

Position of the American Dietetic Association: Oral health and nutrition

ABSTRACT

It is the position of the American Dietetic Association (ADA) that nutrition is an integral component of oral health. The ADA supports the integration of oral health with nutrition services, education, and research. Collaboration between dietetics and dental professionals is recommended for oral health promotion and disease prevention and intervention. Scientific and epidemiological data suggest a lifelong synergy between nutrition and the integrity of the oral cavity in health and disease. Oral health is an integral part of systemic and nutritional health. Two primary oral infectious diseases are directly influenced by diet and nutrition. Dental caries or tooth decay is modulated by numerous factors, including diet composition and frequency. Periodontal or gum disease is associated with malnutrition. Chronic diseases such as diabetes and cardiovascular disease that are modulated by diet and nutrition intervention have oral sequelae. As we advance in our discoveries of the links between oral and nutrition health, practitioners of both disciplines must learn to provide screening, baseline education, and referral to each other as part of comprehensive client/patient care. The future of dietetics practice requires dietetics professionals to provide medical nutrition therapy (MNT) that incorporates a person's total health needs, including oral health. Inclusion of both didactic and clinical practice concepts that illustrate the role of nutrition in oral health is essential in both dental and dietetic education programs. Collaborative endeavors between dietetics and dentistry in research, education, and delineation of health provider practice roles are needed to ensure comprehensive health care to persons with oral infectious disease and/or oral manifestations of systemic diseases. *J Am Diet Assoc.* 2003;103:615-625.

As a body of knowledge, dietetics, and nutrition has expanded to touch all segments of health care. Scientific and epidemiological data suggest a lifelong synergy between nutrition and the integrity of the oral cavity in health and disease. Paralleling this cross-disciplinary trend is a change in the health care system toward a coordinated team care approach that requires collaborative effort among health care providers (1). Thus, partnerships among dietetics, dental, and other health professionals need to be identified, developed, strengthened, and expanded to encourage integrated, comprehensive practice. The multifaceted interactions between nutrition and oral health in practice, education, and research in both dietetics and dentistry merit detailed delineation.

POSITION STATEMENT

It is the position of the American Dietetic Association (ADA) that nutrition is an integral component of oral health. The ADA supports the integration of oral health with nutrition services, education, and research. Collaboration between dietetics and dental professionals is recommended for oral health promotion and disease prevention and intervention.

RATIONALE

Oral health and nutrition have a synergistic relationship. Oral infectious diseases, as well as acute, chronic, and terminal systemic diseases with oral manifestations, impact functional ability to eat as well as diet and nutrition status. Likewise, nutrition and diet may affect the development and integrity of the oral cavity as well as the progression of diseases of the oral cavity. According to The Surgeon General's report on "Oral Health in America," diet and nutrition are major multifactorial environmental factors in the etiology and pathogenesis of craniofacial diseases and disorders (2).

ORAL INFECTIOUS DISEASE

Dental Caries

Dental caries is a major cause of tooth loss in the United States. Nearly 20% of young children, almost 80% of young adults, and approximately 95% of older adults have experienced dental decay (3). Early childhood caries (ECC) in infants and preschool children appears to be related to feeding behaviors after

prolonged bottle- or breastfeeding. Patterns in the introduction of foods, when eating behaviors are being established, may be influential in the prevention and treatment of this disease (4,5). Caries seen in children and young adults, and root and coronal caries in elderly people, causes unnecessary pain and expense (6,7). Furthermore, children and adults with craniofacial problems, neurologic abnormalities, or impaired cognitive abilities are at greater risk for oral infectious diseases that can interfere with appropriate responses to feeding protocols (8).

Diet and nutrition have a direct influence on the progression of tooth decay, a communicable yet preventable oral infectious disease (2). The major components of a preventive dental regimen are designed to maintain an equilibrium in the dynamic demineralization-remineralization of the tooth surface (9). Included are measures to assure diet counseling, fluoride therapy (9,10), use of sealants, and control of cariogenic bacteria (9,11,12). Nutrition education by dental professionals and nutrition counseling by dietetics professionals must address dietary risk factors associated with oral disease (13). The primary factors to consider in determining the cariogenic, cariostatic, and anticariogenic properties of the diet are food form (liquid, solid or sticky, long lasting), frequency of consumption of sugar and other fermentable carbohydrates, nutrient composition, potential to stimulate saliva, sequence of food intake, and combinations of foods (14-17). See Figure 1 for a glossary of related terms.

Tooth erosion associated with eating disorders such as anorexia nervosa and bulimia nervosa (18) and dietary practices involving frequent intake of acidic foods and beverages (19) can weaken tooth integrity and further increase caries risk. A focus on the importance of improved dietary habits for good oral health as well as good general health should be included with counseling. Diet education and counseling for caries prevention and control should be done by a dental professional as a component of a patient's comprehensive dental care (13,18-22). Nutrition counseling for patients with caries who have coexisting medical problems that affect diet, such as cardiovascular diseases, diabetes, end-stage renal disease, eating disorders or cancer, should be performed by a registered dietitian (RD).

