THE DENTAL CLINICS OF NORTH AMERICA

Dent Clin N Am 47 (2003) 355–371

Gerodontic nutrition and dietary counseling for prosthodontic patients

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In 1900, only 4% of the United States population was over 65 years of age. By the year 2030, this number is expected to rise to over 20% of the population [1]. The population over age 85 is growing even more rapidly.

A variety of changes occur with aging that can impact and be impacted by nutrition. Because these changes vary tremendously from person to person, older adults cannot be considered a heterogeneous group as far as health status is concerned. Many people age "successfully," and do not show declines in physiologic and metabolic variables or dietary status. Most people, however, experience a number of lifestyle and physiologic changes (including chronic diseases) that can detrimentally impact nutritional status and general health [2].

Good nutrition enhances quality of life by preventing malnutrition and promoting optimal functioning [3,4]. Poor nutrition compromises quality of life, reduces longevity, and burdens the health care system and economy [5]. This article discusses the changes (and their oral and nutritional implications) that may occur with aging, reviews the nutritional status and requirements of older persons, and provides nutritional strategies for overcoming common nutritional problems.

General nutritional status of older adults

Malnutrition is common in elderly populations throughout the world. Nutritional problems may result from changes associated with the aging

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doi:10.1016/S0011-8532(02)00104-0

process itself, from disease or other medical conditions, from interactions with medications, or from all of these.

The most severe deficiency, protein energy malnutrition, affects 2% to 4% of the free-living elderly [6] and is a major prognostic factor for mortality in the elderly [7]. Even those without overt malnutrition may have insufficient intake of many major nutrients such as protein and may not meet the dietary reference intakes for many other nutrients [8]. Inadequate intakes of calories, folic acid, vitamin D, vitamin B_6, calcium, vitamin B_{12}, and zinc have all been documented in free-living elders over age 60 years [9]. Single-nutrient deficiencies are rare, however. More common is a general decline in food intake that leads to multideficiencies [9,10].

Aging factors that affect nutritional status

Physiologic factors

Declines in physical and cognitive status often increase with age. For example, decreased lean body mass, particularly muscle mass (sarcopenia), is common. Muscle mass is a predictor of strength, mobility, insulin sensitivity, and basal metabolic rate. Thus, with a decline in lean body mass, caloric needs decrease and risk of falling increases.

Declines in gastric acidity also often occur with age, and may affect from 10% to 15% of persons over age 60 years [11,12]. This hypochlorhydria results from atrophic gastritis and can cause malabsorption of food-bound vitamin B_{12}. Atrophic gastritis results in increased levels of bacteria in the stomach and small intestine that bind the vitamin B_{12} for their own use and make it unavailable. Vitamin B_{12} deficiency, in turn, can result in neuropathy, megaloblastic anemia, gastrointestinal symptoms, and cognitive impairment. Neurologic complications are found in 75% to 90% of individuals with vitamin B_{12} deficiency [11]. Vitamin B_{12} deficiency can also result from other health conditions such as pancreatic insufficiency, ileal disease, celiac disease, sprue, radiation enteritis, and so forth [11].

Vitamin D deficiency is also common in the elderly for several reasons: insufficient sun exposure, decline in the skin's ability to synthesize vitamin D from sun, and impaired kidney or liver function needed to activate vitamin D. Vitamin D synthesis at age 80 years is half that at age 20 years, and none is produced roughly from October through March north of 40th degree line (Philadelphia, PA to Reno, NV) [13]. Vitamin D deficiency, in turn, is a major cause of metabolic bone disease in the elderly. In older hospitalized patients, more than 50% of patients studied were deficient in vitamin D [14].

Impairment in the function of the intestinal track secondary to illness, disease, or medications can also result in food maldigestion and malabsorption. A classic example is the increase in lactase deficiency found in older individuals. Lactase deficiency results when the villi of the small

intestine secrete too little lactase enzyme to fully digest the milk sugar, lactose. The resulting pain, bloating, excessive gas, and nausea lead sufferers to avoid dairy products. Because dairy products are the major calcium sources in the American diet, calcium deficiency can result.

