PART II

CLINICAL FOUNDATIONS OF NUTRITION SUPPORT

9

Malnutrition Screening and Assessment

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Objectives

Review definitions of malnutrition, including those that recognize the impact of inflammation.

Describe the rationale for a comprehensive nutrition assessment.

Describe practical nutrition screening and assessment techniques suitable for routine clinical applications.

Demonstrate an approach to nutrition assessment that uses information from the patient's anthropometrics, medical and surgical history, family and social history, medication review, clinical presentation, biochemical data, nutrient intake data, and nutrition-focused physical examination.

Test Your Knowledge Questions

1. Which of the following is an example of a patient condition anticipated to manifest with a severe systemic inflammatory response?

A. Anorexia nervosa with body mass index (BMI) of 15
B. Major depression with compromised dietary intake and 5% loss of body weight
C. Homebound older adult with restricted access to food and 10% loss of body weight
D. Thermal burn injury of second and third degrees covering 15% body surface area

2. A physician informs you that a patient has a serum albumin of 2.8 g/dL and prealbumin of 14 mg/dL and asks whether these laboratory findings mean the patient is malnourished. What is the most appropriate response?

A. The patient’s protein intake is inadequate, and the patient should receive prompt nutrition support.
B. Together, these markers indicate that the patient has moderate protein-energy malnutrition.
C. Consideration of medical history, clinical diagnosis, and laboratory signs of the inflammatory response would help you interpret these findings.
D. For most hospitalized patients, albumin and prealbumin have excellent sensitivity and specificity to identify malnutrition.

3. Which of the following is one of the best validated screening indicators for malnutrition risk?
A. Patient reports a nonvolitional weight loss.
B. Patient reports following a low-carbohydrate, weight loss diet.
C. Patient is 2 days status post laparoscopic cholecystectomy.
D. Patient reports a recent flu-like febrile illness.

Test Your Knowledge Answers

1) The correct answer is D. The burn injury is significant and will be associated with severe systemic inflammatory response. The diagnosis, clinical signs, physical examination data, and laboratory indicators for such a patient will support this conclusion. The other answers describe states of starvation that are not likely to be associated with severe systemic inflammatory response.
2) The correct answer is C. By themselves, these proteins should be interpreted with caution because they lack specificity and sensitivity as indicators of nutrition status. Both albumin and prealbumin may be reduced by the systemic response to injury, disease, or inflammation. Patients with low albumin or prealbumin levels may or may not be malnourished. The patient’s medical history, clinical diagnosis, and laboratory signs of the inflammatory response can help clarify whether inflammation is present and whether the patient is malnourished.
3) The correct answer A. Of the options provided, the only well-validated indicator to screen for malnutrition risk is a nonvolitional weight loss. The other options might be noted in screening and assessment but are not themselves validated measures of malnutrition risk.

Introduction

Nutrition screening and assessment are integral tools used to direct the nutrition care of a patient. Each has the ability to detect malnutrition, but they are distinct from each other.1 Nutrition screening is used “to identify an individual who may be malnourished or at risk for malnutrition and to determine if a comprehensive nutrition assessment is indicated.” Results from the screen may indicate the need for a complete nutrition assessment (for patients deemed at risk for malnutrition) or the need to rescreen at a future date (if the screen is negative). A nutrition assessment is “a comprehensive approach to defining the nutrition state that uses a combination of the following: medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data."[2] Comparatively, screening is a simpler and quicker means to identify individuals at nutrition risk, whereas assessment is a more rigorous evaluation to detect a variety of nutrition abnormalities, including malnutrition, and is the basis to guide therapeutic interventions, enhance nutrition status, and improve outcomes.[1] In the United States, both Centers for Medicare and Medicaid Services and the Joint Commission recognize the importance of screening and assessing patients for nutrition abnormalities.[3,4] US hospital policy makers are required to develop and implement strategies using a collaborative and interdisciplinary approach to determine individual patient needs through routine screening and assessment protocols.[4] Such activities can be accomplished by healthcare team members who have appropriate training, education, and scope of practice as defined by state laws.[4,5] Nutrition screening is usually performed by nursing staff on admission.[6,7] Screening and assessment practices are part of a continuous process that involves reevaluation and monitoring to ensure delivery of suitable nutrition interventions throughout the continuum of care.

Malnutrition—or, more specifically, undernutrition—in hospitalized patients has been a documented concern for decades.[8,9] It has been associated with increased complications, such as poor wound healing, compromised immune status, impairment of organ functions, and increased mortality. Malnutrition is also associated with increased use of healthcare resources.