Periodontal Disease

Periodontal disease (PD) is an oral infectious disease involving inflammation and loss of bone and the supporting tissue of the teeth. Although the pathogenesis of PD involves bacteria and the host response to these bacteria, there are local and systemic factors that influence the severity and progression of the disease (23). Systemic influences on the disease include types 1 and 2 diabetes mellitus, smoking, stress, osteopenia and osteoporosis, immune status of the host, and presence of pathogens associated with PD in the subgingival flora (23,24). Nutrient deficiencies, ie, vitamin C and calcium, may compromise the systemic response to inflammation and infection and alter nutrient needs (23-25). Preliminary research has demonstrated that smokers consuming low levels of vitamin C had significantly higher levels of PD; however, there are no recommendations to date for supplemental doses of vitamin C for prevention or treatment of PD (23).

Nutrient deficiencies can compromise the associated inflammatory response and wound healing (20,26). Nutritional status

Cariogenic Foods/drinks containing fermentable carbohydrates that can cause a decrease in salivary pH to <5.5 and demineralization when in contact with microorganisms in the mouth.

Cariostatic Foods that are not metabolized by microorganisms in plaque and subsequently cause a drop in salivary pH to <5.5 within 30 minutes.

Dental caries (decay) An oral infectious disease of the teeth in which organic acid metabolites produced by the metabolism of oral microorganisms lead to demineralization and destruction of the tooth structure.

Early Childhood Caries (ECC) Rampant dental caries in infants and toddlers. Previously called baby bottle tooth decay or maxillary anterior caries. ECC is one or more primary maxillary incisors that is decayed, missing or filled (99).

Gingivitis Inflammation of the soft tissue component of the periodontium.

Periodontal disease Oral disease characterized by inflammation and destruction of the attachment apparatus of the teeth, including the ligamentous attachment of the tooth to the surrounding alveolar bone.

Root caries (decay) Progressive lesions that are "confined to the root surface, or involve the undermining of the cemento-enamel junction, but . . . [are] clinically indicated to be initiated on the root surface" (17).

Tooth erosion The gradual loss of the outside, hard surface of the tooth due to chemical, not bacterial, processes. It is most commonly associated with frequent consumption of acidic beverages or frequent vomiting or regurgitation as occurs with bulimia or gastro-esophageal reflux disease.

FIG 1. Definitions of oral health terms.

has a direct influence on the synthesis and release of cytokines and their action. Consequently, malnutrition is associated with increased needs for calories and protein to promote repletion, wound healing, and an improved immune response (26). Likewise, malnutrition can elicit adverse alterations in the volume, antibacterial, and physiochemical properties of saliva. Good nutritional status and dietary practices combined with removal of the stimuli of the inflammatory periodontal response are important in diminishing the severity of PD (26). Changes in structural tissue can also affect masticatory functions (12). A balanced diet consistent with the Food Guide Pyramid (*The Food Guide Pyramid*. Washington, DC: US Department of Agriculture Center for Nutrition Policy and Promotion; 1996. Home and Garden Bulletin No. 252) provides for adequate intake of all nutrients including Vitamins C and D, and calcium. Supplemental intake of any nutrients beyond the dietary reference intakes is not recommended for the prevention or treatment of PD.

Positive relationships between PD and other chronic disease states, including cardiovascular disease and obesity, have been demonstrated (27-29). To date, much of the evidence has been based on epidemiological and historical data, including the National Health and Nutrition Examination Survey (NHANES) III. Prospective clinical studies in large populations are needed to explore these relationships in greater detail. Further research

is needed to explore the impact of alternations in oral soft tissues associated with aging on the risk and extent of PD.

Osteoporosis and PD

Bone resorption and loss are common denominators for both PD and osteoporosis. Analysis of the NHANES III data has demonstrated a relationship between low dietary calcium and increased risk of PD (23). Krall and colleagues demonstrated a positive association between calcium and vitamin D supplementation and reduced risk of tooth loss in postmenopausal women, whereas those who experienced tooth loss were significantly more likely to experience systemic bone loss (30). Data from the Veterans Administration Normative Aging Study link the benefits of an adequate calcium intake with a reduced incidence of alveolar bone loss in men (24). Low dietary calcium intake has been shown to be an indicator of risk for PD in women under 40 years of age and men over 60 years of age. Several theories for the link between PD and osteoporosis beyond the common denominator of bone have been postulated; discussion of these go beyond the realm of this paper but can be found in the relevant literature (28,31,32). Research on the role of vitamin D has produced mixed results secondary to small sample sizes, varying definitions of PD and osteoporosis, and lack of prospective data (32). Although increasingly, studies are supporting the association between osteoporosis and PD, the causal relationship remains to be established (31,32). Although studies have demonstrated associations between tooth loss, low calcium intake, and periodontal disease, there is no evidence to support recommendations for calcium intake beyond what is consistent with the Dietary Reference Intakes (DRIs) and for the treatment of osteoporosis.

Medically Compromising Conditions

The oral cavity is the entry portal to the gastrointestinal tract. Thus, risks for oral problems increase with many systemic and chronic disease states, changes in health status, and/or adoption of practices that may also affect diet and nutritional status (29) (Figure 2).

