medical nutrition & disease

A CASE-BASED APPROACH

fifth edition

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WILEY Blackwell

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Preface

The development of *Medical Nutrition & Disease* began in 1990 as a self-instructional, case-based textbook for medical students and was first published by Wiley-Blackwell in 1995. The 5th edition now includes 13 chapters and 26 cases, all of which continue to be co-written by a multidisciplinary team of registered dietitians and physicians. Medical students and medical residents have also been invited to contribute to several 5th edition chapters and cases, offering an opportunity to educate these trainees about nutrition and target our audience. This new edition also recognizes the increasingly important role of team-based care and interprofessional education. During the development of the 5th edition, the Interprofessional Education Collaborative (IPEC) was formed which aims to promote and encourage interprofessional learning experiences to better prepare future clinicians for team-based care of patients. The national organizations included in the IPEC are the Association of American Medical Colleges, American Association of Colleges of Nursing, American Association of Colleges of Osteopathic Medicine, American Association of Colleges of Pharmacy, American Dental Education Association, and the Association of Schools of Public Health. These groups represent higher education in allopathic and osteopathic medicine, dentistry, nursing, pharmacy, and public health and have created core competencies for interprofessional collaborative practice that can guide curricula development at all health professions schools. *Medical Nutrition & Disease* is designed so that medical, physician assistant, dietetic, nursing, public health, and pharmacy students and practitioners can enhance their nutrition knowledge, skills, and attitudes to provide effective counseling to patients with or at risk for a variety of chronic conditions – essentially the ideal text for interprofessional learning.

Over the past 20 years, the role of a healthy lifestyle in preventing and treating the most common chronic diseases, such as obesity, cancer, heart disease, hypertension, and diabetes continues to mount. Each chapter and case is based on strong scientific evidence supporting nutrition and physical activity interventions and provides practical advice on how to counsel patients to make positive behavior and lifestyle changes. All cases include "before and after" diets and over 50 references are included at the end of each chapter. The 5th edition also includes six new cases, covering emerging nutrition issues for macular degeneration, menopause, celiac disease, polycystic ovarian syndrome, colon cancer, and lead poisoning in children.

Registered dietitians and dietetic technicians can earn **48 pre-approved continuing education credits** from the Academy of Nutrition and Dietetics by successfully completing the multiple choice questions included in the book. There are no additional fees and all forms and directions are inserted inside the back cover.

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Part I
Fundamentals of Nutrition Assessment

1 Overview of Nutrition Assessment in Clinical Care

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OBJECTIVES

- Recognize the value of nutrition assessment in the comprehensive care of ambulatory and hospitalized patients.
- Obtain an appropriate patient history, including medical, family, social, nutrition/dietary, physical activity, and weight histories; use of prescription and over-the-counter medicines, dietary and herbal supplements; and consumption of alcohol and other recreational drugs.
- Demonstrate how to interpret physical findings that reflect nutritional status, including body mass index, waist circumference, growth and development, and signs of nutritional deficiency.
- Describe the diagnosis, prevalence, health consequences, and etiology of obesity and malnutrition.
- Identify the most common physical findings associated with vitamin/mineral deficiencies or excesses.
- List the laboratory measurements commonly used to assess the nutritional status of patients.

Source: Objectives for chapter and cases adapted from the *NIH Nutrition Curriculum Guide for Training Physicians*. (www.nhlbi.nih.gov/funding/training/naa)

Nutrition Assessment in Clinical Care

Nutrition assessment is the evaluation of an individual's nutritional status based on the interpretation of clinical information. Nutrition assessment is important because obesity and malnutrition are common in the clinical setting. The purpose of nutrition assessment is to:

- accurately evaluate an individual's dietary intake and nutritional status,
- determine if medical nutrition therapy and/or counseling is needed,
- monitor changes in nutritional status, and
- evaluate the effectiveness of nutritional interventions.

Accurate nutritional assessment leads to correct diagnosis and treatment. Many patients can benefit from medical nutrition therapy (MNT) using established evidence-based protocols.

Integrating Nutrition into the Medical History and Physical Examination

The following illustrates how nutrition can be integrated into all components of the clinical assessment, including the medical history, diet history, review of systems, physical examination, laboratory data, and treatment plan.

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Medical History

Past Medical History

Standard past medical history including immunizations, hospitalizations, surgeries, major injuries, chronic illnesses, and significant acute illnesses may have nutritional implications. Detailed information should be obtained about current or recent medication use including vitamins, minerals, laxatives, topical medications, over-the-counter medications, and products such as nutritional or herbal supplements which patients frequently fail to report as medications. Nutritional supplements include any products that may alter caloric, vitamin, or protein intake. Whether the patient has any known food allergies (i.e., peanut, gluten) or suffers from lactose (milk) intolerance is also important.