Decrease in intestinal function may also be associated with increased constipation in older people. The adoption of low-fiber diets in response to chewing difficulties and/or dentures can exacerbate this condition. The overuse of laxatives may also contribute to malnutrition by causing nutrient malabsorption.

Immune responsiveness decreases in the elderly and, as a result, infection is the fourth leading cause of death in older people. Many nutrient deficiencies common in the elderly, including zinc [15] and vitamin B_6 [16], seem to result in decreased or modified immune responses [7]. Indeed, the immune response in older adults is more sensitive to nutritional status than in younger adults [17].

Dehydration, caused by declines in kidney function and total body water metabolism, is a major concern in the older population. Dehydration can be insidious and unrecognized until serious side effects occur. The thirst threshold may be also be impaired in elders, making thirst a poor indicator of hydration status.

Cognitive function may decline with advancing age and range from simple memory deficit to profound dementia. Until recently, it was assumed that impaired cognition was inevitable with aging. It is now realized, however, that most cases of cognitive impairment are related to disease conditions [18]. Overt deficiency of several vitamins is associated with neurologic and/or behavioral impairment (B_1 [thiamin], B_2, niacin, B_6 [pyridoxine], B_{12}, folate, pantothenic acid, vitamin C, and vitamin E). Mild or subclinical vitamin deficiencies may also play an important role in the declining neurocognitive function in aging [19].

The importance of the B vitamins in cognitive function may be due to their role in the metabolism of the amino acid, homocysteine. High levels of homocysteine in the blood are associated with loss of cognitive function [20] and may also be associated with Alzheimer's disease [21].

Oxidative stress in the body is also thought to be important in the pathogenesis of cognitive decline. With age, there is an overproduction of reactive oxygen species and less effective antioxidant protection. The dietary antioxidants (vitamins E, A, and C, zinc, and selenium) may help counteract oxidative stress [22].

Psychosocial factors

Psychosocial factors may play even greater roles than physical, medical, and dental issues in determining the health and well-being of elders. A host of life-situational factors increase nutritional risk in elders. Elders particularly at risk include those living alone, the physically handicapped

with insufficient care, the isolated, those with chronic disease and/or restrictive diets, and the oldest old [8]. Poverty is also a major contributor to malnutrition. Elders may have reduced economic status as a result of retirement, inflation, death of a wage earner, and increasing health care costs [23]. There is also a strong social aspect to eating, and loneliness can be a major contributing factor to malnutrition. Individuals who have a strong social network of family and friends are more likely to be physically and emotionally fulfilled and tend to have better nutrition. The loss of an eating companion such as a spouse can affect the individual's desire to prepare and eat food and may lead to at least short-term malnutrition. Depression, anxiety, and loneliness all can undermine the desire to prepare and eat food and have been associated with anorexia, weight loss, and increased morbidity and mortality in older people.

Living alone also can have a major impact on the nutritional status of elderly men (not elderly women) [23]. Homebound elders are at particularly high risk for malnutrition for the reasons mentioned previously and because of chronic illness, medication use, oral health problems, a physical inability to shop for or prepare food, the psychosocial effects of social isolation, and economic factors. Resident elder care facilities have fostered communal dining in order to improve appetite and eating.

Functional factors

Functional disabilities such as arthritis, stroke, or vision or hearing impairment can affect nutritional status indirectly. The older person may have difficulty getting to and from grocery stores, carrying groceries, reaching food on shelves, opening cans and packages, and preparing meals in general. Inability to handle eating utensils, see food clearly, or hear others' conversation may all lead to social isolation, poor eating habits, and subsequent malnutrition.