Diabetes Mellitus

Diabetes mellitus (DM) is a chronic disease with systemic manifestations. Poorly controlled diabetes (characterized by hyperglycemia, elevated hemoglobin A1C, and increased salivary glucose) is associated with an increased risk of several diseases and conditions. Microangiopathies, altered vascular permeability, and altered host response mechanisms increase risk of periodontal disease. Xerostomia and its consequent reduced salivary flow increases risk of dental caries, altered sense of taste, and burning mouth syndrome. Individuals with diabetes are also at increased risk for compromised wound healing and increased incidence and severity of local systemic diseases, including fungal infections, gingivitis, and dental caries. Success of certain dental procedures, such as surgery and denture placement, is dependent on good glycemic control, which is a result of good dietary management. Individuals with both types 1 and 2 DM are at increased risk of PD, a relationship that, at times, can be viewed as bidirectional (33). Whereas poorly controlled DM may increase risk of oral infectious diseases, including PD; likewise, PD can compromise the metabolic control of individuals with diabetes (34). The metabolic pathways responsible for these processes deal with the catabolic nature of infections, increasing serum glucose values, and other factors outside of the realm of this paper (34-36). Improved periodon-

- Anorexia
- Bulimia
- Cardiovascular disease
- Craniofacial anomalies
- Developmental disorders
- Diabetes
- Disorders of taste and smell
- Early childhood caries
- End-stage renal disease
- Erosion
- Fad dieting/nutrition quackery
- Gastrointestinal disorders
- Hypertension
- Immunocompromising conditions (eg, cancer, HIV infection, AIDS)
- Infectious diseases
- Juvenile periodontitis
- Kaposi's sarcoma
- Lupus
- Menopause
- Multiple sclerosis
- Musculoskeletal disorders
- Neoplastic disease
- Osteoporosis
- Physical/mental handicaps
- Polypharmacy
- Poor dentition/edentulism
- Protein-energy malnutrition/wasting
- Quadriplegia
- Radiation therapy
- Salivary dysfunction
- Specific disease states:
 - Substance abuse (alcohol and/or drugs)
 - Transplant surgery
 - Ulcers in the oral cavity
 - Von Willenbrandt's disease
 - Weight status
 - Xerostomia
 - Zinc deficiency

FIG 2. Conditions associated with compromised nutritional and oral health status.

tal health in individuals with both types 1 and 2 DM may lead to improved metabolic control and reduced risk of further sequelae of this disease.

It is incumbent on dental professionals to screen individuals with DM for nutrition risk. Individuals at increased risk should be referred to an RD for MNT. The high-risk patient population includes persons at risk for oral problems because of poor glycemic control and those with diabetes who face dental (oral) procedures that will affect their functional ability to eat. Qualified dietetics professionals need to incorporate questions and guidelines on oral sequelae of diabetes into MNT as well as refer patients for dental care (37,38). Medicare reimbursement for MNT for individuals with diabetes supports referrals to an RD by dental professionals.

Human Immunodeficiency Virus Infection

ADA's position statement on nutrition intervention in the treatment of human immunodeficiency virus (HIV) infection states the following: "Medical nutrition therapy and nutrition-related education should be components of the total health care provided to persons infected with human immunodeficiency virus"

(39). Because of the magnitude and impact of human immunodeficiency virus (HIV)-associated oral diseases on dietary intake and nutritional status, dental intervention in conjunction with nutrition management is an essential component of care at the earliest stage of HIV infection. Persons with HIV infection are at risk for oral disease with accompanying nutritional and systemic consequences. For example, oral-pharyngeal fungal infections may cause a burning, painful mouth and dysphagia. Oral viral diseases, such as herpes simplex and cytomegalovirus, lead to chronic, painful ulcerations. These problems, along with stomatitis and periodontitis, are associated with pain and can lead to reduced oral intake (40). Esophagitis and oral and esophageal candidiasis result in painful chewing, sucking, and swallowing, thus reducing an already compromised appetite and intake. Kaposi's sarcoma, an oral malignancy seen in HIV-positive patients, has the combined effect of compromising oral intake and increasing nutrient needs.

Oral and Pharyngeal Cancer

Oral and pharyngeal cancers are the sixth most common cancer worldwide and the third most common in developing countries (2); it is the fourth most common cancer among African Americans in the United States (28). The survival rate of this cancer is approximately 50% in the United States. However, African Americans have the lowest survival rate, only 34%. Oral cancer is associated with a high risk of second primary tumors, ie, individuals who get a cancer of the oral cavity have an increased risk (up to 20-fold) of developing a second primary cancer in the oral cavity (28). The most consistent dietary findings on the role of diet and nutrition in the etiology of oral cancer (41,42) are the protective effects of high fruit consumption and the carcinogenic effect of alcohol intake. Although use of vitamins and other nutrients to reduce risk of oral cancer and oral leukoplakia have shown promise, adverse effects and a lack of biomarkers to measure intermediate outcomes are still a concern. The protective value of a diet rich in fruits and vegetables against risk of oral and pharyngeal cancers has been demonstrated (43-45). Tavani and colleagues (44) found decreased incidence of cancers in persons with the highest intakes of vegetables and fruits. Levi and colleagues (46) found that diet diversity was inversely related to incidence of oral and pharyngeal cancer; the addition of one serving of fruit per day was associated with a 50% reduction in oral cancer risk. The relationship between increased vegetable intake and reduced risk of cancers of the oral cavity is less well defined. Although Gridley and colleagues (43) found that black men with a high vegetable intake had 70% of the risk for cancer compared with those who had a low vegetable intake, there was no significant relationship for women. The relationship between micronutrient intakes via diet and oral cancers has been studied (45,47); vitamin C, carotene, and flavonoids found in citrus fruits and vegetables have been found to have an inverse relationship with incidence of cancers of the oral cavity (45,47). In the future, continued multidisciplinary research is likely to result in a better understanding of the role of diet in oral cancer prevention and treatment.