Family History

In assessing risk for future diseases, patients are asked to identify their parents, siblings, children, and partner, give their respective ages and health status, and indicate familial occurrences of disease or cause of death of any deceased family members. Family history of diabetes, cancer, heart disease, thyroid disease, obesity, hypertension, osteoporosis, food allergies, eating disorders, or alcoholism should be ascertained. Food sensitivity may be based on inherited immune system characteristics and family history of food intolerance should be assessed.

Social History

The diet history is typically obtained as part of the patients' social history because socioeconomic factors such as who the patient lives with and what resources they have available influence food selection and preparation. Pertinent non-medical information recorded in the social history includes the patient's occupation, daily exercise pattern, and marital and family status. Information should be solicited regarding the patient's education, economic status, residence, emotional response and adjustment to illness, and any other information that might influence the patient's understanding of his or her illness and adherence to a nutritional therapy. Details concerning the duration and frequency of the patient's use of substances such as alcohol, tobacco, illicit drugs, and caffeine are also documented. These data can be extremely useful when formulating the treatment plan. Economic limitations that influence access to an adequate diet, difficulties shopping for or preparing food, participation in feeding programs (e.g. Women, Infants, and Children (WIC), Meals on Wheels) are relevant aspects of the nutritional assessment.

The Importance of Taking a Diet History

The purpose of obtaining dietary information from patients is to assess their nutritional intake and establish a baseline from which to negotiate changes. Infants, children, adolescents, pregnant women, older adults, and patients with a family history of or who have diabetes, hypertension, heart disease, hyperlipidemia, obesity, eating disorders, alcoholism, osteoporosis, gastrointestinal or renal disease, cancer, or weight loss or gain should consistently be asked about their eating habits, even during routine visits. Relative strengths for each method of collecting dietary information are described in this section. In addition, patients' past and/or current dietary patterns, such as vegetarian or kosher diet practices, cultural background, and social situations should be considered during the interview. Family members who purchase and prepare foods should be invited for the interview process whenever possible. Diet-related questions may take a few minutes, if properly directed (See Table 1-1). Registered dietitians typically collect more detailed information from a diet history and make this information available to the physician, nurse practitioner, or physician assistant. This history may include information on food preferences, portion sizes, frequency of eating out, and emotional responses to eating. The detailed intake information can be used to determine calories, fat, protein, sodium, and fiber intake along with adequacy of vitamin and mineral intake can serve as a basis for counseling.

Table 1-1 Key Diet History Questions for Brief Intervention

Questions for All Patients
- How many meals and snacks do you eat every day?
- Do you feel that you eat a healthy balanced diet? Why or why not?
- What do you like to drink during the day, including alcohol? How many glasses?
- How often do you eat fruits and vegetables?
- How often do you eat dairy products? Low-fat or regular type?
- How often do you eat out? What kinds of restaurants?
- Do you usually finish what is on your plate or leave food?
- How often do you exercise, including walking?

In addition to the questions above:
Questions for Patients with Hyperlipidemia (Chapter 6)
- How often do you eat fatty meats? (hot dogs, bacon, sausage, salami, pastrami, corned beef)
- How often do you eat fish? How is it prepared?
- What types of fats do you use in cooking and baking?
- What do you spread on your bread?
- What type of snacks and desserts do you eat?

Questions for Patients with Hypertension (Chapter 6)
- Do you use a salt shaker at the table or in cooking?
- Do you read food labels for sodium content? (<400 mg/serving permitted)
- How often do you eat canned, smoked, frozen, or processed foods?

Questions for Patients with Diabetes (Chapter 8)
- What times do you take your diabetes medication (including insulin)?
- What times do you eat your meals and snacks?
- Do you ever skip meals during the day?
- How many servings of starchy foods such as breads, cereals, rice, pastas, corn, peas, or beans do you eat during a typical day?

Source: Lisa A. Hark, PhD, RD. 2014. Used with permission.

24-Hour Recall

Purpose This informal, qualitative, questioning method elicits all foods and beverages the patient has consumed in the preceding 24 hours. This method is recommended for follow-up visits for patients with diabetes because of the ability to assess the timing of meals, snacks, and insulin injections.