Pharmacologic factors: medications and alcohol

Most elders take several prescription and over-the-counter medications daily. These drugs can interact with food and diet, sometimes with serious side effects. Declining physiologic function can keep drugs in the body for longer periods of time than is desirable. Drugs can affect the absorption and utilization of some foods and nutrients, and vice versa. Prescription drugs are the primary cause of anorexia, nausea, vomiting, gastrointestinal disturbances, xerostomia, taste loss, and interference with nutrient absorption and utilization. These conditions can lead to nutrient deficiencies, weight loss, and ultimate malnutrition [24].

Alcohol provides calories but is of little nutritional value and can undermine nutritional status by decreasing appetite and by substituting for more nutritious foods in the diet. A small alcoholic beverage before meals may enhance appetite, but greater amounts can suppress it.

Oral factors that can affect diet and nutritional status

The condition of the oral cavity can affect nutrition, and vice versa. Oral health status (especially the number of teeth) affects the ability and desire to eat. Conversely, dietary and nutritional factors can play a role in the etiology and prevention of the oral diseases that may lead to tooth loss.

Xerostomia

Xerostomia (dry mouth or hyposalivation) affects almost one in five older adults [25]. Saliva provides natural protection to the hard and soft tissues of the oral cavity. When salivary levels decline, teeth become more susceptible to dental caries. The exposed root surfaces of teeth are particularly at risk. Xerostomia can also impair complete denture retention and is associated with increased periodontal disease, burning or soreness of the oral mucosa, and difficulties in chewing and swallowing—all of which can adversely affect food selection and contribute to poor nutritional status [25].

Xerostomia was once considered an inevitable consequence of aging, but it is now known that saliva levels are normal in healthy elders [26] and xerostomia is a side effect of diseases or their treatment. Indeed, the use of medications is the most common cause of xerostomia. More than 400 medications commonly used by elders have xerostomia as a side effect [27].

Sense of taste and smell

Although the olfactory system is generally well preserved with age [28], age-related changes in taste and smell may alter food choice and decrease diet quality in some people. Factors contributing to this reported decreased function may include health disorders, medications, oral hygiene, denture use, and smoking [5]. The principal taste problem associated with aging seems to be inappropriate tastes rather than loss or diminution of function [5]. More profound sensory alterations are generally observed in the institutionalized elderly who most likely have poorer health status than free-living elders [29]. Odor-detection thresholds have not been shown to be related to diet adequacy [30,31], but olfactory dysfunction has been associated with lower preference for bitter, sour, or pungent foods [32]. Sensory changes may diminish the appeal of some foods (eg, sensitivity to the bitterness of cruciferous vegetables), limiting their consumption and potential health benefits [33].

There is little information about the degree to which nutritional deficiencies may play a role in these age-related chemosensory abnormalities [5]. Thus, although changes in chemosensory function may occur in the elderly, there is little evidence to date that these changes alone influence food choices and ultimate nutritional status.

Oral infectious conditions

With the increase in the elderly population and the greater number of teeth being retained into old age, 47% of the elderly show evidence of root caries [34]. In addition, the process of age-related bone loss that occurs throughout the skeleton may also affect the alveolar bone that supports the teeth, resulting in increased risk of tooth loss and edentulism. Periodontal disease also increases with age and may be exacerbated by nutritional deficiencies [35].

Dentate status

Today's seniors are maintaining better dentate status than their predecessors. Over the next 3 decades, the average number of teeth remaining among older adults is predicted to rise to 25.9 teeth from the current average of 20 [36]. Although the proportion of edentulous patients in the elderly population is declining, the number of persons with no teeth in the United States is likely to remain constant over the next few decades.

Dentate status can affect diet, nutrition status, and general health. Conversely, the role of nutritional factors in the development and prevention of tooth loss and oral infections (eg, dental caries, periodontal disease) becomes increasingly important as the number of older individuals maintaining good dentate status continues to increase.

Reduced chewing ability is related to an overall reduction in functional capacity and general health [37,38].