The prevalence of malnutrition is difficult to isolate and ranges from 30% to 50%, depending on the setting and criteria used to define it.[10,11] In 2010, only 3.2% of US hospital patients had a documented diagnosis of malnutrition at discharge.[11] Lack of practitioner awareness and confusion generated by various conflicting definitions and criteria of malnutrition have led to poor detection and treatment of undernutrition.[10,12,13] However, practitioners can increase identification of malnutrition through appropriate screening and assessment methods. To this end, this chapter describes notable approaches to adult malnutrition, including Subjective Global Assessment (SGA), the set of clinical characteristics proposed by the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Academy of Nutrition and Dietetics (AND) as a means to define and improve reporting of malnutrition,[14] and the European Society for Clinical Nutrition and Metabolism (ESPEN) 2015 consensus statement that established criteria to diagnose malnutrition.[15] Practical nutrition screening and assessment techniques suitable for routine clinical applications are also reviewed.

Defining Malnutrition

Malnutrition (undernutrition) has been defined in many ways. All definitions include an inadequacy of nutrients to maintain a person's health that is caused by one or more of the following factors: insufficient intake, impaired absorption, increased nutrient requirements, and altered nutrient transport and utilization. Beyond this broad conceptualization of malnutrition, definitions vary in their terminology and the criteria used to define this condition. Clinicians have historically used SGA to diagnose malnutrition because it has been validated for use in many populations. It is commonly used today; and the Canadian Nutrition Society has adopted it for diagnosing malnutrition. Other nutrition societies have initiated alternate processes to consistently characterize elements of malnutrition. In the

United States, concerns brought forth by the Centers for Medicare and Medicaid Services, and a desire to promote a national standard for consistent diagnosis19 prompted ASPEN and AND to develop an etiology-based methodology that incorporates the inflammatory process into the characterization of malnutrition in adults in clinical settings. Subsequently, in 2015, ESPEN proposed a minimal set of straightforward, well-defined, and generally accepted parameters, independent from etiological factors, to identify malnutrition across a broad spectrum of patients.15 These national and international efforts to find a unifying set of malnutrition characteristics aim to enhance clinical patient care, augment the legitimacy of nutrition practice, and, ultimately, expand the scientific field of nutrition.

Role of Inflammation in Malnutrition

For many years, investigators and clinicians have recognized that infection is consistent with critical deterioration of lean body mass, and such observations have led to the postulate that the identification of acute and chronic inflammation is integral to determine the etiology of malnutrition.10 Therefore, SGA and the ASPEN/AND method attempt to evaluate the presence and severity of the inflammatory process and how inflammation contributes to a patient's malnutrition. For example, SGA uses metabolic stress from disease as a proxy for inflammation.

The onset of an inflammatory process begins with an insult to the body from pathogens, trauma, or other disease-causing agents. The ensuing inflammatory response increases cytokine production. Cytokines subsequently signal hepatocytes to suppress the production of negative acute-phase proteins in favor of freeing amino acids for production of positive acute-phase proteins. Anorexia often accompanies inflammation, further compromising nutrition status. Some disorders and interventions may precipitate malnutrition because they adversely affect the body's ability to ingest or absorb nutrients, or because they impose diet restrictions or other limitations. The presence of inflammation may reduce the effectiveness of nutrition interventions, and the associated malnutrition may, in turn, blunt the effectiveness of medical therapies. During proinflammatory states, hepatic transport proteins, such as albumin and prealbumin, are poor indicators of nutrition status. The down regulation of negative acute-phase proteins allows for more amino acids to be used for producing positive acute-phase proteins, which help mitigate consequences of infection and modify the immune response.

Approaches to Diagnosing Malnutrition

Although this chapter focuses on 3 internationally recognized malnutrition assessment tools (SGA, the ASPEN/AND malnutrition characteristics, and the ESPEN diagnostic criteria), an abundance of other malnutrition assessment tools have been developed (see Table 9-1 for examples).

Historically, clinicians have also determined the severity of malnutrition by a variety of nonstandardized methods, such as depleted serum proteins, poor oral intake, and low BMI.