Questions "Starting with the last thing you ate please describe everything that you ate or drank within the past 24 hours (meals and snacks), including quantities, and how you prepared these foods." Family members are usually consulted if the patient is a child or unable to convey adequate detail. Patients can be asked to write down what they ate the day before while they are waiting to be seen. Hospitalized patients can be monitored through calorie counts reported by the nursing or dietary staff, who can record the daily amounts of food and drink the patient consumes. Keep in mind that the 24-hour recall method, when used alone, may underestimate or overestimate a person's usual caloric intake because the patient's recollection may not reflect long-term dietary habits. It may be helpful to add the question, "Is this fairly typical or was there something unusual about yesterday?" Use caution generalizing this information.

Usual Intake/Diet History

Purpose Similar to the 24-hour recall, a usual intake/diet history is a retrospective method to obtain dietary information by asking the patient to recall his or her normal daily intake pattern, including amounts of foods consumed. This method is suggested for older adults who may

frequently skip meals, or for interviewing pediatric patients whose diets may not be varied. This approach provides more information about usual intake patterns than others and tends to reflect long-term dietary habits with greater accuracy.

Questions "Please tell me what you usually eat and drink during the day for meals and snacks?" As a busy clinician, this question may be all that you will have time to ask, but it can serve as a screening mechanism to identify patients who need further screening with a registered dietitian. When using this approach it is important to be flexible. Begin by asking patients to describe their usual intake and if they cannot recall their usual diet, ask what they ate and drank the day before (a switch to the 24-hour recall method). You can then ask if these 24 hours are typical. Also bear in mind that some patients tend to report having eaten only those foods that they know are healthy. It is also important to ask patients if they have changed their diet for health reasons or because of a health professional's advice.

Food Frequency Questionnaire

Purpose The food frequency questionnaire is another retrospective approach used to determine trends in a patient's usual consumption of specific foods.

Questions Patients are usually asked several key questions regarding the frequency of intake of particular foods. Frequencies have been created to identify daily, weekly, or monthly consumption patterns and are especially good for specific nutrients (e.g., fiber, iron, or saturated fat). Patients can be asked these questions during the history, or these items can be added to the written form for new patients that can be mailed to them prior to their visit or completed while they are in the waiting room. For the clinician, questions can be geared toward the patient's existing medical conditions, which is why this method is effective for patients with diabetes, heart disease, hypertension, or osteoporosis and can be used for evaluating current intake of, for example, fruits, vegetables, dairy products, or processed foods.

Three-Day Food Record

Purpose Unlike the retrospective tools mentioned earlier, a food record is ideally completed prospectively and daily as patients consume their usual diet and reviewed by the clinician at the medical visit. More accurate results can be obtained by collecting data over a longer period (e.g., 7 days).

Questions Patients are asked to record information on meals, food items, quantity consumed, preparation methods, etc., and details such as activities while eating, mood, hunger level, etc., can also collected. This method is preferred for active patients who may be trying to adhere to a new dietary regimen (e.g., a weight loss diet). Three-day records are the most accurate reflection of patients' diets but it is difficult for most patients to keep a written log, including portion sizes, of everthing they ate and drank over three days.

Review of Systems

This subjective reexamination of the patient's history is organized by body systems. It differs from the past medical history by concentrating on symptoms, not diagnoses, and by emphasizing current more than past information. All positive and negative findings are listed. Nutrition questions vary according to the patient's age. One goal of this part of the history is to determine whether any dietary changes have occurred in the patient's life, either voluntarily or as a consequence of illness, medication use, or psychological problems. Examples within the review of systems that may have nutritional implications (and their potential significance) include weakness and fatigue (anemia), clothes tighter or looser (weight gain or weight loss), post-meal cramping or diarrhea (lactose

intolerance), chronic headaches, fatigue, gastrointestinal symptoms (gluten sensitivity), constipation (low fluid or fiber intake), amenorrhea (anorexia nervosa), or changes in appetite.

Physical Examination

The physical examination begins with the patient's vital signs (blood pressure, heart rate, respiration rate, temperature), height, weight, body mass index (BMI), and general appearance. For example, "On examination, she is a well-developed, athletic woman." When terms such as obese, overweight, undernourished, thin, well-nourished, well-developed, or cachectic (profound, marked state of ill health and malnutrition) are used, they should be supported by findings in the physical examination and noted in the problem list.

Body Mass Index (BMI)

To calculate BMI using the metric system:

$$\textbf{BMI} = \frac{\textbf{weight (kg)}}{\textbf{height (m}^2\textbf{)}}$$

To calculate BMI using English units:

$$\textbf{BMI} = \frac{\textbf{weight (lbs)}}{\textbf{height (in}^2\textbf{)}} \times \textbf{703}$$

Body mass index provides a more accurate measure of total body fat (adiposity) than body weight alone. The BMI is also more accurate than the older height–weight tables, which were based on a homogeneous population, primarily Caucasian, with higher than average socioeconomic status. BMI has also been shown to more estimate obesity than bioelectrical impedance tests. BMI values associated with the lowest mortality increase slightly as people age. However, BMI may overestimate body fat in very muscular people and underestimate body fat in some underweight people who have lost lean tissue, such as the elderly. Classifications of underweight, normal weight, overweight, and obesity are shown in Table 1-2. Health professionals should routinely assess height, weight, and BMI, and evaluate growth and development in infants, children, and adolescents.

