Chapter 7
Nutrition

Sandhya A. Lagoo-Deenadayalan and Danny O. Jacobs

Nutrition in the Elderly

Throughout most of adult life, our bodies maintain near-perfect metabolic balance interrupted only by disease. This equilibrium lasts a finite period – until the inevitable aging process begins. Aging is a complex phenomenon that includes molecular, cellular, physiologic, and psychological changes. Individual aging is influenced primarily by a person's genetic makeup, lifestyle, and environment. Of these factors, the first is predetermined and constant; the other two are optional, variable, and therefore modifiable. Some very old individuals can stay healthy and have a good nutritional status [1, 2], but physiologic decline and health problems are expected for most of us before death. Aging of cellular function results in a natural decline in physiologic performance and reserve capacity. Thus elderly individuals have increased susceptibility and are less resistant to illness [3].

These factors contribute to an increased prevalence of illness and increased risk for primary and secondary malnutrition. There is an estimated 5–10% prevalence of protein-calorie malnutrition among community-dwelling elderly. In the USA, approximately 85% of the noninstitutionalized elderly suffer from at least one condition that could be improved by proper nutrition [1]. Physicians often fail to recognize its presence. Malnutrition in this population may predispose the elderly to prolonged hospitalization.

Many studies have documented a high prevalence of malnutrition among the elderly residents of nursing homes. Surveys have shown incidences of malnutrition that range from 30 to 85% and increased mortality rates [4, 5]. Hypoalbuminemia is also common: a 37% incidence of this disorder was documented in a Veterans Administration nursing home. In elderly medical patients, nutritional status during acute illness is a determinant of morbidity, length of hospital stay, and mortality [1, 6]. In older surgical patients malnutrition is associated with high morbidity and mortality, particularly when emergency surgery is necessary. In addition, malnutrition negatively affects postoperative functional recovery and rehabilitation [3]. Nutritional screening and intervention in the elderly has been proposed as a cost-effective measure [1], as approximately 30% of the health-care budget is spent on this age group.

Physical and Psychosocial Issues in Nutrition

A combination of physical, social, and psychological factors contributes to primary malnutrition in the elderly. Physical deterioration with age can influence nutritional status. As years pass, the elderly become frail, have diminished visual function, increased cognitive impairment, and gait and balance disorders that affect mobility and decrease their ability to obtain and prepare food. The US National Health and Nutrition Examination Survey (NHANES) III cohort study evaluated the hypothesis that socio-economic status is consistently and negatively associated with levels of biological risk. The nine parameters known to predict health risk are diastolic and systolic blood pressure, pulse, HDL and total cholesterol, glycosylated hemoglobin, C-reactive protein, albumin, and waist–hip ratio. Education and income effects were each independently and negatively associated with cumulative biological risks, independent of age. However, older age was associated with significantly weaker education and income gradients [7].

Adherence to lifestyle guidelines has been shown to markedly reduce mortality in middle-aged women in a study that observed them for 24 years. Guidelines addressed five lifestyle factors, namely cigarette smoking, being overweight, little to moderate exercise, light to moderate alcohol intake and low diet quality score [8].

Malnourishment is common in home-bound adults due to a variety of causes. These include various co-morbidities, medications, economic, social, religious, and psychological problems. Men are more likely to be undernourished than women and the higher the patients' body mass index, the

S.A. Lagoo-Deenadayalan (✉)
Department of Surgery, Duke University Hospital,
Durham, NC, USA
e-mail: lagoo002@mc.duke.edu

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greater the odds of under eating, defined as not consuming enough calories to maintain their current body weight [9].

Dental diseases are common in the elderly. There is a direct relationship between poor dentition and difficulty ingesting certain food items, such as meat and hard foods such as nuts, raw vegetables in salads, and multigrain bread or rolls. This may result in changes in choice and the quality of food intake. Taste and smell are also affected. A progressive loss of taste buds occurs, predominantly affecting the anterior tongue. This region has taste buds that detect sweet and salt. Because the remaining buds detecting bitter and sour are relatively increased with aging, elderly people have a greater sensitivity to these tastes. This could explain their preference for high sugar foods. The elderly need a greater concentration change to perceive a difference in intensity. They also have a reduction in taste intensity (hypogeusia) and an increase in taste distortion (dysgeusia). These conditions can be exacerbated by medications and concurrent disease states [10, 11]. Use of food flavors (roast beef, ham, natural bacon, maple, and cheese) has been found to increase intake and nutritional status in elderly institutionalized patients.

The presence of multiple diseases can also affect nutritional status. Disorders that interfere with eating include neurological diseases, such as Parkinson's disease, cerebrovascular disease, chronic obstructive pulmonary disease, congestive heart failure, and chronic renal insufficiency. Some of these diseases require dietary restrictions that affect the palatability or variety of the food offered. Swallowing disorders are not uncommon in the elderly, and nutritional disorders are frequently associated with dysphagia in institutionalized persons (refer to Chap. 43 on swallowing disorders).

Disturbances of mood and affect are common in the elderly. Anorexia is a common symptom during depression, and these depressed patients often become malnourished. The prevalence of malnutrition among older patients hospitalized for depression can be as high as 20–35% [5]. One of the most difficult situations in geriatric medicine is to determine if the refusal of food is due to a curable depression or is the will of a mentally healthy individual. In particular, the death of a spouse can dramatically influence appetite and food intake. Depressed patients may put less effort into caring for themselves and may lose the symbolism of warmth and sharing associated with eating. The anorexia of aging is neither depression nor willfulness yet it is also a major cause of poor nutrition (see below).

Cognitive impairment such as dementia may also significantly decrease nutrient intake. To study this, a prospective study of 349 patients with a mean age of 85.2 years admitted to a Geriatric Rehabilitation center was carried out. Patients included those with no dementia, mild cognitive dysfunction or dementia. Although there was no significant difference in co-morbidities between older demented vs. nondemented patients, there was a considerable deterioration in nutritional and functional status in the patients with dementia [12]. Routine nutritional assessments, functional assessment and review of medications should therefore be performed more often in patients with dementia so that appropriate interventions can be instituted.

Approximately 30% of elderly Americans live alone, and 25% of free-living elderly need assistance with activities of daily living. Social isolation can lead to problems of obtaining and preparing food. Timing of meals in hospitals and nursing homes may be disadvantageous, as meals may be separated by short periods of time. Appetite may be poor for each meal when they are offered too close together. Food presentation is key for patients to accept the meals offered. Food intake can increase by 25% if the environment is changed to a familiar one (home cooked meals, family and friends visiting during meal times, favorite music). Pureed food is not readily accepted, so imaginative ways of presenting such meals should be tried [13].

Age-Related Changes in Body Composition

Lean Body Mass

Presently, the most widely used body composition model is a two-compartment model in which the body is divided into lean body mass and fat. Aging is accompanied by a net loss of lean body mass. As a consequence, the elderly becomes debilitated and lose an important portion of their tissue amino acid and energy reserves. The lean body mass declines by approximately 6.3% every 10 years. Thus it decreases by an average of 0.45 kg/year after age 60. By age 70 muscle mass may be 20% less than that in young adults. This loss occurs disproportionately more from skeletal muscle than from viscera. Studies have suggested that changes in growth hormone metabolism may mediate age-related changes in body composition. People deficient in growth hormone have a decrease in lean body mass similar to that experienced by the healthy elderly [14, 15]. In addition, treatment with growth hormone or insulin-like growth factor-I (IGF-I) increases lean body mass, nitrogen retention, and muscle strength in the elderly [16]. Androgens have also been proposed to play a role in the body composition changes of aging. Plasma levels of testosterone may decrease with aging, and testosterone supplementation in aging individuals may increase their lean body mass.

Serum total testosterone and the calculated free testosterone correlate well with each other and are superior in defining a group of elderly men with suspected androgen deficiency. In contrast, free testosterone measured by direct

RIA reflects gonadal function poorly. Repetitive use of total testosterone is therefore recommended when screening for androgen deficiency in elderly men [17]. A study investigating the association between various testosterone measures and clinical and biochemical parameters of the aging male was undertaken. The parameters included serum levels of sex hormone-binding globulin, estradiol, and lipid profile after an overnight fast; questionnaires assessing clinical symptoms, erectile function and mood; bone mineral density and body composition. Testosterone values did not correlate with clinical signs and symptoms of hypogonadism. It is therefore critical that symptoms of the aging male be considered multifactorial and not be indiscriminately assigned to the age-associated decrease in testosterone levels [18].

Age-associated decline in growth hormone and androgen secretion contributes to the alterations in body composition and organ function seen during the normal aging process. Despite all these changes, the elderly may continue to function adequately but may have decreased capacity to adapt and to mobilize endogenous protein stores during the catabolic stress imposed by infection or trauma.