Cancer therapies often produce oral complications that compromise appetite and intake. Radiation treatment of the oropharyngeal area may result in loss of teeth, painful stomatitis, xerostomia, fibrosis of the muscles of mastication, and loss of sense of taste. Borderline vitamin and mineral deficiencies associated with cancer treatment may manifest themselves in the oral cavity. Surgical treatment, including reconstruction,

causes alterations in masticatory functions, increases energy and nutrient needs for healing, and can permanently affect chewing and swallowing. Nutrition management should focus on sensory and functional abilities, appetite, and individual nutrient needs (48). Diet consistency, temperature, and composition may require alterations. Dietary management of xerostomia must include caries risk reduction strategies because of increased caries risk caused by lack of saliva.

Polypharmacy

US adults are using increasing amounts of over-the-counter (OTC) and prescription medications (49). Drug use tends to be greatest in the elderly population (49). Medications used to treat the oral and systemic manifestations of HIV infection, cancer, autoimmune diseases, and cardiovascular diseases as well as local oral diseases may also have notable side effects on a person's ability to ingest, digest, and absorb an adequate diet. Common consequences of antiretroviral, antiviral, antifungal, antiparasitic, antihypertensive, antidepressant, antihistamine, narcotic, sedative, and antineoplastic agents include xerostomia, stomatitis, reduced salivary flow, altered taste, and/or oral ulcers. For example, an individual taking an antihistamine and an antidepressant is likely to experience xerostomia and consequently is at increased risk of dental caries. All of these factors impact on food choices, quality, and quantity of foods consumed and the local effect of foods on the oral cavity leading to compromised nutrient intake (39). Individuals with HIV/AIDS have lifelong needs for pharmacotherapy (39), which inevitably impacts on nutrition status. Patients should be carefully questioned about use of prescription and OTC medication use as well as the use of herbs, minerals, vitamins, and other dietary supplements. It is up to the provider to review the potential drug-drug, drug-nutrient, drug-symptom, and drug-supplement interactions with patients and guide them appropriately.

HIGH-RISK GROUPS THROUGHOUT THE LIFE SPAN

Infants and Children

Adequate nutrients are needed pre-, peri-, and postnatally for normal growth and development of the oral cavity (15,20,50). Craniofacial malformations such as cleft lip with or without cleft palate has been associated with cigarette smoking and folate deficiency, further indicating the need to encourage dietary folic acid intake with additional supplementation (51). Women of childbearing age should consume adequate folate to meet the DRI or take a folic acid supplement to decrease the incidence of cleft lip/palate in infants. One episode of mild to moderate malnutrition in the first year of life and/or folate deficiency was associated with increased incidence of caries in deciduous and permanent teeth later in life (2). On the basis of findings in two cross-sectional studies of 1,776 Peruvian children between the ages of 1 and 13 years and a longitudinal study of 209 children, researchers have concluded that one episode of mild to moderate malnutrition in the first year of life is associated with both increased incidence of caries in deciduous and permanent teeth later in life and salivary gland atrophy and reduced saliva, important in reducing dental plaque acid activity (50). Maxillary anterior caries manifested in ECC because of feeding practices is the major nutrition-related oral disease found in young children (50). A combination of infant/child feeding practices and repeated sequential consumption of fermentable carbohydrates, such as sweetened beverages or highly processed starchy/sugary foods, increases caries risk.

For school-age children, meal and snack behaviors should involve food choices that promote oral health (52). Other conditions that may affect oral health include developmental anomalies that alter eating ability and require specialized feeding strategies (8,53) and craniofacial surgery, which causes increased energy, protein, and nutrient needs for wound healing and may require multiple feeding modes, including oral supplements and tube feedings.

Teens and Young Adults

Eating patterns associated with lifestyles of teens and young adults can contribute to caries risk. Frequent consumption of caffeinated, carbonated beverages has been shown to be associated with increased caries risk (54). Promotion of snacking patterns to meet increased energy needs of teens and young adults should address oral health promotion (55). Eating disorders are the “third most common chronic illness in adolescent females” (56). The relationship between eating disorders, in particular bulimia, and integrity of the oral cavity is based on local factors; in particular, the increased insult of acidic gastrointestinal contents from “purging” can lead to tooth erosion of the lingual and occlusal surfaces. In addition to erosion, an enlarged parotid gland may also be evident. Altered function of the oral cavity has also been shown to impact individuals with preexisting eating disorders. Maine and Goldberg (57) demonstrated a relationship between oral surgery and exacerbation of eating disorders in young women under 25 years of age.