Effects of dentures on taste and swallowing

A full upper denture can have an impact on taste and swallowing ability. The hard palate contains taste buds, so taste sensitivity may be reduced when an upper denture covers the hard palate. It also becomes difficult to determine the location of food in the mouth when the upper palate is covered. As a result, swallowing can be poorly coordinated and dentures can become a major contributing factor to deaths from choking [39].

Effects of dentures on chewing ability

As adults age, they tend to use more strokes and chew longer to prepare food for swallowing [37,40]. Masticatory ability, however, seems to be more a function of dentate status than of age [41], and the degree of dental impairment determines chewing performance and food selection [42,43]. One fourth of older adults surveyed recently reported difficulty chewing one or more of the following foods: steaks, chops, fibrous meats, raw carrots, celery, fresh apple, lettuce or spinach salad, and cooked vegetables [44].

Individuals with intact dentitions chewed the best, followed in descending order by those with partially compromised dentitions (24 to 29 teeth) or compromised dentitions (20 to 26 teeth). People with one or two full

dentures had the poorest chewing performance. Several recent studies have confirmed these findings [45]. Indeed, masticatory efficiency in complete denture wearers is approximately 80% lower than in people with intact natural dentition. Other factors that affect chewing ability include mobile teeth, bone resorption, reduced sensory perceptions, and motor impairment.

Effect of dentures on food choices, diet quality, and general health

The effect of dentures on nutritional status varies greatly among individuals [46–48]. Some people compensate for decline in masticatory ability by choosing processed or cooked foods rather than fresh and by chewing longer before swallowing. Others may eliminate entire food groups from their diets [40,49]. Nutrient intakes of individuals with impaired dentition can also fall below minimum requirements if an already marginal eating pattern is subjected to sudden insults such as illness, loss of taste, inability to chew, or changes in economic status and living situation [41,50,51].

When dentate status causes changes in food habits, nutritional status can suffer. In one study of older, frail adults, the number of oral problems (including limited chewing ability) was the most important predictor of weight loss [52]. As the degree of dental impairment increases, diet quality seems to decrease [46,53,54]. In a large group of free-living elders, inferior diets were associated with denture wearing, low income, and low educational attainment [55]. Those elders who were wearing one or two complete dentures had a 20% decline in the nutrient quality of their diets compared with dentate peers [56]. Intake of vitamin A, fiber, and calcium also declined as the number of teeth decreased [54]. Dentate adults tend to eat more fruits and vegetables than full-denture wearers [57,58].

Replacing ill-fitting dentures with new ones results does not necessarily result in significant improvements in dietary intake [53,59,60]. Similarly, exchanging optimal complete dentures for implant-supported dentures has not resulted in significant improvement in food selection or nutrient intake [47,61,62].

Poor oral function has also been linked to decreased self-esteem and a decline in the quality of life [63]. Adults with missing teeth or loose dentures may avoid certain social activities because they are embarrassed to speak, smile, or eat in front of others.

Changes in food habits associated with denture wearing may also affect general health. The Health Professionals Study found that the edentulous subjects' diets contained fewer vegetables and less carotene and fiber (foods that are associated with decreased risk of cancer and heart disease), and more cholesterol, saturated fat, and calories than persons with 25 teeth or more [51]. In other studies, edentulous, middle-aged Swedish men and women were heavier and had lower HDL-cholesterol (beneficial type of cholesterol) concentrations than dentate adults [64], and edentulous older men had a significantly higher prevalence of type 2 diabetes mellitus than dentate or partially edentulous men [65]. Among a healthy, well-educated

group, denture wearers also consumed more refined carbohydrates and sucrose than dentate adults [54].

Poor oral function also is a risk factor for gastrointestinal pathology. In a recent study of geriatric institutions, subjects with a natural set of teeth suffered from fewer gastrointestinal pathologies than did partially edentulous subjects ($P = 0.011$) [66]. Furthermore, the types of foods chosen were related to oral functional characteristics. Those with poor oral function had a low-fiber diet, resulting in a semisolid or soft consistency of the alimentary bolus. This form of bolus may be the origin of some gastric disorders [47]. The use of gastrointestinal drugs also appears to be higher in adult edentulous subjects with poor masticatory ability [67].