Body Fat

The proportion of body fat increases with age and is redistributed from subcutaneous to intramuscular sites. Body fat increases at a rate of 0.4–1.5% per year, beginning at around age 30. As with lean body mass, growth hormone and androgen administration appear to minimize alterations in body fat. The impact of testosterone supplementation on body fat is less dramatic. Testosterone appears to decrease the uptake of triglycerides and increase triglyceride turnover while reducing lipoprotein lipase activity. Furthermore, growth hormone and androgens may act together in the regulation of fat metabolism during adult life.

Energy Requirements

The total energy expenditure (TEE) can be divided into three parts: resting energy expenditure (REE, the energy expended at rest after overnight fasting), thermic effect of feeding (TEF, the increase in energy expenditure above baseline due to the consumption and processing of food), and energy expenditure for physical activity and arousal (EEPAA). Daily energy expenditure declines progressively throughout adult life. REE is approximately 15% lower (7.35 vs. 6.20 mega Joules (MJ)/day) in elderly subjects than that in the young. Changes in REE and EEPAA, which account for most of the energy consumed during daily activity, account for most (73%) of the decline in TEE observed in elderly individuals [19]. Interestingly, body weight, rather than fat-free mass, appears to best predict the REE (Fig. 7.1). Aging is also associated with a significant decrease in energy expenditure per unit of fat-free mass and body weight. Changes in muscle mass affect energy consumption and utilization. Creatinine excretion, which is an index of muscle mass and is closely related to the basal metabolic rate, decreases with aging; thus the reduction in energy expenditure is in large part due to a decrease in lean body mass (fat-free mass) and to a more sedentary life style. These changes are reflected in a decreased total energy requirement in men from 2,700 kcal/day at age 30 to 2,100 kcal/day by age 80 [20]. These observations suggest that preservation of muscle mass and prevention of muscle atrophy could help prevent the decrease in metabolic rate associated with advancing age [21].

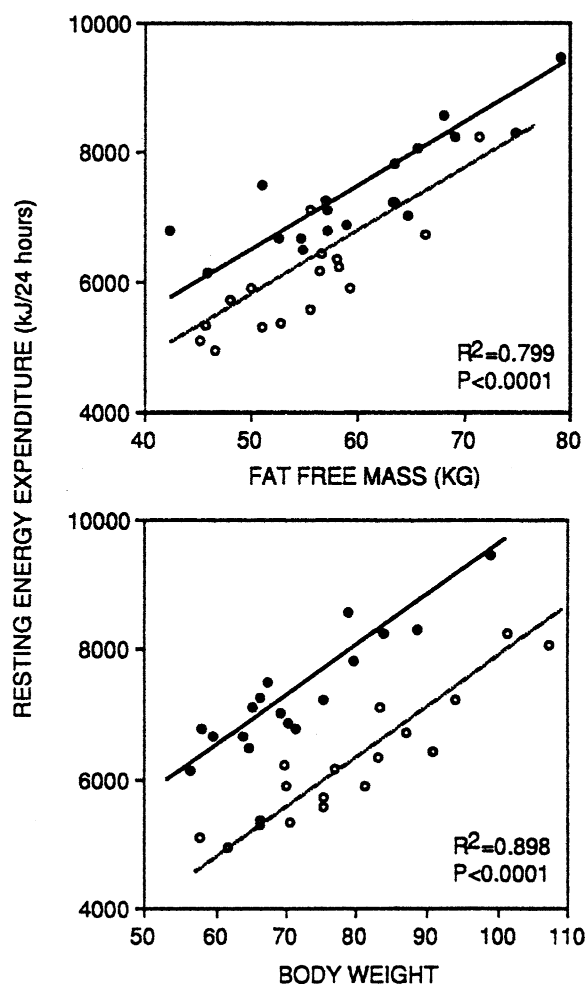


Figure 7.1 Resting energy expenditure in relation to fat-free mass and body weight in young men (*filled circles*) and elderly men (*open circles*) (from Roberts et al. [18], with permission).

Nutritional Assessment

Nutritional assessment is a key aspect of elderly patient care. With so many physiologic changes due to aging that heighten the susceptibility to disease, the importance of proper nutrition grows. It is a challenge, however, to identify elderly persons who would benefit from dietary intervention. Not every elderly patient needs to undergo a cascade of anthropometric, dietary, and laboratory tests to assess their nutritional status in the perioperative period. Simplified nutritional assessment can be done quickly (see Chap. 22) and will provide the caregivers with the appropriate perspective to plan for perioperative nutritional needs. This knowledge can drastically influence therapy and outcome. Key elements of a full nutritional assessment are defined below.

History and Physical Examination

A detailed social, nutritional, and medical history is an essential first step in assessing the nutritional status of the elderly. Particular attention should be paid to the presence of chronic diseases. Cancer by itself impairs nutritional status. Other diseases such as chronic obstructive pulmonary disease and congestive heart failure may make feeding difficult. Neurological illnesses that interfere with the eating process place patients at particular risk. Swallowing function and absorptive capacity should be specifically assessed. Disturbances of mood and affect (e.g., depression) are not uncommon and should be considered during the evaluation.

A social history is equally important. The degree of independence can influence the capacity to purchase and prepare food. Information about who lives with the patient, cooking facilities, and income is also needed. Particular attention should be paid to patients who live in nursing homes and institutions. The physical and cognitive conditions of these patients and the eating environment and food presentation may be unsuitable, placing them at risk of undernourishment. Elderly patients commonly take multiple medications. These drugs should be listed, as should alcohol use; and possible drug–nutrient interactions must be considered. Drugs that may interfere with nutrition are listed in Table 7.1.

The physical examination should always include body weight and height. Oral health, dentition, and swallowing capability should be assessed. Because dehydration may present subtly and atypically in the elderly, hydration status must be carefully evaluated. Orthostatic hypotension or tachycardia may indicate dehydration. Physical signs of malnutrition include muscle wasting and dermatitis associated with deficiency syndromes as well as perioral stomatitis and hair loss due to zinc deficiency. Cognitive impairments could indicate a deficiency of vitamin B_{12}, which should always be considered in the elderly if mentation is affected. The presence of decubitus ulcers is a common sign of malnutrition in institutionalized elderly and can indicate protein or vitamin C deficiency.

Table 7.1 Drug therapy that interferes with nutritional support

Drug therapy	Subject of interference or effect
Drugs that interfere with nutrient assimilation	
AlOH and MgOH	Phosphorus
H_2 antagonists	Vitamin B_{12}
Cholesterol-binding agents	Fat-soluble vitamins, folate
Phenytoin	Vitamins D and K, folate
Drugs interfering with nutrient delivery	
Sucralfate	Forms clogs in the feeding tube
Digoxin, phenytoin, theophylline, potassium chloride	Diarrhea due to hyperosmolarity
Nutrients affecting drug therapy	
Calcium	Phenytoin absorption
Vitamin K	Anticoagulants

Source: Data are from Rolandelli and Ullrich [3]

Table 7.2 Screening tools at the time of hospital admission for assessing nutritional risk

Screening tool
Nutritional risk index (NRI)
Malnutrition universal screening tool (MUST)
Nutritional risk screening tool 2002 (NRS-2002)
Subjective global assessment (SGA)
Mini nutritional assessment (MNA)

Source: Reprinted from Kyle et al. [25], with permission from Elsevier

Nutrition Screening Initiative

Evaluation of nutritional status is an especially important aspect of the surgical evaluation. Many attempts have been made to standardize nutritional risk assessment in the elderly. Screening tools are shown in Table 7.2. The Malnutrition Universal Screening Tool (MUST) classifies malnutrition risk as low, medium, or high based on body mass index, unintentional weight loss, and acute illness. This test is for community-based ambulatory populations but also has high validity in a hospital setting [22]. Another test, the Mini Nutritional Assessment (MNA) has been developed to evaluate the risk of malnutrition in the elderly in home-care programs, nursing homes, or hospitals [23]. The factors included in the evaluation are shown in Table 7.3. The MNA-SF (Mini Nutritional Assessment – Short Form) was developed and validated to allow a two-step screening process. The MNA-SF and MNA are both sensitive, specific, and accurately identify nutrition at risk. The MNA detects risk of malnutrition before severe change in weight or serum protein. In hospital settings,

Table 7.3 Mini-nutritional assessment (MNA): (Short Form – 6 questions)