The Elderly Population

The elderly population is the fastest growing population segment in the United States. National trends indicate that older patients frequently have one or more chronic diseases and/or other problems that can affect their dental treatment. Among the frail elderly population and among those wearing defective dentures and the edentulous, poor oral health is thought to be an important contributing factor in the development of substantial involuntary weight loss associated with protein-energy malnutrition (58,59). Because today’s elderly population tends to retain more of their natural teeth, new patterns of oral diseases, including root and coronal decay, are becoming more common. Oral manifestations of chronic diseases, xerostomia, side effects of polypharmacy on the oral cavity, osteoporosis, menopause, and eating problems associated with denture placement are examples of the scope of oral nutrition problems faced by the elderly population (60). The negative effects of tooth loss, edentulism, and removable prostheses on eating habits, masticatory function, sense of taste, and gastrointestinal disorders has been documented (61,62). Persons who wear dentures have been termed “oral invalids” (63). Researchers have found that they have about one-fifth the chewing ability of their dentate counterparts (64) and take more drugs (including laxatives and antireflux agents) for gastrointestinal disorders (62).

Despite clear evidence of the relationship between diet and nutritional status and oral problems faced by the elderly population, dietary quality can be achieved when nutrition counseling is a routine component of dental practice (64-66). Conversely, when planning MNT, qualified dietetics professionals should be encouraged to routinely consider the oral manifestations of diseases and medications or the oral problems faced by patients who wear dentures and experience related problems (67). The Nutrition Screening Initiative, introduced in 1990 as a national approach to early detection of nutrition risk and its

potential causes in the elderly population, is an example of a rapid strategy to detect combined nutrition and oral health problems (68). This initiative exemplifies multidisciplinary care by dental and dietetics professionals. The *Determine Your Nutritional Health Checklist* and the separate *Oral Health Risk Factor Checklist* identify oral problems contributing to nutrition risk in the elderly population (65).

EVOLVING ISSUES IN NUTRITION AND ORAL HEALTH

Herbs and Dietary Supplements

Shifts in the food supply and use of herbs and dietary supplements can also impact nutrition and oral health. Although there is little scientific evidence for the use of many herbs for oral or systemic manifestations of disease, their use by consumers is increasing at very rapid rates; six out of 10 adults use dietary supplements on a regular basis, and one in four adults regularly use herbs (69). Several dietary supplements have recognized impacts on the integrity of the oral cavity (goldenseal, feverfew, echinacea) and on immune status (echinacea, vitamin E), platelet aggregation (vitamin E, ginkgo biloba, garlic), heart rate (ma huang, ephedra), and cognitive function (St John’s wort, valerian root). Mounting evidence has demonstrated that many herbs and dietary supplements have pharmacological activities that have adverse interactions when taken with prescription medications (49). Herbs that are metabolized using the P450 enzyme pathway have the potential to interact with drugs metabolized in this manner. It is incumbent upon dietetics and dental professionals to ask patients about use of herbs, vitamins, and other dietary supplements and to be familiar with resources on these products and guide patients appropriately about any potential side effects and risks because of disease, medication, or manifestations as a result of their use. Increasingly, research is uncovering new evidence in support of select products for health and disease. The health professional should be aware of these findings relative to oral and systemic health and disease and be prepared to address these issues with patients.

The impact of other dietary supplements, notably antioxidants and foods such as green and black tea, on the oral cavity has also been documented (23,70). The evidence in support of antioxidant use for oral disease/infection/surgery is scant. Select components of green and black tea have been shown to have anticariogenic properties (70). The catechins in tea have antistreptococcal activity against *S. mutans* and *S. sobrinus*; although the evidence on the degree of activity is varied, it does support that these catechins may have inhibitory and bacteriocidal action. Large clinical trials and strategies to deal with the myriad of confounding factors in humans are needed prior to making any practical recommendations regarding tea (70,71) and dental caries. Green tea polyphenols may have chemopreventive effects in prevention of oral leukoplakia and oral and gastrointestinal cancers (72,73). Clinical applications warrant further investigation prior to any statements regarding the chemopreventive effects in humans.

Food Technology

A combination of food choices and eating patterns interact with other oral health risk factors to determine the incidence and course of oral disease. As the food supply expands to include new and innovative foods that take the human diet beyond basic unprocessed foods, the strength and direction of interac-

tions will be altered. There is a strong relationship between consumption of fermentable carbohydrates (dietary sugars and starches) and caries, yet a variety of synthetic sweeteners (74) offers alternatives for inclusion in the diet. Alternatively, foods engineered as fat replacers (75) that can be significant sources of modified starch may increase risk for caries. Other components of foods that include casein (76) in dairy products and tannin in teas (77) are anticariogenic. As foods become fortified and enhanced to promote health issues relative to oral health, these issues will need to be examined.