Optimizing diet and nutrition in older adults

Conducting diet screening and assessment

Due to the many factors already described, older patients may have malnutrition-induced deterioration of health long before exhibiting signs of clinical malnutrition. It is important to detect malnutrition risk in elders early because it is difficult to improve nutritional status after it has deteriorated [68]. Several screening tools have been developed in recent years to assist in this process. The United States Nutrition Screening Initiative, a multidisciplinary effort to promote nutrition screening and awareness, developed the ''Determine Your Nutritional Health Checklist'' and other data collection tools to help health care professionals identify major risk factors and indicators of poor nutrition in elders (Appendix 1) [69–71]. The ''DETERMINE'' checklist is an awareness tool that identifies specific areas that may have negative effects on nutritional health. The cumulative score for the checklist is interpreted as indicating higher or lower nutritional risk and sets the stage for further screening and intervention if needed [72]. This simple awareness tool has been used successfully in a variety of settings including dental practices [73]. Another rapid nutrition assessment tool, The Mini Nutritional Assessment, has also been developed and validated [74]. Oral health care professionals should use these tools to help pinpoint elders who may need further care by nutrition professionals.

Diet recommendations for older adults

Although changes in diet and exercise are most effective in the prevention of nutrition-related conditions when they are instituted early, they can be beneficial at any age [4]. New knowledge of the changes in nutritional requirements that accompany aging has led to revision of dietary guidelines for some nutrients for the elderly [75,76]. One significant change from previous recommended dietary allowances is the recognition that the very old, that is, individuals aged 70 years and above, may have different needs than adults between 51 and 70 years old. For example, the new dietary

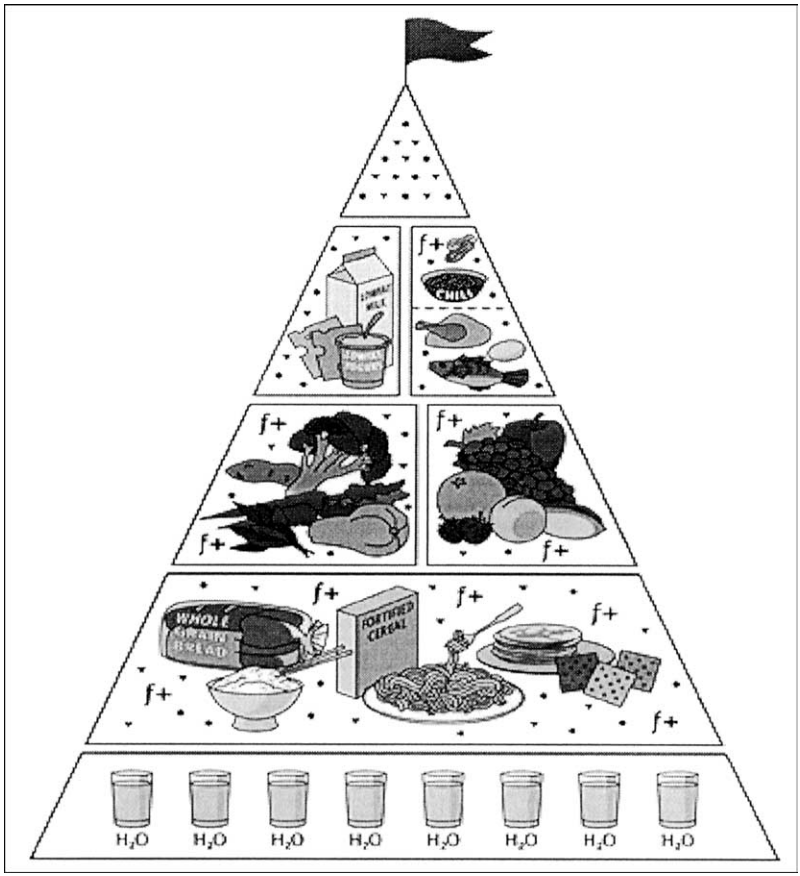

Fig. 1. Modified food pyramid for adults 70+ years. © Tufts University; with permission.

reference value for vitamin D doubles from ages 31 to 50 years to ages 51 to 70 years, and doubles again for individuals 70 years and older. On the other hand, because the storage of vitamin A improves with age, the requirement for this vitamin has not increased.