Question	Ratings	Score
Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?	0 = Severe loss of appetite 1 = Moderate loss of appetite 2 = No loss of appetite	
Weight loss during the last 3 months?	0 = Weight loss greater than 3 kg 1 = Does not know 2 = Weight loss between 1 and 3 kg 3 = No weight loss	
Mobility?	0 = Bed or chair bound 1 = Able to get out of bed/chair but does not go out 2 = Goes out	
Has the patient suffered psychological stress or acute disease during the past 3 months?	0 = Yes 1 = No	
Neuropsychological problems?	0 = Severe dementia or depression 1 = Mild dementia 2 = No psychological problems	
Body mass index (BMI) = weight(kg)/height(m^2)	0 = BMI less than 19 1 = BMI 19 to less than 21 2 = BMI 21 to less than 23 3 = BMI 23 or greater	
Maximum screening score: Total score of 12 or more: not at risk for malnutrition; no need to complete the remainder of MNA		
Total score less than 12: may be at risk for malnutrition; complete the full MNA assessment		
Additional questions for full MNA (12 questions)		
Lives independently (not in a nursing home or hospital?	0 = No; 1 = Yes	
Takes more than 3 prescription drugs per day?	0 = Yes; 1 = No	
Pressure sores or skin ulcers?	0 = Yes; 1 = No	
How many full meals does the patient eat daily?	0 = 1 meal; 1 = 2 meals; 2 = 3 meals	
At least 1 serving of daily products per day? Yes or No	0 = If 0 or 1 Yes answers	
2 or more servings of legumes or eggs per week? Yes or No	0.5 = If 2 Yes	
Meat, fish, or poultry every day? Yes or No	1.0 = If 3 Yes	
Consumes 2 or more servings of fruits or vegetables per day?	0 = No; 1 = Yes	
How much fluid is consumed per day?	0 = Less than 3 cups 0.5 = 3–5 cups 1.0 = More than 5 cups	
Mode of feeding?	0 = unable to eat without assistance 1 = Self-fed with some difficulty 2 = Self-fed without any problem	
Self view of nutritional status?	0 = View self as malnourished 1 = Uncertain of nutritional state 2 = Views self without nutritional problems	
In comparison with other people of the same age, how do they consider their health status?	0 = Not as good 0.5 = Does not know 1.0 = As good 2.0 = Better	
Mid-arm circumference (MAC) in cm?	0 = MAC less than 21 0.5 = MAC 21 or 22 1.0 = MAC 22 or greater	
Calf circumference in cm?	0 = CC < 31; 1 = CC > 31	
Maximum full assessment score = 16	*Total score ≥ 23.5* – normal nutrition, no further action required	
Combine screening + full assessment scores = maximum of 30	*Total score ≤ 23.5* – risk of malnutrition *Total score ≤ 17* – protein and calorie	

a low MNA score is associated with increased mortality, prolonged length of stay, and a greater likelihood of discharge to a nursing home [24]. Other screening tools include nutritional risk index (NRI), nutritional risk screening tool 2002 (NRS-2002) and subjective global assessment (SGA) (Table 7.2). NRS-2002 has been shown to have higher sensitivity and specificity than the MUST and NRI. In general, nutritional status and risk can be assessed by SGA, NRS-2002, and MUST in patients at hospital admission [25].

Anthropometrics

Anthropometric measurements are a convenient tool for evaluating nutritional status. They are inexpensive, safe, and easily performed in any outpatient clinic or surgery ward. They do have some drawbacks. First, anthropometric data are affected by age and severity of illness more than any other index of nutritional status [26]. Second, they are subject to individual variation depending on who monitors the measurements. Third, they must be compared to normal standards; and in the case of the elderly, there are few normative anthropometric data. Change of a specific parameter over time is generally more important than comparing it to standards. Various tables of weight per height that include elderly populations have been suggested by various investigators [27, 28], and a more valid ideal weight can be assigned using these age-specific tables. Weight loss of 5% over 4 weeks or 10% over 3 months is a sensitive indicator of malnutrition.

If the patient is not able to stand upright, height can be calculated from knee-height measurements using a normogram or the following height formulas [29].

$$\text{Stature for men} = (2.02 \times \text{kneeheight}) - (0.04 \times \text{age}) + 64.19$$

$$\text{Stature for women} = (1.83 \times \text{knee height}) - (0.24 \times \text{age}) + 84.88$$

Calculation of ideal body weight provides a valid weight reference for the individual. Percent of ideal weight is calculated as follows:

$$\text{Actual weight} / \text{ideal weight} \times 100$$

An ideal body weight of less than 90% is an indicator of malnutrition. Weight/height ratios can be expressed as the body mass index (BMI) – weight in kilograms/height in square meters. A normogram for body mass index is shown in Fig. 7.2. The Euronut–Seneca survey, which studied apparently healthy elderly individuals aged 70–75 years, found a mean BMI that ranged from 24.4 to 30.3 in men and from 23.9 to 30.5 for women. Results of the Third National Health and Nutrition Examination Surveys (NHANES III) include BMI data from men and women over 60 years of age in 10-year increments [30]. BMI, however, correlates more strongly with body fat than with lean body mass and may not be a sensitive index of muscle or body protein stores, except in the presence of emaciation.

Other anthropometric measures can determine body fat and lean body mass. Body fat can be assessed by measuring the triceps and subscapular skinfold thickness, and at other sites [31]. Lean body mass can be estimated in women and men by measuring the mid-arm muscle circumference and by the creatinine height index. Equations that use these indexes have been developed to relate anthropometric measurements to body composition [32]. In 1989 Frisancho reported standards for the elderly 64–74 years of age [33], the anthropometric data for European elderly over 90 years old were completed later [34].

Biochemical Markers

Use of serum laboratory values is an integral part of nutritional assessment in the adult population, although aging itself can affect test results. The most commonly used parameter, albumin, has been reported to be modified in the elderly. Albumin concentration decreases 3–9% each decade after age 70 in the community-dwelling elderly [35, 36].

In these individuals, the albumin loss is close to 0.8 g/l per decade [35], and in institutionalized individuals, the albumin has been observed to decrease by 1.3 g/l per decade. Of course, relative hypoalbuminemia may indicate poor nutritional status. Serum albumin is positively correlated with muscle mass in the elderly, and the relation may reflect shared changes with age in protein synthesis [37]. This decrease may be attributed to the decrease in skeletal muscle mass. Because of the minimal decline in albumin levels with age, hypoalbuminemia should not be ascribed solely to aging, and other causes should be considered [1]. Albumin is an important predictor of length of hospitalization, morbidity, and mortality among elderly people [37]. Severe hypoalbuminemia (<20 g/l) strongly predicts 90-day mortality and extended hospitalization in the elderly. It requires focused clinical attention regardless of the elderly patient's admitting diagnosis [38]. In the VA National Surgical Quality Improvement Program (a prospective analysis of surgical risk factors), low serum albumin was the single factor most predictive of poor postoperative outcome [39].

Because of their shorter half-lives compared to that of albumin, prealbumin, transferring, and retinal-binding protein are better markers for acute changes in nutritional status. The serumconcentration of these proteins, especially prealbumin, are better maintained in the geriatric population [39].

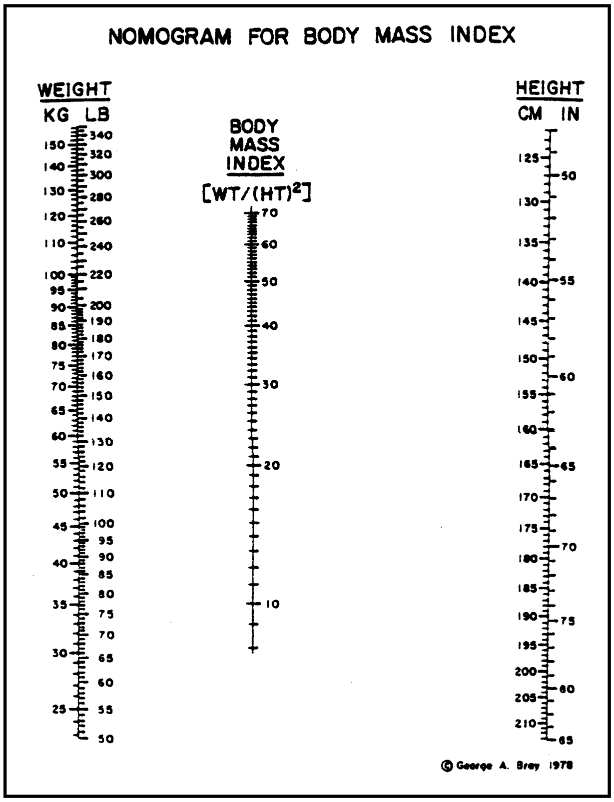
LEVEL II SCREEN **Name:** **Date:**

Level II Screen

Complete the following screen by interviewing the patient directly and/or by referring to the patient chart. If you do not routinely perform all of the described tests or ask all of the listed questions, please consider including them but do not be concerned if the entire screen is not completed. Please try to conduct a minimal screen on as many older patients as possible, and please try to collect serial measurements, which are extremely valuable in monitoring nutritional status. Please refer to the manual for additional information.