Diagnosis and Assessment of Overweight and Obesity

Body Mass Index (BMI)

According to the National Heart Lung and Blood Institute's (NHLBI) *Clinical Guidelines*, many people with a BMI of 25 kg/m^2 or greater begin to experience negative health effects, such as elevated low-density lipoprotein cholesterol (LDL-C) and total cholesterol levels, high blood pressure, and glucose intolerance. These guidelines define overweight individuals as those with a BMI of 25

Table 1-2 Classifications of BMI

Underweight	$<$18.5 kg/m^2
Normal weight	18.5–24.9 kg/m^2
Overweight	25–29.9 kg/m^2
Obesity (Class 1)	30–34.9 kg/m^2
Obesity (Class 2)	35–39.9 kg/m^2
Extreme obesity (Class 3)	$\geq$40 kg/m^2

Source: National Heart, Lung, and Blood Institute, NIH. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. 1998. Used with permission.

to 29.9 kg/m^2 and obese individuals as those with a BMI of 30 kg/m^2 and above. The NHLBI *Clinical Guidelines* classify BMI as shown in Table 1-2. BMI values can be determined from height and weight measurements as shown in Figure 1-1.

Waist Circumference

Waist circumference is an independent measure of risk in normal weight and overweight individuals. Excess fat located in the abdominal area (termed visceral adipose tissue) is reflected by waist circumference measurement. Waist circumference is a predictor of morbidity, and is considered an independent risk factor for diabetes, dyslipidemia, hypertension, and cardiovascular disease when BMI is not markedly increased. In patients with a BMI greater than 35 kg/m^2, there is little additional risk from elevated waist circumference, as severe risk is already present. Therefore, measuring waist circumference is recommended in patients with a BMI less than 35 kg/m^2. The waist circumference measurement is particularly important for patients with a family history of diabetes and those who may be borderline overweight.

In order to obtain an accurate waist circumference measurement, patients should be standing in only their underwear. A horizontal mark should be drawn just above the uppermost lateral border of the right iliac crest, which should then be crossed with a vertical mark in the midaxillary line. The measuring tape is placed in a horizontal plane around the abdomen at the level of this mark on the right side of the trunk. The plane of the tape should be parallel to the floor and the tape should be snug but not tight. Patients should be advised to breathe normally while the measurement is taken. Waist circumference values greater than 102 cm (40 inches) in men and greater than 88 cm (35 inches) in women are considered indicators of increased risk, although these values may differ for different ethnic groups. Waist circumference is one of the diagnostic criteria of metabolic syndrome (Chapter 1: Case 1). In patients trying to lose weight by exercising, waist circumference may decrease without significant weight loss.

Percent Weight Change

Weight loss is very common in hospitalized patients and those residing in chronic care facilities. Weight loss is also frequently seen in older adults or those with decreased changes due to chronic illnesses such as cancer, gastrointestinal problems, or secondary to surgery, chemotherapy, or radiation therapy. If weight loss is identified in the medical history or review of systems, it is essential to take a diet and weight history and determine the percent weight change over that period of time using the patient's current body weight and usual weight. Severity of weight loss is defined by percent change in a defined period of time (Table 1-3).

$$\textbf{Percent weight change} = \frac{\text{Usual Weight} - \text{Current Weight}}{\text{Usual Weight}} \times 100$$

Physical Examination Findings

Nutrition-oriented aspects of the physical examination focus on the skin, hair, eyes, mouth, nails, extremities, abdomen, skeletal muscle, and fat stores. Areas to examine closely for muscle wasting include the temporalis muscles, thenar, hypothenar, and interosseous muscles on the hands. The skeletal muscles of the extremities are a less sensitive indicator of malnutrition. Subcutaneous fat stores should be examined for losses due to a sudden decrease in weight or for excess accumulation in obesity. Isolated vitamin deficiencies such as scurvy or pellagra are rarely seen in modern clinical practice. At the present time, the most commonly encountered nutritional problem seen in clinical practices in the United States and many developed countries is obesity and its associated complications. Specific clinical signs that are attributable to nutrient deficiencies and significance on physical examination are shown in Table 1-4. Combined nutrient deficiencies are still seen in those with disordered intake such as alcoholics or patients receiving chemotherapy.