Key Points

Leaders in the promotion of nutrition and oral health include experts from the dietetics and dental professions. It is essential that a body of knowledge that supports practice in these specialties be delineated to ensure health promotion and comprehensive health care. Knowledge of the synergy between oral health and nutrition should also be promoted in other health education programs. Collaborative efforts within the oral health and nutrition specialties to promote interdisciplinary health care teams will foster successful strategies related to oral health and nutrition. Figure 3 presents strategies for dietetics and dental professionals to address oral health and nutrition issues in practice. The dietetics professional can use these strategies in pediatric/adolescent counseling, when caries risk is high, as a component of MNT for diabetes mellitus, or as a component of healthy lifestyle counseling. When counseling women regarding osteoporosis management or risk reduction, emphasize the importance of bone health for periodontal health. Likewise, the dental professional can address the Dietary Guidelines for Americans and healthy weight management as a component of oral health education. Patients with orally compromising conditions impacting eating ability or nutrition status should be referred to an RD for MNT; however, basic diet education can be initially provided in the dental setting. Multiskilling on basic levels of care, including risk identification and referral for intervention, is becoming common for health professionals (78) as clients seek comprehensive health care. The Institute of Medicine (IOM) study supports comprehensive training of dental professionals to ensure that they can “assess and treat the whole patient, not just the mouth” (79). This study emphasizes the need for preventive health measures, including improved feeding practices (80). The 1998 Pew Health Professions Commission Report recommends that relationships between dentists and allied health professionals be developed and expanded and that interdisciplinary competence is required of all health professionals (1).

Nutrition in Dental Education

Predoctoral nutrition education competencies are not specifically delineated in the *2000 Competencies for the New Dentist* (81,82). Although the 1990 standards for nutrition in dental education specifically addressed knowledge of basic nutrition, the role of diet and nutrients in health and oral diseases, and nutrition counseling as it relates to oral health, the 1998 standards focus on broad-based competency statements. For example, biomedical sciences standards do not address specific sciences, rather that the standards must “ensure an in-depth understanding of basic biological principles, consisting of a core of information on fundamental structures, functions, and interrelationships of the body systems” (82). In a similar vein, “in-depth information” must be provided to develop understanding of oral and oral-related disorder epidemiology, etiol-

ogy, diagnosis, prevention, and treatment with no specificity to clinical sciences such as nutrition. The core knowledge of principles of nutrition and diet and their clinical application in practice provides the underpinning for achievement of several of the competencies. The accreditation standards for the majority of advanced specialty postdoctoral education programs vary in the specificity to which they address nutrition. The specialty postdoctoral program in periodontics does address knowledge of “principles of nutrition, especially as they relate to patient evaluation, disease processes, and wound healing” (83). Other postdoctoral programs include competencies focusing on management of medically compromised patients, those with chronic and terminal diseases, and those who have undergone surgical interventions. Implied in these required competencies is knowledge of diet and nutrition as they relate to comprehensive dental management (84).

During the last two decades of the 20th century, several national surveys documented that dental curriculum hours devoted to nutrition are low compared to time dedicated to other curriculum areas (84-88). The majority of recommendations focus on integration of nutrition in the dental curriculum (86-88) throughout the 4 years of didactic and clinical coursework. Development of a core curriculum on nutrition and oral health for medical, dental, and allied health education has also been suggested (89), along with the need to survey the state of the art of nutrition in dental education and vice versa (89). The need for this integration is supported by *Healthy America: Practitioners for 2005* (1,47), which highlights the need for expanded access to care by health providers in coordinated teams.

The Accreditation Standards for Dental Hygiene Education Programs (90) specify that the biomedical science content of the curriculum include nutrition. Clinical instruction competencies indirectly address the ability to evaluate an individual's diet and provide diet education relative to oral health. In the practice setting, it is often the dental hygienist that completes the comprehensive patient health assessment and provides oral hygiene and health promotion instruction including diet.

Oral Health in Dietetics Education

Oral health education is not outlined as a specific competency or criterion in the Standards of Education for Dietetics Education (91). However, the standards do require that entry-level dietetics education programs with a nutrition therapy emphasis address competency in the performance of basic physical assessment. Basic physical assessment includes the performance of a head, neck, and oral exam. Because a healthy, functional oral cavity is a necessary part of mastication and digestion, oral health concepts should be incorporated into didactic and clinical training in baccalaureate, preprofessional, and graduate levels of dietetics education (Figure 4). The outcomes of the exam include detection of nutrition- and diet-related risk factors (deficiencies, factors affecting ability to eat/drink) to incorporate into MNT or referral to a dentist for any nonnormal findings. The need for dental professionals to form partnerships with qualified dietetics professionals to facilitate patient referrals has been identified (37,79,88), yet these practices have not been documented in the literature. Oral health and disease topics and opportunities for clinical experiences in dental clinic/office settings should be included in dietetics education programs. Preprofessional program students, including those in dietetics internships and coordinated programs should be given opportunities to work side by side with dental students/residents in the clinical setting to provide nutrition