Anthropometrics

Measure height to the nearest inch and weight to the nearest pound. Record the values below and mark them on the Body Mass Index (BMI) scale to the right. Then use a straight edge (paper, ruler) to connect the two points and circle the spot where this straight line crosses the center line (body mass index). Record the number below; healthy older adults should have a BMI between 22 and 27; check the appropriate box to flag an abnormally high or low value.



Height (in):________________
Weight (lbs):________________
Body Mass Index
(weight/height²):______________

Please place a check by any statement regarding BMI and recent weight loss that is true for the patient.

- ❑ Body mass index <22
- ❑ Body mass index >27
- ❑ Has lost or gained 10 pounds (or more) of body weight in the past 6 months

Record the measurement of mid-arm circumference to the nearest 0.1 centimeter and of triceps skinfold to the nearest 2 millimeters.

Mid-Arm Circumference (cm):____________
Triceps Skinfold (mm):________________
Mid-Arm Muscle Circumference (cm):_______

Refer to the table and check any abnormal values:

- ❑ Mid-arm muscle circumference <10th percentile
- ❑ Triceps skinfold <10th percentile
- ❑ Triceps skinfold >95th percentile

Note: mid-arm circumference (cm) - {0.314 x triceps skinfold (mm)}= mid-arm *muscle* circumference (cm)

For the remaining sections, please place a check by any statements that are true for the patient.

Laboratory Data

- ❑ Serum albumin below 3.5 g/dl
- ❑ Serum cholesterol below 160 mg/dl
- ❑ Serum cholesterol above 240 mg/dl

Drug Use

- ❑ Three or more prescription drugs, OTC medications, and/or vitamin/mineral supplements daily

FIGURE 7.2 Normogram for body mass index (from the Nutrition Screening Initiative, a project of the American Academy of Family Physicians, the American Dietetic Association, and the National Council on the Aging, with permission. Funded in part by a grant from Ross Products Division, Abbott Laboratories).

Serum prealbumin protein appears to be a more sensitive marker of protein malnutrition than transferrin, although its use as a predictor of clinical outcome has yet to be determined [39, 40].

Iron stores (ferritin) usually increase with aging, which can cause circulating transferrin levels to diminish. Other conditions that may decrease transferrin levels include the anemia associated with chronic disease, acute inflammation,

Clinical Features

Presence of (check each that apply):

- ❑ Problems with mouth, teeth, or gums
- ❑ Difficulty chewing
- ❑ Difficulty swallowing
- ❑ Angular stomatitis
- ❑ Glossitis
- ❑ History of bone pain
- ❑ History of bone fractures
- ❑ Skin changes (dry, loose, nonspecific lesions, edema)

Percentile	Men 55-65 y	Men 65-75 y	Women 55-65 y	Women 65-75 y
Arm circumference (cm)				
10th	27.3	26.3	25.7	25.2
50th	31.7	30.7	30.3	29.9
95th	36.9	35.5	38.5	37.3
Arm muscle circumference (cm)				
10th	24.5	23.5	19.6	19.5
50th	27.8	26.8	22.5	22.5
95th	32.0	30.6	28.0	27.9
Triceps skinfold (mm)				
10th	6	6	16	14
50th	11	11	25	24
95th	22	22	38	36

From: Frisancho AR. New norms of upper limb fat and muscle areas for assessment of nutritional status. Am J Clin Nutr 1981; 34:2540-2545. © 1981 American Society for Clinical Nutrition.

Eating Habits

- ❑ Does not have enough food to eat each day
- ❑ Usually eats alone
- ❑ Does not eat anything on one or more days each month
- ❑ Has poor appetite
- ❑ Is on a special diet
- ❑ Eats vegetables two or fewer times daily
- ❑ Eats milk or milk products once or not at all daily
- ❑ Eats fruit or drinks fruit juice once or not at all daily
- ❑ Eats breads, cereals, pasta, rice, or other grains five or fewer times daily
- ❑ Has more than one alcoholic drink per day (if woman); more than two drinks per day (if man)

Living Environment

- ❑ Lives on an income of less than $6000 per year (per individual in the household)
- ❑ Lives alone
- ❑ Is housebound
- ❑ Is concerned about home security
- ❑ Lives in a home with inadequate heating or cooling
- ❑ Does not have a stove and/or refrigerator
- ❑ Is unable or prefers not to spend money on food (<$25-30 per person spent on food each week)

Functional Status

Usually or always needs assistance with (check each that apply):

- ❑ Bathing
- ❑ Dressing
- ❑ Grooming
- ❑ Toileting
- ❑ Eating
- ❑ Walking or moving about
- ❑ Traveling (outside the home)
- ❑ Preparing food
- ❑ Shopping for food or other necessities

Mental/Cognitive Status

- ❑ Clinical evidence of impairment, e.g. Folstein<26
- ❑ Clinical evidence of depressive illness, e.g. Beck Depression Inventory>15, Geriatric Depression Scale>5

Patients in whom you have identified one or more major indicator (see pg 2) of poor nutritional status require immediate medical attention; if minor indicators are found, ensure that they are known to a health professional or to the patient's own physician. Patients who display risk factors (see pg 2) of poor nutritional status should be referred to the appropriate health care or social service professional (dietitian, nurse, dentist, case manager, etc.).

Figure 7.2 (continued)

and chronic infection. High transferrin levels may be found with iron deficiency.

Plasma IGF-I concentration is considered a valuable index of PEM in young and middle-aged adults. As mentioned previously, because IGF-I levels decrease with age, it may not be valid to extrapolate these results to the elderly. However, changes in IGF-I strongly predict the likelihood of life-threatening complications in the elderly [41]. Furthermore, in one study IGF-I was well correlated with markers of nutritional status, including (1) serum albumin, transferrin, and cholesterol; (2) triceps skinfold thickness; and (3) percentage of ideal body weight. These changes may reflect the detrimental effects of low IGF-I concentrations. Despite these findings, the validity of

IGF-I as a nutritional marker in the elderly still must be determined.

Various signaling pathways are influenced by reactive oxygen species. The glutathione precursor cysteine has been shown to decrease insulin responsiveness in the fasted state. Supplementation with cysteine in clinical trials leads to improvement of various conditions that deteriorate with aging. These include skeletal muscle function, immune functions and plasma albumin levels. It also causes a decrease in body fat/lean body mass ratio. These data suggest that aging may also be associated with a deficiency in cysteine [42].

Immune Markers

Total lymphocyte count is a nonspecific indicator of protein-energy malnutrition (PEM). An absolute lymphocyte count of less than 1,500/mm^3 indicates malnutrition if other causes of lymphopenia can be excluded. The lymphocyte count appears to decrease in the elderly, although it remains above 1,500/mm^3 [43].

Delayed hypersensitivity skin testing is a parameter used to assess relative immune competence. An anergic response has been linked to both increasing age and malnutrition. As yet it is unclear whether PEM-Associated changes in immune competence can be distinguished from those due to aging alone. In general, anergy is a poor predictor of malnutrition in the elderly and may be less reliable than in younger patients.

Functional Assessment

Functional assessment of the elderly helps detect physical and cognitive alterations that may increase the risk of malnutrition. Nutritional well-being is related to the ability of elders to perform the activities of daily life. The BMI, used as a standard measure of overall nutrition, is related to the functional capabilities of community-dwelling elderly. Elderly individuals with a low BMI are at greater risk for functional impairment [44]. Among other methods for evaluating capacity, direct measurements of neuromuscular performance, including motor strength, vibratory sense, gait and balance, and gait speed, are strongly related to disability [45]. In addition, many evaluation scales for cognitive and physical assessment that vary in simplicity have been developed [46]. These include the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADLs). ADL include bathing, dressing, toileting, transfer in and out of bed/chair, bowel and bladder continence, and the ability to feed oneself. Instrumental activities of daily living include the ability to use the telephone, shopping, food preparation, laundry, transportation, responsibility for medications, and ability to handle finances. Poor performance scores on these tests should be carefully evaluated because deficits may result from malnutrition or may render the patient susceptible to malnutrition. Depressive symptoms and cognitive impairment are independent predictors of decline in functional status and increased dependence in activities of daily living [47]. These, in turn, can lead to inadequate food intake and malnutrition.