Body Mass Index Chart

in/cm	lbs/kg 100/45	105/48	110/50	115/52	120/55	125/56	130/59	135/61	140/64	145/66	150/68	155/70	160/73	165/75	170/77	175/79	180/82	185/84	190/86	195/89	200/91	205/93	210/95	215/98	220/100	225/102	230/104	235/107	240/109	245/111	250/114
5'0"/153	20	21	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
5'1"/155	19	20	21	22	23	24	25	26	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	43	44	45	46	47
5'2"/158	18	19	21	22	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	36	37	37	38	39	40	41	42	43	44	45	46
5'3"/160	18	19	20	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	34	35	35	36	37	38	39	40	41	42	43	43	44
5'4"/163	17	18	20	21	21	21	22	23	24	25	26	27	27	28	29	30	31	32	33	33	34	35	36	37	38	39	39	40	41	42	43
5'5"/165	17	17	19	20	20	21	22	22	23	24	25	26	27	27	28	29	30	31	32	32	33	34	35	36	37	37	38	39	40	41	42
5'6"/168	16	17	19	19	19	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	35	36	36	37	38	39	40	40
5'7"/171	16	16	18	19	19	20	20	21	22	23	23	24	25	26	27	27	28	29	30	31	31	32	33	34	34	35	36	37	38	38	39
5'8"/173	15	16	17	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	33	33	34	35	36	36	37	38
5'9"/176	15	16	17	18	18	18	19	20	21	21	22	23	24	24	25	26	27	27	28	29	30	30	31	32	32	33	34	35	35	36	37
5'10"/178	14	15	17	17	17	18	19	19	20	21	22	22	23	24	24	25	26	27	27	28	29	29	30	31	32	32	33	34	34	35	36
5'11"/181	14	15	16	17	17	17	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	29	29	30	31	31	32	33	33	34	35
6'0"/183	14	14	16	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	31	31	32	33	33	34
6'1"/186	13	14	15	16	16	16	17	18	18	19	20	20	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	32	32	33
6'2"/188	13	13	15	15	15	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	28	28	29	30	30	31	31	32
6'3"/191	12	13	14	14	15	16	16	17	17	18	19	19	20	21	21	22	22	23	24	24	25	26	26	27	27	28	29	29	30	31	31
6'4"/193	12	13	13	14	15	15	16	16	17	18	18	19	19	20	21	21	22	23	23	24	24	25	26	26	27	27	28	29	29	30	30

Underweight	Normal	Overweight	Obese
<18.5	19–24.9	25–29.9	>30

Figure 1-1 BMI Values Based on Height and Weight

Table 1-3 Interpretation of Percent Weight Change

Time	Significant Weight Loss	Severe Weight Loss
1 week	1–2%	>2%
1 month	5%	>5%
3 months	7.5%	>7.5%
6 months	10%	>10%
1 year	20%	>20%

Table 1-4 Physical Examination Findings with Nutritional Implications

Exam	Nutritional implications
Vital signs	Blood pressure, height, weight, BMI, percent weight change
General	Wasted, cachectic, overweight, obese, muscle weakness, anorexic, waist circumference
Skin	Acanthosis nigricans (obesity, metabolic syndrome, insulin resistance, diabetes) Ecchymosis (vitamin K, C deficiency) Dermatitis (marasmus, niacin, riboflavin, zinc, biotin, EFA deficiency) Follicular hyperkeratosis (vitamin A deficiency) Petechiae (vitamin A, C, K deficiency) Pigmentation changes (niacin deficiency, marasmus) Pressure ulcers/delayed wound healing (kwashiorkor, diabetes, vitamin C, zinc deficiency) Psoriasiform rash, eczematous scaling (zinc deficiency) Purpura (vitamin C, K deficiency) Scrotal dermatosis (riboflavin deficiency) Pallor (iron, folic acid, vitamin B_{12}, copper, vitamin e deficiency) Thickening and dryness of skin (linoleic acid deficiency)
Hair	Dyspigmentation, easy pluckability (protein), alopecia (zinc, biotin deficiency)
Head	Temporal muscle wasting (marasmus and cachexia) Delayed closure of fontanelle (pediatric undernutrition or growth retardation)
Eyes	Night blindness, xerosis, bitot spots, keratomalacia (vitamin A deficiency) Photophobia, blurring, conjunctival inflammation, corneal vascularization (riboflavin deficiency), macular degeneration
Mouth	Angular stomatitis (riboflavin, iron deficiency) Bleeding gums (vitamin C, K, riboflavin deficiency) Cheilosis (riboflavin, niacin, vitamin B_6 deficiency) Dental caries (fluoride deficiency) Hypogeusia (zinc, vitamin A deficiency) Glossitis (riboflavin, niacin, folic acid, vitamin B_{12}, vitamin B_6 deficiency) Nasolabial seborrhea (vitamin B_6 deficiency) Papillary atrophy or smooth tongue (riboflavin, niacin, iron deficiency) Fissuring, scarlet or raw tongue (niacin, folate, B_{12}, B_6 deficiency)
Neck	Goiter (iodine deficiency) Parotid enlargement (marasmus, bulimia)
Thorax	Thoracic achitic rosary (vitamin D deficiency)
Abdomen	Abdominal obesity (metabolic syndrome, diabetes, heart disease) Diarrhea (niacin, folate, vitamin B_{12} deficiency, marasmus) Hepatomegaly/ascites (kwashiorkor, alcoholism)
Cardiac	Heart failure (thiamin, selenium deficiency, anemia)
Genital/urinary	Delayed puberty (marasmus, eating disorder, celiac disease) Hypogonadism (zinc deficiency)
Extremities	Ataxia (vitamin B_{12} deficiency, vitamin B_6 toxicity) Bone ache, joint pain (vitamin C deficiency) Bone tenderness, kyphosis (vitamin D deficiency)

