plants), are applied to the teeth and oral tissues to protect against disease. A recent study indicated that "plantibodies" painted on the teeth could prevent mutans streptococci colonization for 120 days, the period of the experiment (Ma et al. 1998).