Nutritional Requirements of the Elderly

Energy requirements in the elderly decrease because of a reduction in muscle mass and a reduction in physical activity. Subjects over the age of 70 consume about a third less calories than their younger counterparts. Without adequate supplementation, this results in a reduction of all nutrients. Unfortunately, the requirements for these nutrients does not decrease. Nutrient dense foods can decrease mortality and decrease LOS in hospitals [48]. The modified MyPyramid (Fig. 7.3) was developed by researchers at Tufts University

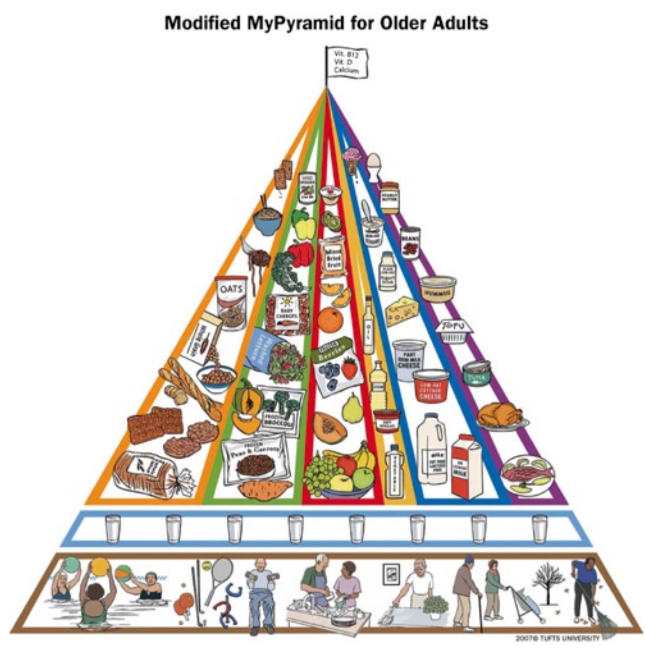


Figure 7.3 The major features of the modified MyPyramid for Older Adults graphic that are different from MyPyramid are the expanded presentation of food icons throughout the pyramid highlighting good choices within each category, a foundation depicting a row of water glasses and physical activities emphasizing the increased importance of both fluid intake and regular physical activity in older adults, and a flag on the top to suggest that some older adults, due to biological changes, may need supplemental vitamins B-12 and D, and calcium (reprinted from Lichtenstein A (2008) Modified pyramid of older adults. J Nutr 138(1):5–11, with permission from the American Society for Nutrition).

in Boston and emphasizes the importance of nutrient and fiber-rich foods and provides guidance about alternate food forms and the importance of regular exercise and adequate fluid intake [49]. The pyramid is most useful when used in combination with the US Department of Agriculture's general MyPyramid food guide.

Fluid Requirements

Dehydration is one of the main discharge diagnoses in patients over age 65 [50]. Inadequate intake is one of the most common reasons for water and electrolyte disorders in this age group. Possible explanations include a decrease in the thirst sensation with increasing age. Age-related decreases in vasopressin secretion and an alteration in the opioid system may also impair fluid regulation [51]. Renal function decreases with age, as does the kidney's capacity to adapt to changes in hydration status and electrolyte intake, thereby interfering with regulatory mechanisms. Stress and infection are often associated with decreased fluid intake and hydration. Fluid losses may be further increased by fever, vomiting, diarrhea, fistulas, and open surgical wounds, and they should be accounted for. In addition, fluid intake may be restricted owing to chronic renal insufficiency or congestive heart failure. The above factors predispose the elderly patient to hydration and fluid overload. Thus a more gradual approach to fluid delivery is appropriate. Dehydration may lead to confusion, resulting in decreased fluid intake. Patients and their families should be informed about the importance of adequate fluid intake and the need for monitoring intake and output during stressful periods.

Various formulas can be used to predict baseline fluid requirements, although some formulas do not account for obesity and low body weight and may give unrealistic estimates [52]. The following formula is appropriate for establishing fluid recommendations, as it adjusts for height and weight: 100 ml fluid/kg for the first 10 kg of body weight, 50 ml/kg for the next 10 kg of body weight, and 15 ml/kg for the remaining kilograms of body weight. A goal of at least 1,500–2,000 ml fluid is recommended. Given the reduced volume of formula required to meet the decreasing energy needs of the elderly, patients receiving the tube feeding may need additional fluid to maintain adequate hydration [1].

Energy Requirements

Several formulas are available to estimate energy requirements of the elderly. The Harris and Benedict equations (HBEs), which take into consideration sex, age, height, and weight, can be used to estimate the resting energy expenditure (REE).

$$\text{Men} = 66.47 + [13.75 \times W(\text{kg})] + [5.0 \times H(\text{cm})] - [6.76 \times A(\text{years})]$$

$$\text{Women} = 66.51 + [9.6 \times W(\text{kg})] + [1.85 \times H(\text{cm})] - [4.68 \times A(\text{years})]$$

W is the weight, H is the height, and A is the age. The REE obtained is expressed in kilocalories per day. Unfortunately, the HBEs are performed poorly in some instances, and they can underestimate the actual REE in malnourished and critically ill patients [53]. The same is true in undernourished nursing home residents [54]. In these instances, direct measurement of REE is more appropriate. REE can also be predicted without height with only a minor loss of accuracy [1].

$$\text{Men} = 13.5(W) + 487$$

$$\text{Women} = 19.5(W) + 596$$

A correlation factor should be added to the REE depending on the degree of metabolic stress of the patient (Table 7.4).

Currently, recommendations for energy requirements in the elderly are based on assumed levels of physical activity relative to the basal metabolic rate (BMR). However, substantial error is found when total energy expenditure is derived from measurements or predictions of BMR [55]. Furthermore, current recommended daily allowances (RDAs) may significantly underestimate the energy requirements for physical activity in healthy elderly persons. Accurate estimation of energy needs is important for delivering adequate nutritional care and preventing disability. Human aging has been associated with reduced ability to regulate energy balance. This might explain the vulnerability of older persons to unexplained weight gain and weight loss [56]. Thus in some older individuals, successful weight maintenance may require increased control over food intake and energy requirements.

Table 7.4 Adjustment factors for resting energy expenditure

Correction factor	Stress
1.0–1.1	Postoperative
1.1–1.3	Multiple fractures
1.2–1.5	Weight gain/replenishment
1.3–1.6	Severe infection/bullet wounds
1.6	Sepsis
1.5–2.1	Third-degree burns
1.2	Confined to bed
1.3	Out of bed
1.5	Active

Source: Data from Nelson and Franzi [13]

Protein Requirements

Although the recommended daily allowance for protein is 0.8 mg/kg/day, recent studies have shown that the protein requirement in the elderly should be as much as 1.5 g/kg/day, i.e., 15–20% of total caloric intake [57]. This may increase muscle mass and function leading to greater activity. This is particularly important in patients with co-morbidities such as diabetes, low-grade inflammation, etc. that cause anorexia. A 24-h urine urea nitrogen (UUN) can determine the amount of total nitrogen excreted and can be used to estimate protein requirements, though it is rarely used in clinical practice. Rather, nitrogen losses are more commonly estimated or extrapolated. The following formula accounts for insensible and fecal losses and can be used to estimate total nitrogen loss.

$$\begin{aligned}\text{Total nitrogen loss} = {} & 24\text{ h UNN (g / day)} \\ & +(0.20 \times 24\text{ UNN}) + 2\text{ g / day}\end{aligned}$$

$$\begin{aligned}\text{Nitrogen (N) balance} = {} & \text{N intake} \\ & -[\text{urine N} + \text{stool N} + \text{insensible} \\ & \text{N losses}]\end{aligned}$$

Generally a positive nitrogen balance of 4–6 g is necessary for anabolism. During the metabolic response to trauma, proteins are broken down to amino acids and are used for hepatic gluconeogenesis. The decrease in lean body mass that occurs with aging reduces tissue protein reserve and may diminish the body's capacity to resynthesize proteins. However, excluding burn patients, it seems prudent that during periods of stress such as infection, surgical trauma, or cancer, the daily protein intake should be increased to 1.5 g/kg/day [7].

Vitamin Requirements

As we have discussed, it is a combination of physical, social, and psychological factors that make the elderly population particularly susceptible to malnutrition. Aging alone might be accompanied by a decrease in some vitamin levels. These modifications may lead to an increased risk of vitamin deficiencies and disease. In the following sections, we review the most important vitamins and the role their supplementation may play in the nutritional status of aged individuals.

Vitamin A

Special consideration should be given to vitamin A supplementation in elderly subjects. In contrast to other vitamin levels, serum concentrations of vitamin A are usually within the normal range in the elderly. The liver has a great capacity to store vitamin A, and hepatocellular levels of vitamin A are maintained through life. In addition, older individuals have an increased capacity to absorb vitamin A, and they have decreased renal excretion. Thus, over supplementation could predispose the elderly to vitamin A toxicity [58]. Increased vitamin A intake by the elderly can raise serum retinyl ester concentrations, which are an index of vitamin A overload. Elderly subjects with elevated fasting plasma retinyl esters were shown to have elevated liver function tests, indicative of liver damage. In view of the above findings, the current RDA for vitamin A of 5,000 IU for men and 4,000 IU for women may be too high for the elderly and should probably be reduced.