TABLE 9-1 Comparison of Nutrition Assessment Instruments

	SGA[22]	ASPEN/AND Malnutrition Clinical Characteristics[14]	ESPEN Consensus Statement[15]	MNA[25,26]	PG-SGA[27]
Nutrition history[a]	X	X	X	X	X
Biochemical data		X[b]		X	
Anthropometrics					
Weight change	X	X	X	X	X
BMI			X	X	
Other				X	
Physical examination					
Muscle mass	X	X	X		X
Fat stores	X	X			X
Fluid status	X	X			X
Functional capacity	X	X		X	X
Medical history					
GI symptoms	X				X
Medical conditions	X	X[b]		X	X
Neurologic issues				X	

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition; BMI, body mass index; ESPEN, European Society for Clinical Nutrition and Metabolism; GI, gastrointestinal; MNA, Mini Nutritional Assessment; PG-SGA, Scored Patient-Generated Subjective Global Assessment; SGA, Subjective Global Assessment.

[a]Intake and diet histories.

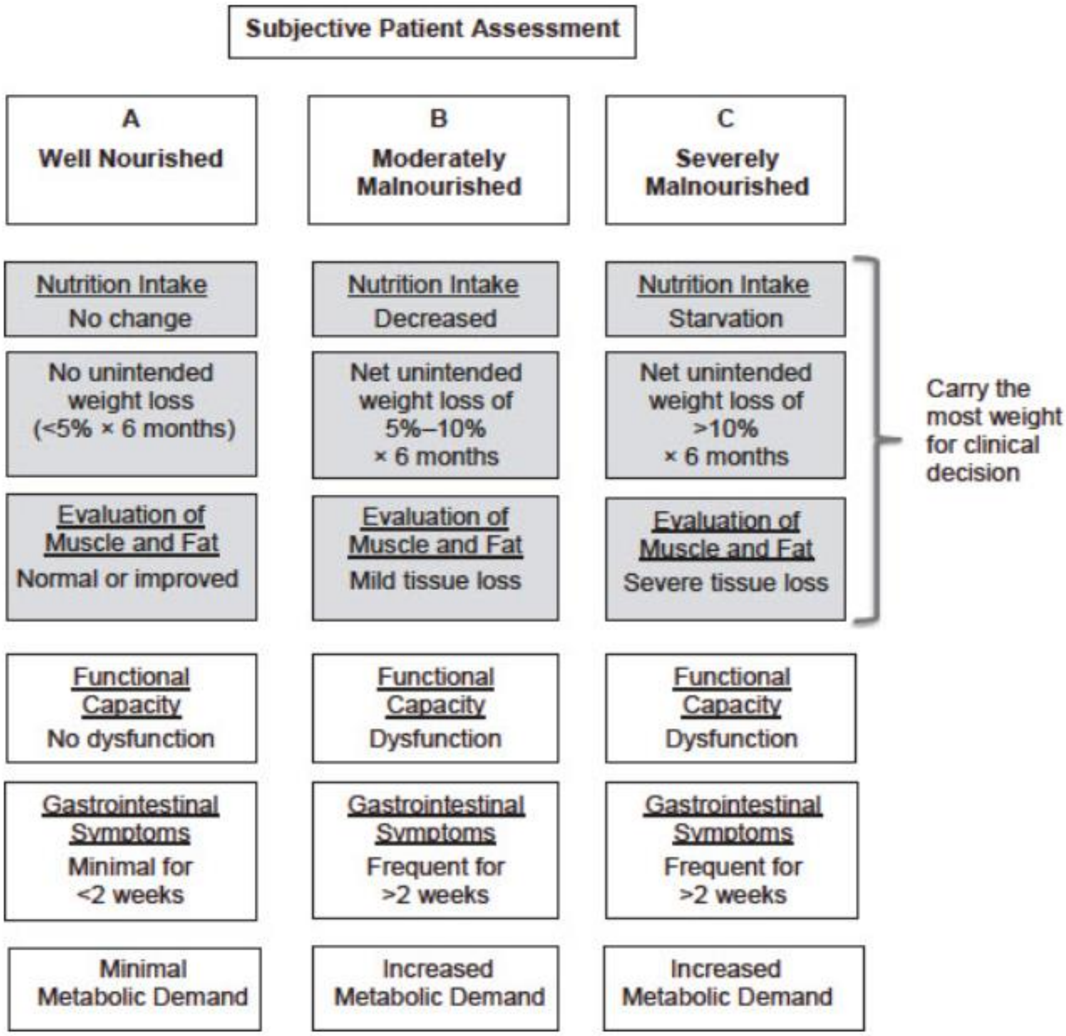
[b]Laboratory test data and medical history are used indirectly to assess level of inflammation.

Source: Data are from references 14, 15, 22, and 25–27.