Table 1-4 (*Continued*)

Exam	Nutritional implications
	Edema (thiamin or protein deficiency) Growth retardation, failure to thrive (energy deficiency) Hyporeflexia (thiamin deficiency) Bone tenderness, kyphosis (calcium, vitamin D deficiency) Muscle wasting and weakness (vitamin D, magnesium deficiency, marasmus) Tenderness at end of long bones (vitamin D deficiency) Squaring of shoulders—loss of deltoid muscles (kwashiorkor)
Nails	Spooning (koilonychias) (iron deficiency) Transverse lines (kwashiorkor, hypochacemia)
Neurological	Dementia, delirium, disorientation (niacin, thiamin, vitamin E deficiency) Loss of reflexes, wrist drop, foot drop (thiamin deficiency) Ophthalmoplegia (vitamin E, thiamin deficiency) Peripheral neuropathy (thiamin, vitamin E, vitamin B_{12} deficiency) Tetany (vitamin D, calcium, magnesium deficiency)

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

Laboratory Data Used to Diagnose Nutritional and Medical Problems

No single blood test or group of tests accurately measures nutritional status. Therefore clinical judgment is important in deciding what tests to order based on the individual's history and physical findings. The following tests are grouped according to medical condition.

Alcoholism: Aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), thiamin, folate, and vitamin B_{12}.

Anemia: Complete blood count (CBC), serum iron and ferritin, total iron binding capacity (TIBC), transferrin saturation, mean corpuscular volume (MCV), reticulocyte count, red blood cell folate, and serum vitamin B_{12}.

Diabetes: Fasting serum glucose, hemoglobin A1C, insulin levels, C-reactive protein (CRP), serum, and urinary ketone bodies.

Eating Disorders: Potassium, albumin, serum amylase, thyroid studies, beta carotene aspartate amino transferase (AST), alanine aminotransferase (ALT), and anemia.

Fluid, Electrolyte, and Renal Function: Sodium, potassium, chloride, calcium, phosphorus, magnesium, blood urea nitrogen (BUN), creatinine, urine urea nitrogen, urinary and serum, oxalic acid, and uric acid.

Hyperlipidemia: Cholesterol, triglyceride, low density lipoprotein-cholesterol (LDL-C), high density lipoprotein-cholesterol (HDL-C), LPa, homocysteine, and thyroid stimulating hormone (TSH) (secondary cause).

Musculoskeletal pain, weakness: 25(OH) vitamin D, phosphate, parathyroid hormone (PTH).

Malabsorption: 24-hour fecal fat, barium imaging studies, electrolytes, albumin, serum triglycerides, and hydrogen breath test.

Metabolic Syndrome: Fasting serum glucose, lipid panel, and uric acid.

Refeeding Syndrome: Albumin, calcium, phosphorous, magnesium, and potassium.

Malnutrition: Protein Status

Clinically, visceral protein status may be depleted by increased protein losses in the stool and urine as a result of wounds involving severe blood loss, or by poor dietary protein intake. The following serum protein levels may prove useful in conjunction with other nutrition assessment parameters.

Once again, however, each of these tests has limitations because serum protein levels are affected not only by nutrition and hydration status, but by disease states, surgery, and liver dysfunction.