Vitamin B_6

Vitamin B_6 appears to play an important role in the regulation of homocysteine metabolism. Vitamin B_6 plasma concentrations inversely correlate with homocysteine concentrations, and elevated levels of homocysteine are associated with the development of occlusive vascular disease [59]. In addition, plasma pyridoxal-5′-phosphate (the coenzyme of vitamin B_6) concentrations have been linked to stenosis [60]. At this time, it cannot be concluded that lowering plasma homocysteine by increasing vitamin intake reduces the risk of vascular disease. It is not uncommon to encounter low vitamin B_6 plasma levels among the elderly, so it is probable that vitamin B_6 requirements are insufficient [60, 61]. Considering the above findings, a vitamin B_6 intake of 1.9–2.0 mg/day is adequate.

Vitamin B_{12}

Serum vitamin B_{12} levels decline with advancing age. Prevalence of vitamin B_{12} deficiency varies among countries, from none in the United Kingdom up to 7.3% in the rest of Europe [62]. In the USA, the prevalence of vitamin B_{12} deficiency was shown to be more than 12% in a large sample of free-living elderly. By measuring serum homocysteine, a vitamin B_{12} metabolite, many elderly people with normal serum vitamin concentrations were found to be metabolically deficient in cobalamin [63]. The reasons for the high prevalence of vitamin B_{12} deficiency is probably a major etiologic factor. The vitamin B_{12} level may also be affected by the high prevalence of atrophic gastritis (a partial decrease in fundic glands and of parietal cell mass) in the elderly population. There is a significant association between age and the prevalence of atrophic gastritis, which is as high as 24% after age 50 and 37% after age 80 [64]. In addition, gastric and intestinal bacterial overgrowth may contribute to vitamin B_{12} malabsorption.

In view of these findings, the current RDA may underestimate the need for vitamin B_{12} in the elderly. Low B12 concentrations were less prevalent among persons consuming B12-containing supplements. Biochemical B12 deficiency has been found to be higher in adults over 50 years of age. Current recommended daily allowance for B12 of 2.4 mug may be insufficient for those aged >50 years [65]. Clinically, the hematological changes typical of megaloblastic anemia can be absent in most subjects with evidence of deficiency.

Neuropsychiatric symptoms of vitamin B_{12} deficiency may be present even with normal serum levels of vitamin B_{12}. Any elderly patient who is, or is suspected to be, vitamin B_{12}-deficient, based on the neurologic symptoms of vitamin B_{12} deficiency, should receive a course of parenteral vitamin B_{12} to replete stores [1]. Once the etiology of the deficiency is determined, appropriate maintenance therapy can be initiated.

Calcium and Vitamin D

With aging, serum vitamin D levels decline as a result of less-efficient synthesis of vitamin D by the skin, less-efficient intestinal absorption, and possibly reduced sun exposure and intake of vitamin D [66]. Sun exposure is essential for maintaining vitamin D levels and institutionalized elderly who do not receive enough sun are at particular risk of vitamin D deficiency. [67] Note that exposure of skin to sunlight that has passed through windowpane glass or Plexiglas does not produce cholecalciferol [68]. Sunscreen use and dark skin pigmentation can also substantially influence cutaneous production of vitamin D. Latitude influences the amount of vitamin D as well. In northern latitudes and during winter, ultraviolet B rays do not reach the earth's surface. People in these regions are entirely dependent on dietary sources of vitamin D during this season. In the USA, the major dietary source of vitamin D is milk. Elderly individuals with lactose intolerance may avoid milk products that contain vitamin D and may be dependent on endogenous synthesis of this vitamin.

Intestinal calcium absorption is independently reduced with age and after menopause as estrogen levels decrease [69]. This might be due to age-related changes in the metabolism of vitamin D. Although antifracture efficacy is of primary interest, change in bone mineral density (BMD) is widely used in clinical trials because it is a strong predictor of fracture risk; with its use, a far smaller number of patients are required for a study [68]. Data have shown that calcium supplements significantly reduce bone mineral loss and increased bone density. In addition, calcium combined with vitamin D supplements have reduced hip and other nonvertebral fracture rates in nursing home residents [70]. However, vitamin D supplements alone do not decrease the incidence of hip fractures, which suggest that only the combination of calcium and vitamin D is beneficial [71]. *The current vitamin D RDA* of 200 IU may not be sufficient to minimize bone loss. An intake of 400–800 IU/day appears to be needed for healthy postmenopausal women [1, 62, 72]. A randomized placebo-controlled double blind study in patients greater than or equal to 64 years of age revealed that in greater than 97.5% of these individuals, the requirement for vitamin D is met by intake between 7.9 and 42.8 mug/day of Vitamin D. Factors influencing this requirement include summer sun exposure at an adequacy of 25(OH)D [73]. Calcium intakes of 1,000 mg/day for postmenopausal women taking estrogen and 1,500 mg/day for women not taking estrogen are now considered optimal by many [54, 61, 68]. Calcium intake should not exceed 2,400 mg/day, because of the risk of nephrolithiasis [1].

Nutritional Problems in the Elderly

Obesity

Obesity is a major problem worldwide. In the USA, 74% of men and 66% of women aged 60 and older in are overweight or obese based on body mass index. A recent study showed that increased body mass index did not correlate with increased mortality in the elderly. Instead, it was the waist circumference that served as a more significant marker of increased mortality in the elderly [74]. It is therefore felt that both body mass index and waist circumference should be taken into account when evaluating obesity in the elderly. Obesity has also been shown to relate to functional disability in the elderly. In women, waist circumference has been found to be a better predictor of functional disability than BMI [75]. Obesity may exacerbate cardiovascular disease through several mechanisms including systemic inflammation, hypercoagulopathy and activation of the renin–angiotensin mechanisms [76].

Anorexia of Aging

Anorexia commonly occurs with aging. The decrease in appetite can be due to a decrease in basal metabolic rate, most likely secondary to a decrease in lean body mass and to a more sedentary lifestyle. Drugs can also cause anorexia as well as interfere with the intake, absorption, and metabolism of nutrients. Because of their use of multiple medications, the elderly are at increased risk of drug interactions, which may interfere with nutrient assimilation. Decreased food intake is more common in men than in women [4]. It is also seen in healthy elderly individuals. Psychosocial factors, such as depression and isolation also influence food intake.

The physiological decrease in food intake in the elderly is termed anorexia of aging and can be attributed to several factors. Among these are an increase in peripheral satiating systems, decreased compliance of the fundus of the stomach, an increase in basal levels of cholecystokinin and in secretion of cholecystokinin in response to intraduodenal fat. Decrease in testosterone in males results in increased levels of leptin and this in turn may accentuate anorexia.

Cachexia

Cachexia may result from an adaptation to an underlying illness such as cancer. A diagnosis of cachexia is made when there is a weight loss of at least 5% in a period of 12 months accompanied by three of the five following factors: decreased muscle strength, fatigue, anorexia, low fat-free mass index and abnormal biochemistry such as increased CRP or IL-6, anemia or low serum albumin. These factors help to distinguish cachexia from anorexia alone. Cachexia can result from problems with oral intake due to mucositis, or due to gastrointestinal concerns such as nausea and vomiting, bowel obstruction due to tumor burden, or delayed gastric emptying. Increased levels of TNF-α and IL-1 can cause cachexia, nausea, and vomiting. Central nervous system mediated effects result from pain and altered sense of smell and taste. Treatment options are limited. The use of androgens, selective androgen receptor modulators, antimyostatin drugs, growth hormone, insulin-like growth factor, and ghrelin have yet to show significant efficacy [77]. Megestrol acetate has been shown to improve appetite and decrease nausea in some cases, by causing a reduction of IL-1, IL-6, and TNF-α [78]. Data is still sparse for geriatric recommendations with nutriceutical repletion using Omega-3 fatty acids, co-essential/essential aminoacids.

Sarcopenia

Decreased food intake coupled with decreased activity leads to decreased muscle mass, which is termed sarcopenia. Cytokines play a role in both anorexia and sarcopenia. Chronic inflammatory conditions lead to an increase in cytokines such as IL-1β, IL-6, and TNF-α. Several cytokines belong to the same family as leptin and exert their effects by stimulating the leptin receptor. IL-I causes a decrease in luteinizing hormone, resulting in decreased testosterone levels and worsening anorexia and sarcopenia. Recently, a specific dietary approach has been found to prevent or slow down muscle loss with ageing. Rather than suggesting a large global increase in protein intake, it has been found that ingestion of a sufficient amount of protein with each meal is more beneficial. Dietary plans that include 25–30 g of protein with each meal can maximize muscle protein synthesis [79].

Unintentional Weight Loss

Unintentional weight loss is a common problem in elderly patients and should be recognized and evaluated without undue delay. Several studies have shown that weight loss of 4–5% of body weight or more within 1 year or 10% over 5–10 years is associated with increased morbidity and mortality [80]. Low BMI (body mass index of less than 18.5) is an indication of protein-calorie malnutrition [81]. In nursing home residents 65 years of age or older, low BMI has a negative impact on the quality of life [82].