The recommended dietary allowance for vitamin B_{12} for adults is set at 2.4 μg (an increase over prior recommendations of 2.0 μg). Due to the high prevalence of vitamin B_{12} deficiency in the older population, older people should receive their vitamin B_{12} from fortified foods (eg, cereals) and/or vitamin supplements. The reason is that absorption of vitamin B_{12} in this crystalline form is not affected by the presence of atrophic gastritis.

A new food pyramid has been designed for people aged 70 years and above to reflect the unique needs of older people [77] (Fig. 1). Compared with the original Food Guide Pyramid [78], the modified food pyramid for elders stresses fewer servings of grain products and more servings of dairy,

Table 1
Dietary suggestions for common oral complaints in the elderly

Food group	Difficulty chewing or swallowing	Impaired taste or appetite	Liquid choices	Soft choices
Dairy 2–4 + Servings/d	Cottage cheese and yogurt instead of hard cheeses Add milk or yogurt to moisten dry foods	Use flavored milk and yogurt Add powdered milk to foods to increase protein and calorie intakes	All forms of milk, milk shakes, instant breakfast drinks, soft custards, ice cream, yogurt, and pudding	All forms of milk, milk shakes, instant breakfast drinks, soft custards, ice cream, yogurt, and pudding Soft cheeses like cottage chesses
Meat 2 + Servings/d	Substitute fish, eggs, peanut butter, and tofu for hard-to-chew meats Cut into small pieces Add broths, gravies, and sauces Use soups and stews with high water content Avoid nuts and tough meats	Chew thoroughly Add herbs and spices instead of salt	Broth, strained creamed soups, eggs in custard, strained or pureed meat or poultry in soups, plain yogurt, pudding	Eggs, cheese, milk and milk shakes, pea and bean soups, soups with tender meat, fish, poultry, chowders, tender meat in gravy
Fruits 2–3 + Servings/d	Use cooked and canned fruits Cut into small pieces or puree	Choose ripe fruits	Fruit juices, nectars, ices, popsicles, applesauce, strained fruits	Fruit juices, ices, nectars, popsicles, applesauce, pureed or strained cooked fruits, canned fruits, fruit gelatins

Vegetables 2–3+ Servings/d	Use cooked and canned vegetables Cut into small pieces or puree		Vegetable juices, strained or pureed vegetables mixed with broth	Vegetable juices and strained or pureed vegetables mixed with broth Pureed, soft, canned, and cooked vegetables
Grains 6–11 Servings/d	Avoid breads with hard crusts; use pasta, rice, cooked cereals	Use whole grains such as rye and pumpernickel	Soft bread with crusts removed softened in soup or milk, diluted cereals	Cooked cereals, soft breads, mashed potatoes, pasta, rice crackers in soup
Other	Avoid seeds and nuts that tend to slip under dentures	Wine before a meal may stimulate the appetite when used in moderation		

From The Nutrition Screening Initiative. Nutrition Screening Initiative: report of nutrition screening. Washigton (DC): TaCV; 1991; with premission.

and emphasizes adequate water intake. Elders should be encouraged to have six to eight 8 oz glasses of fluid daily (not including caffeine-containing beverages, which are diuretics). Supplements may also be necessary to supply adequate intakes of some nutrients that are consistently found at low intake levels in the elderly population. Studies to date indicate that multivitamin/mineral supplementation at daily reference intake (DRI) levels is helpful for the immune response of free-living elders. In the healthiest group, supplementation may protect against a decline in immune response. In elders with nutritional deficiencies, such supplementation will partially restore decreased immune response. In diseased hospitalized patients with multiple nutritional deficiencies, supplementation always improves nutritional status and may improve immune response [8].