The half-life ($t_{1/2}$) of each protein is given because it allows use of these tests to monitor changes in protein nutrition over time:

- **Serum albumin** Serum albumin has a half-life of 18 to 20 days and reflects nutritional status over the previous 1 to 2 months. Levels may decrease with acute stress, overhydration, trauma, surgery, liver disease, and renal disease. False increases occur with dehydration. This test is not a good indicator of recent dietary status or acute changes in nutritional status (less than 3 weeks) given its long half-life. Significantly reduced levels of serum albumin (<3.5 mg/dL) have been associated with increased morbidity and mortality in clinical studies.
- **Serum transferrin** Serum transferrin has a half-life of 8 to 9 days. Changes in serum transferrin levels are influenced by iron status, as well as by protein and calorie malnutrition. Results of this test reflect intake over the preceding several weeks.
- **Serum prealbumin** With a half-life of 2 to 3 days, serum prealbumin reflects nutritional status as well as protein and calorie intake over the previous week. Prealbumin levels may be falsely elevated with renal disease or, as with albumin, reduced with severe liver disease.

Assessment and Problem List: Medical Nutrition Therapy

The healthcare professional clinically assesses the individual patient based on his/her history, review of systems, physical examination, and laboratory data.

Active problems are listed in order of their importance. Inactive problems are also recorded. Evidence of a nutrition disorder should be considered primary if it occurs in patients with no other etiology that explains signs and symptoms of malnutrition. A primary nutrition problem is usually the result of imbalances, inadequacies, or excesses in the patient's nutrient intake. Manifestations may include obesity, weight loss, malnutrition, or poor intake of vitamins or minerals such as iron, calcium, folate, vitamin D, or vitamin B_{12}.

Patients having normal weight and no other risk factors should be encouraged to maintain their weight. Overweight patients with co-morbidities, such as diabetes, hypertension, or heart disease, should be advised to lose weight by increasing their physical activity level and reducing their total calorie and saturated fat intake, using smaller portion sizes, and selecting healthier foods. Referral to a registered dietitian for additional counseling and support has been shown to be effective.

Secondary nutrition problems occur when a primary pathologic process results in inadequate food intake, impaired absorption and utilization of nutrients, increased loss or excretion of nutrients, or increased nutrient requirements. Common causes of secondary nutritional disorders include anorexia nervosa, malabsorption, trauma, acute medical illness, and surgery. Malnutrition may occur as a result of a chronic condition or an acute episode complicating an underlying disease. After assessing each problem, medical nutrition therapy should be recommended that includes both a diagnostic component and a treatment plan. Patient education is an essential part of medical nutrition therapy. Key dietary issues by age and disease are summarized in Table 1-5.

Estimating Energy and Protein Requirements

Resting Energy Expenditure (REE)

The amount of energy required to maintain vital organ function in a resting state over 24 hours is referred to as the resting energy expenditure (REE). Basal metabolic rate (BMR) is the minimum calorie requirement for an individual at a neutral environmental temperature while fasting. BMR is generally impractical to measure. REE is approximately 10 percent above BMR. Thus, the REE is used clinically for estimation of BMR. REE accounts for approximately 65 percent of total daily energy expenditure and varies considerably among individuals with different height, weight, age,

Table 1-5 Key Dietary Issues by Age and Disease

Age/Disease	Key Dietary Issue
Infants	Fluoride, iron, calories, protein, fat for growth and development
Children	Fluoride, iron, calcium, calories, protein, fat for growth and development
Teenagers	Iron, calcium, calories, protein for pubertal development (screen for eating disorders)
Pregnancy	Folate, iron, calcium, vitamin D, protein, appropriate weight gain
Alcoholism	Folate, thiamin, vitamin B_{12}, calories
Anemia	Iron, vitamin B_{12}, folate
Ascites	Sodium, protein
Beriberi	Thiamin
Cancer	Adequate protein, calories, and fiber
Celiac Disease	B complex, vitamins, vitamin D
COPD, Asthma	Vitamin D, calcium, weight loss, calories
Diabetes	Carbohydrates, saturated fat, cholesterol, calories, fiber
Heart Disease	Saturated fat, monounsaturated fat, cholesterol, sugar, fiber
Hyperlipidemia	Saturated fat, monounsaturated fat, cholesterol, sugar, fiber
Heart Failure	Sodium
Hypertension	Sodium, calcium, potassium, alcohol, sugar, total calories
Kidney Stones	Calcium, oxalate, uric acid, protein, sodium, fluid
Liver Disease	Protein, sodium, fluid
Malabsorption	Vitamins A, D, E and K
Obesity	Total calories, portion sizes, saturated fat
Osteoporosis	Vitamin D and calcium
Pellegra	Niacin
Renal Failure	Protein, sodium, potassium, phosphorous, fluid
Rickets	Vitamin D and calcium
Scurvy	Vitamin C
Vegetarian diet	Protein, vitamin B_{12}, iron, calcium

Source: Lisa A. Hark, PhD, RD and Darwin Deen, MD, MS. 2014. Used with permission.