Although a quarter of these patients may not have any identifiable cause to explain the weight loss, the etiology can be detected in others by specific symptom-related investigation. Common causes of unintentional weight loss include malignant diseases (16–36%), psychiatric disorder (9–42%), gastrointestinal disease (6–19%), hyperthyroidism (4–11%), nutritional disorders or alcoholism (4–8%), and respiratory disease (6%) or renal disease (4%) [83] (Table 7.5). A thorough history and physical examination and the mini-nutritional assessment are used to assess unintentional weight loss. Attention should also be paid to medications that cause anorexia, dry mouth, nausea or vomiting, and dysphagia. Psychological and psychosocial causes should be identified and addressed. Nonpharmacological interventions include minimizing dietary restrictions [84] adding favorite foods to the diet, adding nutritional supplements, and involving nutritional programs such as meals on wheels. Pharmacological therapies are used to either stimulate appetite or cause weight gain. These include megestrol, acetate, ornithine, oxoglutarate, recombinant human growth hormone and dronabinol.

Table 7.5 Meals on wheels pneumonic for weight loss in older adults

*M*edications
*E*motions – depression
*A*lcoholism
*L*ate life paranoia
*S*wallowing problems
*O*ral factors
*N*osocomial infections
*W*andering
*H*yperthyroidism, hypercalcemia, hypoadrenalism
*E*nteral
*E*ating problems
*L*ow salt, low cholesterol diets
*S*tones

They are associated with multiple side effects and there are no prospective randomized trials that justify their use in elderly patients.

Frailty

Both undernutrition and obesity should be viewed as indicators of frailty in the older adult. The definition proposed by Fried [85] includes the presence of three or more of the following factors: unintentional weight loss, self-reported exhaustion, weakness, slow gait speed, and low physical activity. Severity and duration of weight loss and enquiry into activities of daily living (ADL) such as cooking and meal preparation are important. Frail older people may show low leptin levels and increased levels of IL-6 and C-reactive protein [86]. Other markers include 25-hydroxyvitamin D, lGF-1, and D-Dimer, suggesting a state that is pro-inflammatory [87].

Anemia

It has been shown that there is a significant association between anemia and malnutrition in the elderly. A third of anemia cases can be attributed to deficiency of nutritional factors such as iron, vitamin B12, and folic acid [88]. A cross-sectional study of 60 elderly hospitalized patients showed a 36.7% incidence of anemia. In this study, mid-arm muscle circumference (MAMC), albumin, and prealbumin correlated with hemoglobin in the bivariate analysis. MAMC and albumin were found to be significant predictors of hemoglobin in patients without inflammation (estimated by erythrocyte sedimentation rate) and prealbumin was found to be a predictor of hemoglobin in patients with inflammation [89].

Calorie Restriction

Changes with age include a gradual build up of degradative agents such as reactive oxygen and nitrogen species. Gene stability and function at fat-soluble and water-soluble sites within the mitochondria are affected by these reactive species [90]. The only intervention that has been shown to alter this phenomenon is calorie reduction. Restriction of total caloric intake has been shown to delay the rate of primary aging in many species such as worms, flies, and mice [91] although the mechanism responsible for this is not clear. Candidate mechanisms of calorie restriction in these species include decreased oxidative damage due to a reduction of reactive oxygen species generation and increased removal, altered neuroendocrine function and decreased incidence of chronic diseases such as obesity, diabetes and cardiovascular diseases [92].

In overweight nonobese humans, caloric restriction improves whole body metabolic efficiency and lowers markers of oxidative stress [93]. Studies in mice and rats have shown that caloric restriction leads to a delay in immunosenescence – the expected decline in humoral and cell-mediated immune function associated with aging. The phenomenon may account for the delay in the development of certain neoplasms in these animals. Caloric restriction has also been shown to decrease the oxidative damage to proteins, lipids, and DNA resulting in decreased production of free oxygen radicals. Surrogate measures show that calorie restriction in humans reduces the risk factor for atherosclerosis and diabetes [94]. These include a very low level of inflammation as evidenced by low circulatory levels of c-reactive protein and TNFα, serum triiodothyronine levels at the low end of the normal range, and a more elastic "younger" left ventricle (LV), as evaluated by echo-Doppler measures of LV stiffness.

Nutritional Supplementation

Acute Care

Nutritional support in elderly patients is particularly important during admission for acute illness. Attention should be focused on the initial medical or surgical management of the acute problem. Strategies to counteract decreased consumption, poor appetite, and chewing problems are particularly critical in the elderly [95].

Enteral Nutrition

Physicians should be careful with orders that prohibit or limit oral intake. Such orders should be temporary in nature, with specific plans for nutritional supplementation in the event that the oral intake has to be withheld longer than anticipated. Fast-track rehabilitation may be possible in elderly patients following laparoscopic or open colonic surgery. In a small nonrandomized study, early enteral feeding and mobilization coupled with pain relief and management of postoperative nausea and vomiting (PONV) was feasible in patients over the age of 70 and resulted in improved organ function and improved outcomes [96].

There is a need to determine values or markers that can help assess prognostic factors of 6-month mortality in patients admitted in the post-acute care setting. Functional and nutritional changes following an acute health crises can help determine such outcomes [97]. The INTERACTIVE trial combines nutrition (recommendations of nutrient dense foods, provision of recipes and referral to community meal programs and supplementation with commercial liquid diets, protein supplements or multi-vitamins where deemed necessary by a dietitian) and exercise therapy (exercise and fall prevention information) as an early intervention to address deconditioning, weight loss, and the ability to return to pre-admission status in elderly patients following proximal femur fractures. The study will be completed in September 2009, following which the results will become available [98].

Meal replacement products are often used to supplement oral intake in older adults. Liquid products, more than solid replacements, blunt the postprandial decline in hunger and therefore increase subsequent food intake in older adults [99].

Enteral nutrition is a preferred form of nutritional supplementation in the postoperative period. It helps to maintain epithelial cell structure and function and also helps in maintenance of mucosal immunity. Enteral tube feeding may be necessary in elderly patients hospitalized for an acute illness when they are unable to eat or swallow but have a functioning gut. Short-term feeding is possible through a small bore nasogastric feeding tube that does not interfere with the patient's ability to swallow. Radiographic evidence of proper placement of tubes is important before starting feeds. Full strength formulas should be used, starting at 25 ml/h and gradually increasing to reach the goal in 24–48 h.

Gastrostomy tube and jejunostomy tubes are used for long-term feeding, especially in patients who may require nutritional support for greater than 6–8 weeks. Temporary feeding tubes help maintain nutrition with the perioperative period. However, there is concern about placing feeding tubes in elderly patients who will not benefit from its intervention and whose quality of life in terminal stages of illness is adversely affected. Problems encountered include need for placement in nursing homes, lack of social interaction, need for restraints to protect the feeding tube and cellulites at the tube sites. Multidisciplinary approaches and frank discussions between the patient, the patient's family, and physicians can help with informed decision-making [100].

In patients with the prerenal disease, the BUN:plasma creatinine ratio may be greater than 20:1 due to an increased absorption of urea. BUN also increases with increased nitrogen intake. Adequate attention needs to be paid to high protein administration in elderly patients with impaired renal function [101]. These patients can retain excessive fluid resulting in peripheral edema and cardiac failure.

Fiber supplementation is important in enteral feeding. Although it does not have any effect on nutrition, it results in improved bowel function. In a study of 183 patients (mean age = 82 years), randomized to enteral feeds with and without fiber, the patients who received fiber had reduced stool frequency and more solid stool [102].

Total Parenteral Nutrition

Elderly patients tolerate total parenteral nutrition (TPN) well and are not at greater risk of complications than their younger counterparts [103]. If oral feeds have to be withheld for greater than 7 days due to a nonfunctioning gut as in paralytic ileus, then TPN should be considered, through a centrally or peripherally inserted central venous catheter. There is no data showing any significant advantage of peripherally inserted central catheters over centrally inserted central venous catheters. A recent study showed that while peripherally inserted lines were not superior to centrally inserted lines, the incidence of thrombotic complications was higher in peripherally placed lines. Other studies show that peripherally placed lines have a lower cost of insertion, lower rate of infection, and lower complication rate [104].

Irrespective of the site of the intravenous catheter, parenteral nutrition can be associated with metabolic, infectious, and technical complications [105]. It should therefore be used for the shortest period possible and every attempt made to start enteral or oral feeding as soon as possible. Protein and caloric requirements can be provided and are calculated using the Harris–Benedict Equation. The goal is to achieve a positive nitrogen balance using amino acids, 10% dextrose and intralipids. Calorie requirements should be calculated carefully and patients should not be given excessive calories. Metabolic complications include hyper- or hypoglycemia, hyperlipidemia, hypercapnia, acid-base disturbances, and refeeding syndrome. Older patients are particularly susceptible to overfeeding with resultant azotemia, hypertonic dehydration, and metabolic acidosis [106].