DIETETICS EDUCATION (ADA COMPETENCIES)	DENTAL EDUCATION
<p>1. Baccalaureate Program</p> <p>a. Didactic Topics</p> <ul style="list-style-type: none"> ■ Oral anatomy and physiology ■ Oral manifestations of acute, chronic, terminal and systemic diseases ■ Oral sequelae of medications, chemo and radiation therapies ■ Primary diseases of the oral cavity and their effects on taste, smell and mastication <p>b. Clinical Experiences</p> <ul style="list-style-type: none"> ■ Field visits to dental schools/clinics ■ Work with dental students in clinical/community settings ■ Oral health screening questions as a component of nutrition assessment activities 	
<p>2. Dietetic Internship/Coordinated Program Competencies</p> <ul style="list-style-type: none"> ■ Conduct nutrition screening and diet counseling in dental school and community dental clinic rotations ■ Integrate oral health screening questions in diet/nutrition assessment activities ■ Integrate appropriate oral health guidelines into the conduct of diet counseling and education ■ Participate in oral health and nutrition research ■ Perform basic physical assessment including oral and cranial nerve screening exams ■ Design nutrition care plans for patients with compromised oral health 	<p>2. Doctoral Program</p> <p>a. Didactic Topics</p> <ul style="list-style-type: none"> ■ Nutritional biochemistry ■ Nutrition and oral health throughout the lifespan ■ Diet education and intervention relative to oral health/disease ■ Effect(s) of oral disease(s), symptomatology and their treatment(s) on diet and nutrition status ■ Diet/nutrition screening, education and referral in dental practice ■ Diet/nutrition concerns and management strategies of high-risk patients <p>b. Clinical Experiences</p> <ul style="list-style-type: none"> ■ Self evaluation of diet ■ Training techniques for diet evaluation and education ■ Nutrition risk screening and diet education relative to oral health of patients ■ Consultation and supervised practice with registered dietitians and or dietetic technicians, registered
<p>3. Graduate Education</p> <ul style="list-style-type: none"> ■ Design oral health and nutrition research ■ Perform oral physical assessment exams including intra/extraoral screening and cranial nerve examinations 	<p>3. Graduate Programs</p> <ul style="list-style-type: none"> ■ Oral health and nutrition research ■ Integration of nutrition screening and diet education into dental and oral disease specialties ■ Collaborative education endeavors on related topics with dietetics programs
<p>4. Continuing Professional Education</p> <ul style="list-style-type: none"> ■ Collaboration between dietetics and dental professionals in case presentations, multidisciplinary care meetings, conferences about diseases and the lifespan, multidisciplinary seminars ■ Training opportunities using different media, eg, distance learning, CD-ROMs, videotapes 	<p>4. Continuing Professional Education</p> <ul style="list-style-type: none"> ■ Collaboration between dietetics and dental professionals in case presentations, multidisciplinary care meetings, conferences about diseases and the lifespan, multidisciplinary seminars ■ Multiskilling training opportunities using different media, eg, distance learning, CD-ROMs, videotapes

FIG 3. Didactic and practice components of a curriculum model for dietetics and dental education programs to promote collaboration and multiskilling in nutrition and oral health.

and diet intervention as a component of oral health management. Competencies in oral exams (head/neck exams, intra/extra oral assessment, and cranial nerve exams) should be taught to students in the preprofessional setting (78). Graduate and continuing education programs should include research and applications as they relate to medical and nutrition management of orally compromised patients. The conduct of oral assessments and identification of oral risk should be included (79,92). Models for community health promotion should include oral health messages in combination with nutrition messages.

Collaborative Approach to Nutrition and Oral Health Education

The changing social and economic realities of today's health care system have had a dramatic effect on the preparation and training of health professionals, including dietetics professionals, dentists, and allied dental personnel. The ADA position on nutrition education of health professionals states that "nutrition education is an essential component of the curricula for the majority of health care professionals. Curricula should include nutrition principles and identification of nutrition risk factors . . ." (93).

	DIETETICS PROFESSIONAL	DENTAL PROFESSIONAL
CLINICAL SETTING	<ul style="list-style-type: none"> ■ Include oral health screening in nutrition assessment protocols (ie, cranial nerve function, occlusion, edentulism, masticatory ability, swallowing, salivary adequacy) ■ Recognize oral manifestations of systemic diseases and provide patients with guidelines to maximize oral intake ■ Confer with and refer patients (via consults) to dental practitioners for management of oral diseases and or risk factors for oral diseases ■ Consult with dental professionals in interpretation of oral-nutrition assessment findings and planning in the long-term care setting 	<ul style="list-style-type: none"> ■ Include diet screening, education, and referral for oral infectious disease prevention/control, optimal masticatory function and management of other oral diseases/treatments as a component of comprehensive dental care ■ Collaborate with dietetics professionals in delivery of medical nutrition therapy (MNT) and provision of oral health care in long-term care settings ■ Provide diet and nutrition guidelines for health promotion and disease prevention to patients and provide guidelines for diet to maximize oral intake ■ Consult with and refer patients (via consult) to dietetics professionals for management of nutrition risk due to compromised oral health (eg: caries, immunosuppressive disorders, xerostomia, diabetes, oral surgery, cancer)
COMMUNITY SETTING	<ul style="list-style-type: none"> ■ Establish partnerships with dental professionals community and private practice settings ■ Develop and implement collaborative oral health and nutrition screening/education programs in schools, worksites and health maintenance organizations ■ Promote collaborative education on nutrition and oral health among dietetics and dental professionals ■ Develop nutrition education messages that encourage oral health ■ Promote oral health in school and community nutrition programs 	<ul style="list-style-type: none"> ■ Establish partnerships and dietetics professionals in community and private practice settings to promote nutrition/diet screening and education in dental practice ■ Develop and implement collaborative oral health and nutrition screening/education initiatives in schools, worksites and health care organizations ■ Promote collaborative education on nutrition and oral health among dietetics and dental professionals ■ Develop oral health messages that integrate nutrition and diet education ■ Promote diet and nutrition as a component of school and community oral health programs
RESEARCH SETTING	<ul style="list-style-type: none"> ■ Promote collaborative nutrition and oral health research initiatives ■ Design and conduct nutrition/diet components of oral health research initiatives ■ Identify and support integration of oral health issues (eg, screening, disease, management, education) as a component of nutrition research 	<ul style="list-style-type: none"> ■ Promote collaborative oral health and nutrition research initiatives ■ Design and conduct oral health component of nutrition/diet research initiatives ■ Identify and support integration of nutrition topics as a component of oral health research as appropriate