Lean body mass can be improved with moderate resistance-training exercises, and the effects are even greater when the diet is augmented with nutritional supplements containing calories and protein [79].

To manage lactase deficiency, low-lactose milk and milk products can be readily obtained in the supermarket. Yogurt with active cultures, hard cheeses, and tofu processed with calcium are also good calcium sources that are low in lactose Over-the-counter lactase-containing products such as Lactaid (McNeil Nutritionals, a Division of McNeil-PPC, Inc., Washington, PA) or Dairy Ease (Morningstar Foods Inc., Dallas, TX) can also be taken before meals to facilitate lactose digestion.

Diet suggestions for denture wearers

With nutritional guidance, denture wearers can easily consume nutritionally adequate diets. Most patients with new dentures may want to initially consume a soft diet while they become accustomed to the new denture (Table 1). These patients should also begin adaptation to their new dentures by cutting foods into small pieces and chewing them with the molars. They can then progress to biting and incising food. New denture wearers will need to chew longer, eat more slowly, and cut fibrous foods such as apples and carrots into bite-sized pieces. Table 1 lists food-choice suggestions for common oral complaints of elders.

Explaining the importance of generous fiber, calcium, and vitamin D intakes, and reducing saturated fat intake for the prevention of chronic diseases may also help motivate patients to adapt rapidly to well-balanced diets.

Summary

The older dental patient can be at risk of poor nutrition for a variety of reasons including physiologic, oral, psychosocial, functional, and medical factors. Any decline in the ability to eat increases the risk of malnutrition. Oral impairments can affect diet and nutrition because of changes in the ability and desire to taste, bite, chew, and swallow foods. The dental team

must be aware of these potential detrimental effects of dental treatment and provide counteractive dietary guidance. Problems vary with the patient and the dental condition, so suggestions must be tailored to meet the patient's specific needs.

Caregivers should:

- Screen patients to determine whether there are risk factors that could compromise nutrition.
- Provide diet guidance to prepare patients for any changes in eating ability.
- Promote diet adequacy by suggesting appropriate choices from each food group in the Food Guide Pyramid.
- Consult with and refer clients to a registered dietitian whenever possible.

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Appendix 1

The Nutrition Screening Initiative checklist for nutritional and oral health

The Warning signs of poor nutritional health are often overlooked. Use this checklist to find out if you or someone you know is at nutritional risk.

Read the statements below. Circle the number in the Yes column for those that apply to you or someone you know. For each Yes answer, score the number in the box. Total your nutritional score.

	Yes
I have an illness or condition that made me change the kind and/or amount of food I eat.	2
I eat fewer than 2 meals per day.	3
I eat few fruits or vegetables or milk products.	2
I have 3 or more drinks of beer, liquor, or wine almost every day.	2
I have tooth or mouth problems that make it hard for me to eat.	2

Appendix 1 (*continued*)

	Yes
I don't always have enough money to buy the food I need.	4
I eat alone most of the time.	1
I take 3 or more different prescribed or over-the-counter drugs a day.	1
Without wanting to, I have lost or gained 10 pounds in the last 6 months.	2
I am not always physically able to shop, cook, and/or feed myself.	2
Total	

Total your nutritional score. If it's:

0–2	GOOD! Recheck you nutritional score in 6 months.
3–5	You are at moderate nutritional risk. See what can be done to improve your eating habits and lifestyle. Your office on aging, senior nutrition program, senior citizens center, or health department can help. Recheck your nutritional score in 3 months.
6 or more	You are at high nutritional risk. Bring this checklist the next time you see your doctor, dietitian, or other qualified health or social service professional. Talk with them about any problems you may have. Ask for help to improve your nutritional health.