Liver dysfunction can occur when patients are on TPN. Liver function tests are monitored on a weekly basis. In a prospective cohort study of patients in 40 Intensive Care Units, administration of TPN within the first 24 h after admission was found to have a protective effect on liver function [107]. Once the patient is able to tolerate 50% oral intake or enteral feeds, TPN can be weaned off. Percutaneous lines should be left in place until there is assurance that the patient can continue to tolerate oral intake.

Frequent accuchecks are critical to avoid hypoglycemia. Patients are usually given 10% Dextrose at 50 cc/h during the weaning period. Inability to tolerate oral intake should be an indication of failure to wean and the patient should be restarted on TPN. The importance of glycemic control in older sick surgical patients, particularly in the ICU cannot be overemphasized. Hyperglycemia (glucose > 10 mmol/l) contributes to mortality seen in critically ill ICU patients. The incidence of infectious complications also increases with hyperglycemia. Currently glucose levels between 4.5 and 6.1 mmol/l are recommended, as there is a significant risk of hypoglycemia in patients treated to tighter limits [108].

Nutritional Issues in Specific Disease States

Few changes in the gastrointestinal system occur with aging and therefore signs and symptoms should be attributed to specific disease processes. Table 7.6 summarizes age-related alterations in the GI tract. The information is helpful in the evaluation and management of understanding nutritional needs in the elderly in the perioperative period [109].

Pancreatitis

Nutrition in the setting of acute pancreatitis is a challenging problem. Most of these patient present with abdominal pain, nausea, and vomiting. A metaanalysis of 11 randomized controlled trials showed that enteral nutrition in comparison with parenteral nutrition resulted in a statistically significant (59%) decrease in infectious complications and a statistically non-significant (40%) decrease in mortality [110]. A subsequent metaanalyses evaluated the effect of timing of the commencement of feeds in patients with acute pancreatitis. When started within 48 h of admission, enteral nutrition as compared to parenteral nutrition showed a statistically significant reduction in the risk of multiple organ failure, infectious complications, and mortality. There was no decrease in multiple organ failure risk, infectious complications or mortality if initiation of enteral nutrition was delayed to greater than 48 h following admission. This shows that timing of artificial nutrition is critical in patients with pancreatitis [111].

When enteral feeding is started, it is usually through a Dophoff tube with the tip positioned as distally to the ampulla of Vater as possible. Once the pancreatitis has resolved, low fat oral intake is encouraged.

Enterocutaneous Fistula

Maintenance of fluid and electrolyte balance is critical in the initial management of small bowel fistulas. Nutritional disturbances are present in 55–90% of patients with enterocutaneous fistulae [112]. Parenteral nutrition maybe initiated and should include trace elements and vitamins. Enteral nutrition should be administered in small bowel fistulas that are not expected to close spontaneously, in colocutaneous fistulas and when fistula output does not interfere with wound care [113]. Clear fluid up to 500 cc/day can be ingested. Enteral nutrition should consist of low residue diets [114].

Pressure Ulcers

Pressure ulcers can be a significant drain on energy reserves. Advanced stage pressure ulcers cause a catabolic and this state is influenced by the volume of the ulcers [115]. Specific instructions should be followed by the nursing staff to prevent development of pressure ulcers during hospitalizations for an acute problem. MNA is a useful screening and assessment tool in multimorbid geriatric patients with pressure ulcers [116]. Identification and management of nutritional deficiencies can decrease the risk of developing pressure ulcers.

Table 7.6 Gastrointestinal changes of senescence by segment

Segment of GI tract	Age-related alterations in GI tract	Diseases with nutritional consequences
Esophagus	Minor alterations in UES	Dysphagia
		GERD
Stomach	↓ Pepsin activity	Gastritis type A
	↓ Prostaglandin synthesis	Gastritis type B
	↓ Mucosal blood flow	Delayed gastric emptying
	↓ Gastric fluid secretion	Achlorhydria
Small intestine	↓ Lactase activity	Bacterial overgrowth
	↓ Intestinal blood flow	Lactose intolerance
	↓ Sodium/glucose co-transport	Inflammatory bowel disease
Colon	↓ In neuronal density	Constipation
	↓ Wall elasticity from collagen deposition	Diverticulosis
	↓ Resting pressure of internal sphincter	Angiodysplasia
Liver	↓ Liver size and blood flow	Hepatic encephalopathy cirrhosis (hepatitis C, ethanol, primary biliary cirrhosis)
	↓ Dynamic liver function	
Pancreas	↓ Pancreatic mass	Pancreatic cancer
	Ductular changes/fibrosis	Chronic pancreatitis
		Diabetes

Source: Adapted with permission from Dryden and McClave [110]

CASE STUDY

A 74-year-old man presented with an incarcerated ventral hernia. At exploratory laparotomy he was found to have a small bowel perforation within the hernia sac. Following small bowel resection and anastomoses, his fascial defect was too large to be repaired primarily. It was therefore repaired with a double layer of vicryl mesh and wound vacuum device. His past medical history was significant for diabetes, hypertension, and remote history of left hemicolectomy for diverticular disease.

Nutrition Assessment included weight 125 kg, height 175 cm, ideal body weight (IBW): 75 kg, percent IBW:167%, BMI = 41. Duration of inadequate nutrition: 7 days. He was eating adequately until a week prior to admission. His albumin (1.9) was severely depleted but likely represented a stress response rather than long-term nutritional status. Preoperatively, it was recommended that he receive: 1,875–2,250 cal/day to maintain weight. As part of the weekly nutritional assessment, he was weighed three times a week, and visceral protein labs were checked once a week.

The patient was kept NPO following surgery. The nasogastric tube placed prior to surgery was removed on postoperative day 2; he was given clear liquids on postoperative day 3; and advanced to a regular diet on postoperative day 5 after return of bowel function. He was subsequently discharged home on postoperative day 6.

He was readmitted 2 weeks later following increased drainage from abdominal wound and found to have an enterocutaneous fistula with an output of 1,200 cc/day. He was kept NPO and started on total parenteral nutrition (TPN) through a PICC line. Three weeks later, examination of his abdominal wound revealed small bowel mucosa at the site of the enterocutaneous fistula. At this time it was felt that the fistula would not close spontaneously and that he would need to undergo an exploratory laparotomy with small bowel resection and anastomoses. He was started on a low residue diet and weaned off his TPN. He was allowed 1,000 ml of free water per day to avoid dehydration. Calorie counts performed over a 2-day period showed an average calorie intake of 1,600 cal/day, with 80 g of protein per day. A higher protein intake of 113–135 g/day (1.3–1.5 g/kg) was advised.

At the time of his preoperative evaluation 5 months later, he weighed 125 kg.

His nutritional lab findings revealed an albumin of 3.3. He underwent a successful takedown of his enterocutaneous fistula and repair of his ventral hernia with bilateral separation of components. Five days following his surgery he was tolerating a regular diet.

Correcting zinc and calcium deficiencies and increasing the protein intake to 25% of total caloric intake increases the rate of healing of pressure ulcers.

Palliative Care

Artificial nutrition is considered medical treatment and not basic care [117]. The distinction is important because patients have a right to avail themselves of, or deny, medical treatment. Whenever possible, patient's wishes regarding enteral nutrition, parenteral nutrition, and the acceptable length of time for such intervention should be elicited. The "TLC" model of palliative care encourages a timely and team-oriented, longitudinal, collaborative, and comprehensive approach [118]. Artificial nutritional support is indicated in patients with head and neck cancers or esophageal cancer who are unable to swallow but continue to have an appetite. However, it has not been shown to improve survival in patients with advanced cancer. Megestrol acetate can be used in these patients to stimulate appetite, as can a short course of corticosteroids. The patient's condition, prognosis, and treatment goals should be discussed with patient and family. Treatment options should include curative treatment and palliative care. Treatment withdrawal should be discussed. Specific details of comfort care afforded to terminally ill patients should be shared with patients. In a study of patients who had cancer or stroke as their terminal diagnosis, patients were offered food and assistance with feeding but without force. Fifty three percent of patients did not experience hunger; 34% initially felt hunger but this resolved. Sixty two percent of patients did not experience thirst or did so only initially [119]. When a terminally ill patient cannot make decisions, the advance directive should be consulted to obtain information regarding the patient's wishes. If this does not exist, the legal guardian or first order relative of the patient will need to make decisions based on the patient's known wishes. In unbefriended patients, the physician's judgment should be used to determine a care plan [120].

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