FIG 4. Dietetics and dental professional role modeling to achieve effective integration of oral health and nutrition service in health promotion and disease prevention and intervention.

A joint World Health Organization/Food and Agricultural Organization (WHO/FAO) expert consultant's recommendation encouraged international organizations, including WHO/FAO (94), to recognize nutrition as an essential part of training for dental professionals, as well as an important component of educational programs for dietetics and other health professionals. (94). Oral health and nutrition experts should assume leadership in promoting this dual content area in the curricula of other allied health professions. Dental and dietetics professionals need to form networks with other members of the health care team (eg, physicians, physician assistants, speech and language pathologists, nurses) to advance health promotion and preventive/community health initiatives that promote oral health and nutrition as they relate to general health. Recommendation five of the IOM study states the following: "To prepare future practitioners for more medically based modes of

oral health care and more medically complicated patients, dental educators should work with their colleagues in medical schools and academic health centers" (80).

Partnerships in Practice

One of the focus areas within the US Public Health Service's Healthy People 2010 Objectives for the Nation (95) specifically addresses the prevention and control of oral and craniofacial diseases/conditions/injuries and access to related services. Eighteen targeted objectives speak to the need to reduce the occurrence and severity of oral disease and the need to improve oral health literacy. Alleviating barriers (physical, cultural, racial, ethnic, social, educational, health care delivery, environmental) that prevent people from achieving healthy oral functioning and enhanced and appropriate research exploring new ways of improving oral health are included (95).

Health promotion and disease prevention initiatives launched by national dental organizations, federal and state agencies, and private foundations to meet these objectives will contribute to good nutritional status. Specific issues related to fluoride, ECC, and oral cancer prevention are examples of topics being addressed. Opportunities to carry nutrition into the oral health arena are open to dietetics professionals who are knowledgeable about oral health and related public health initiatives.

In certain dental and medical settings, nutrition counseling aimed at improving oral health may be submitted for third-party reimbursement. The integration of oral and nutrition health therapy as part of the treatment provided by both dietetics and dental professionals is an excellent example of comprehensive and cost-effective care.

SUMMARY AND FUTURE DIRECTIONS

MNT can reduce the risk of oral infectious diseases and improve the outcome of treatment of patients with oral manifestations of acute, chronic, and terminal diseases as well as improve systemic health. Continued research to identify the often bidirectional relationships between oral health/disease and nutrition/diet may support findings of epidemiological, animal, and laboratory research and provide a foundation for effective health promotion, disease prevention, and successful treatment modalities. Consistent with the current climate of health care delivery, which stresses collaboration between health care providers, qualified dietetics and dental professionals should pursue opportunities to create a health care paradigm that will mesh optimum oral and nutrition health care with improved oral, nutritional, and systemic health status (Figure 3).

To prepare practitioners with the skills and knowledge that exemplifies this paradigm in practice, dietetics and dental educators must assume responsibility for integrating oral health/diet and nutrition topics and clinical/community experiences in education, respectively. Figure 4 provides a foundation for these initiatives. Changes in the epidemiology of oral disease and new findings in nutrition research, along with population shifts and new technology, have major implications for the future of dentistry and dietetics (89). Continued research exploring the links between nutrition and oral health and disease is critical to maximize the oral, nutrition, and systemic health of individuals (28,89). Future research should also address issues such as optimal diet management of dental implants and other reconstructive surgeries and the impact of dietary supplements on the oral cavity.

Collaborative endeavors between dietetics and dentistry in research, education, and delineation of health provider practice roles are needed to ensure that comprehensive health care is provided to persons with oral infectious disease and/or oral manifestations of systemic diseases. The burden of responsibility for health professionals to provide comprehensive health care is rapidly increasing (1,79,80,95-97). Dental practitioners of the future will be called on to expand their role not just to treat and prevent oral disease but to share with other health professionals the responsibility for attaining and maintaining a patient's total health. "Dental schools should seek to collaborate across academic health units and with health professionals in medical, public health, and allied health education" (98). Similarly, the future of dietetics practice requires dietetics professionals to provide MNT that incorporates a person's total health needs, including oral health. As we advance in our discoveries of the links between oral and nutrition health, practitioners of both disciplines must learn to provide screening,

baseline education, and referral to each other as part of comprehensive client/patient care. Likewise, dental and dietetics educators must prepare students with the foundation knowledge and basic competencies to promote optimum oral health, screen patients for risk, and to provide baseline education and referral. Continued collaborative research will provide the critical findings needed to advance oral health and nutrition collaboration in practice and education.

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