Subjective Global Assessment

SGA is a prominently used, validated, and reliable assessment tool for diagnosing nutrition status, which relies on the patient’s medical history and physical assessment (see Figure 9-1). SGA is comprised of 5 components that consider medical history (weight changes, dietary intake, gastrointestinal [GI] symptoms, functional capacity, and metabolic stress from disease) and 3 components focusing on physical examination (muscle wasting, fat depletion, and nutrition-related edema). The clinician subjectively tallies information obtained during the physical examination, and results are used to classify an individual as well nourished, moderately malnourished, or severely malnourished. The SGA is not a specific grading system, but rather a weighted system where weight loss, oral intake, and physical assessment are most important for making clinical decisions. The remaining components of SGA (GI symptoms, functional capacity, and metabolic demand) are used to confirm clinician findings and are less influential for making a malnutrition diagnosis. SGA attempts to account for inflammation by accounting for metabolic stress from disease as a proxy. For patients who are critically ill, where SGA may have limited use, ASPEN and the Society of Critical Care Medicine recommend that clinicians use the Nutrition Risk Score (NRS-2003) or Nutrition Risk in Critically Ill (NUTRIC) tool to determine nutrition risk and plan appropriate interventions.29 Practice Scenario 9-1 illustrates the clinical use of SGA.

FIGURE 9-1 Decision Tree for Determining Severity of Malnutrition Using Subjective Global Assessment



Select an option from each characteristic (intake, weight, physical assessment, functional capacity, gastrointestinal symptoms and metabolic demand), and then select the Subjective Global Assessment rank (A, B, C) based on subjective weight of the categories.

Source: Data are from reference 22.

<u>Practice Scenario 9-1</u>

Question: According to Subjective Global Assessment (SGA) criteria,22 what severity of malnutrition best describes a patient who presents with cirrhosis complicated by portal hypertension, ascites, and edema?

Scenario: A 52-year-old man presented with an established history of cirrhosis and portal hypertension in the setting of long-term ethanol abuse. He had gained 10 pounds (4.5 kg) over the prior 2 weeks and exhibited massive ascites. Additional findings included mild encephalopathy (grade 1) with poor concentration, asterixis, and scleral icterus.

Upon admission, his clinical and laboratory criteria included the following: temperature, 36.7°C (normal: 36.1–37.2°C); albumin, 1.7 g/dL (normal: 3.9–4.9 g/dL); prealbumin, 6.8 mg/dL (normal: 17–36 mg/dL); white blood cell count, 3900/mcL (normal: 3700–11,000/mcL); total bilirubin, 3.8 mg/dL (normal: 0.2–1.3 mg/dL); aspartate aminotransferase, 96 IU/L (normal: 6–40 IU/L); alanine aminotransferase, 111 IU/L (normal: 20–60 IU/L); alkaline phosphatase, 162 IU/L (normal: 44–147 IU/L); and prothrombin time, 18 seconds (normal: 11–14 seconds).

A family member reported that the patient's food intake had been severely compromised for at least 1 month. Upon further probing, the family member reported intakes less than 50% of the patient's usual intakes. The patient complained of chronic early satiety, loss of appetite, and diarrhea due to lactulose. At presentation, the patient was 68 inches (172.7 cm) in height and weighed 161 pounds (73 kg). Family reported his usual weight as approximately 150 pounds (68 kg).

Physical findings were notable for ascites as well as grade 3–4+ lower extremity edema. The physical examination was limited because of fluid retention but revealed severe subcutaneous fat loss in the triceps and chest and severe muscle wasting in the deltoids. Muscle wasting in the quadriceps could not be assessed because of edema. The patient had physical limitations and spent most of his time lying in bed or sitting in a chair.

Intervention: Promote adequate energy intake with balanced macronutrients, sodium-restricted diet, and replacement of appropriate micronutrients (refer to Chapter 27). The patient may benefit from protein-energy supplements and vitamin/mineral replacement.

Answer: The patient's SGA ranking is C: Severely Malnourished. Malnutrition is identified by his poor nutrition intake, muscle wasting, and loss of subcutaneous fat, and supported by data showing his decreased functional capacity, persistent gastrointestinal symptoms for greater than 2 weeks, and increased metabolic demand (see Figure 9-1).