Table 1-6 Definition of Energy/Calorie

Energy is expressed in kilocalories (kcal) and is produced by the oxidation of dietary protein, fat, carbohydrate, and alcohol.

- One gram of **protein** yields approximately 4 kcal.
- One gram of **carbohydrate** yields approximately 4 kcal.
- One gram of **fat** yields approximately 9 kcal.
- One gram of **alcohol** yields approximately 7 kcal.

A calorie is the amount of heat required to raise the temperature of 1 gram of water by 1 degree Celsius. A kilocalorie is the amount of heat required to raise the temperature of 1 kilogram of water by 1 degree Celsius.

body composition, and gender. REE significantly correlates with lean body mass. Regular physical activity, especially weight-bearing exercises, can increase muscle mass, and thus increase REE. Since REE decreases as people age due to the loss of lean body mass over time, regular exercise can play a significant role in maintaining REE, especially in older adults. The energy produced by the oxidation of dietary macronutrients is shown in Table 1-6. The Mifflin–St. Jeor equation to estimate energy requirement is shown in Table 1-7. Activity factors are added to the REE as necessary to calculate total daily caloric needs, which vary for active and inactive patients. Total energy expenditure (TEE) is equal to the REE times the appropriate physical activity factor. The physical activity factor for hospitalized patients or those confined to bed is 1.2; for non-hospitalized, sedentary patients, 1.3.

Table 1-7 Mifflin-St. Jeor Equation to Estimate Energy Requirement

Adults 19 years and older
Estimated Energy Requirement (kcal/day) = Total Energy Expenditure
Men
10 × weight (kg) + 6.25 × height (cm) − 5 × age (y) + 5
Women
10 × weight (kg) + 6.25 × height (cm) − 5 × age (y) − 161

Source: Mifflin, MD, St. Jeor ST, Hill LA, Scott, BJ, Daughtery SA, Koh YO. A new perspective equation for resting energy expenditure in healthy individuals. *Am J Clin Nutr*. 1990;(2):1241–-1247.

Protein Needs of Hospitalized or Critically Ill Patients

Protein requirements in a critically ill patient depend on the degree of catabolic stress the patient is experiencing. Guidelines are as follows:

- In unstressed well-nourished individuals, protein needs range from 0.8 to 1.0 g/kg body weight per day.
- In post-surgical patients protein needs range from 1.5 to 2.0 g/kg body weight per day.
- In highly catabolic patients (burns, infection, fever), protein needs can be over 2 g/kg body weight per day.

Malnutrition

According to the World Health Organization (WHO), malnutrition affects all age groups across the entire lifespan, from conception to older adults. Health consequences range from intrauterine brain damage and growth failure to reduced physical and mental capacity in childhood to an increased risk of developing diet-related chronic diseases later in life.

Insufficient food intake results in loss of fat, muscle, and ultimately visceral tissue. This reduction in tissue mass is reflected in weight loss. The smaller tissue mass reduces nutritional requirements, likely reflecting more efficient utilization of ingested food and reduction in work capacity at the cellular level. The combination of decreased tissue mass and reduction in work capacity impedes homeostatic responses, including responses to illness or surgery. The stress of critical illness inhibits the body's conservation response to malnutrition. In addition, undernourished individuals experience nutrient deficiencies and imbalances that exacerbate the reduction in cellular work capacity. Malnutrition is also associated with a decrease in the inflammatory response and immune function. These alterations result in increased morbidity and mortality among undernourished patients. Adequate nutrition is essential for reversing these physiological effects. Aggressive nutritional support, instituted early in critical illness, may reduce the adverse effects of malnutrition in the critically ill patient.

Etiology/Causes of Malnutrition

Decreased Oral Intake Poverty, poor dentition, gastrointestinal obstruction, abdominal pain, anorexia, dysphagia, depression, social isolation, and chronic pain are some of the many possible causes of decreased oral intake.

Increased Nutrient Loss Glycosuria, proteinuria, gastrointestinal bleeding, diarrhea, malabsorption, a draining fistula, or protein-losing enteropathy can result in nutrient losses.

Increased Nutrient Requirements Hypermetabolism state or excessive catabolic processes can result in increased nutrient requirements. Common examples of situations that can dramatically