Rationale: Cirrhosis is a condition with an increased metabolic demand that is consistent with characteristics of moderately or severely malnourished (SGA rankings B and C, respectively).22 Abnormal liver function tests (total bilirubin, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, albumin, prothrombin time, and prealbumin) are consistent with a diagnosis of liver failure and cannot be reliably interpreted to support malnutrition.30 The presence of gastrointestinal symptoms for more than 2 weeks (SGA rankings B and C) is considered significant and has prevented adequate intake.22

The patient's family reported food intakes to be less than 50% of usual intake for 1 month (SGA ranking C). This finding is consistent with severe, prolonged, restricted energy intake and helps support a diagnosis of malnutrition.

In this case, ascites and severe edema are the major contributors to the patient's weight change, masking any true losses that may be occurring. It is not feasible to use weight change as reliable evidence supporting a diagnosis of malnutrition for this patient.

Muscle in the lower extremities was difficult to evaluate because of fluid accumulation but the physical examination identified severe muscle loss of the deltoids (SGA ranking C) and subcutaneous fat loss of the triceps and chest (SGA ranking C). These findings are concerning in a patient who has not been eating well for a prolonged period of time and are suggestive of improper nutrition when all other causes have been ruled out.22 If available, other body composition measures, such as dual-energy x-ray absorptiometry, computed tomography, and magnetic resonance imaging, may be used to demonstrate and confirm loss of muscle and subcutaneous fat.31,32

Ascites and lower extremity edema are indicative of cirrhosis and are not a direct result of malnutrition in this patient. In this situation, edema and ascites interfere with the clinician's accurate evaluation of weight loss.

A notable indication of physical decline is seen by the increased time he spends in a bed or chair (SGA rankings B and C). His functional decline may be related to malnutrition, but it is not the sole, definitive cause.

ASPEN/AND Classification

The etiology-based classification system developed by ASPEN/AND has elements similar to those of SGA (see Table 9-1), but the ASPEN/AND method includes a modern understanding of how proinflammatory states affect malnutrition and seeks to identify an etiology on a case-by-case basis as a framework for determining malnutrition. This approach recognizes 3 underlying etiologies for malnutrition. The first etiology, social/environmental/behavioral circumstances, describes an absence of inflammation, such as pure starvation. The other etiologies, chronic illness and acute illness or injury, incorporate different degrees of inflammation. Chronic illness describes inflammation of a longer-term condition with a mild to moderate intensity. Acute illness or injury recognizes inflammation of a much greater intensity that is associated with a short-lived process. Table 9-2 presents examples of medical conditions and their associated malnutrition etiology. The table is not all-inclusive, and the determination of malnutrition etiology is subject to clinician judgment. The patient's medical diagnosis alone should not be used to determine the malnutrition etiology; consider all parameters for evidence of inflammation. Table 9-3 lists inflammatory markers that can assist in evaluating patients for the presence and severity of inflammation. This table is also not all-inclusive; inflammatory markers should be considered within the larger scope of the patient's medical situation. For example, an acute exacerbation, infection, or other complication can be superimposed onto an existing chronic condition or disease. Etiologies associated with a patient's malnutrition can also change over time because of the fluid nature of illness.

TABLE 9-2 Inflammatory States Associated with Various Medical/Surgical Diagnoses

Malnutrition Etiology	Associated Inflammatory Condition	Common Medical/Surgical Diagnosis
Acute illness/injury (short duration)	Heightened, intense inflammatory response	Critical illness; major infection/sepsis; adult respiratory distress syndrome; systemic inflammatory response syndrome; severe burns; major abdominal surgery; multitrauma; closed head injury; severe acute pancreatitis; postoperative ileus
Chronic illness (≥3-month duration)	Mild to moderate inflammatory response	Cardiovascular disease; congestive heart failure; cystic fibrosis; inflammatory bowel disease; celiac disease; chronic pancreatitis; rheumatoid arthritis; solid tumors; hematologic malignancies; sarcopenic obesity; diabetes mellitus; metabolic syndrome; cerebrovascular accident; neuromuscular disease; dementia; organ failure/transplant of the kidney, liver, heart, lung, or gut; periodontal disease; pressure wounds; chronic obstructive pulmonary disease; HIV; lupus; small bowel obstruction; prolonged ileus
Social/behavioral /environmental circumstances	No inflammatory response	Starvation; anorexia nervosa; compromised food intake in the setting of financial disparity; dementia; alcohol/drug abuse; pain; small bowel obstruction

Source: Data are from references 33 and 34.

TABLE 9-3 Suggested Parameters to Assess for the Presence of Inflammation

Biochemical data:

- Depleted albumin, prealbumin, transferrin
- Elevated CRP, ferritin
- Hyperglycemia
- Leukocytosis, leukopenia
- Thrombocytopenia

Microbiological data:

- Urine cultures (urinary tract infection)
- Blood cultures (bloodstream infections)
- Fecal cultures (gastrointestinal infections)
- Bodily fluid cultures (infected abscess, pleural fluid, sputum, ascites)

Imaging:

- Chest x-ray (pneumonia, infiltrations, inflammation)
- CT, MRI, PET scan; abdominal/pelvic x-ray (abscess, pancreatitis, cancer, inflammatory process, bowel obstruction)
- Gastric emptying study/small bowel follow-through (gastroparesis, dysmotility)
- EGD/colonoscopy (IBD, radiation enteritis, GVHD, gastritis, ulcers, fistula, strictures)
- ECHO (vegetation, endocarditis)

Clinical manifestations:

- Fever, hypothermia, chills, night sweats
- Tachycardia, low blood pressure

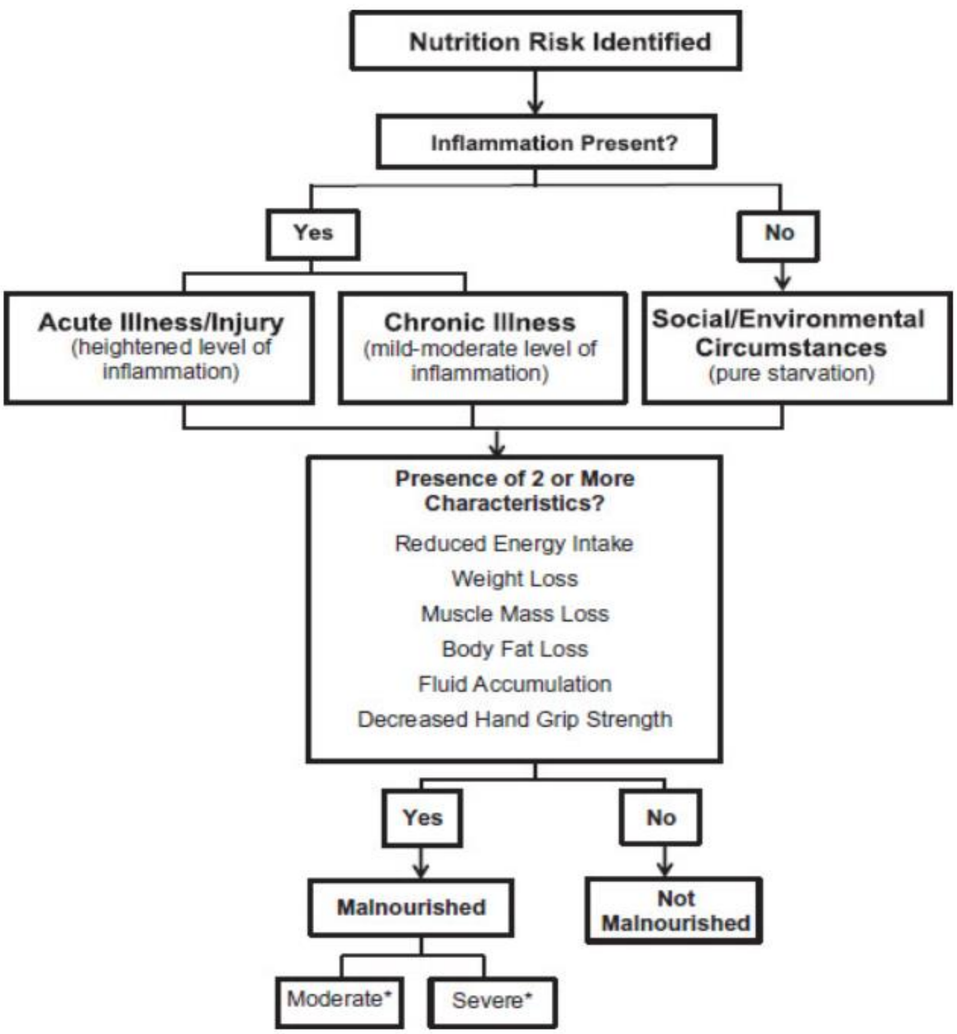
- Rashes; skin redness, swelling, tenderness
- Discharge from eyes or nose
- Swelling or redness of mouth and gums
- Pain with urination, productive cough, burns

CRP, C-reactive protein; CT, computed tomography; ECHO: echocardiogram; EGD: esophagogastroduodenoscopy; GVHD: graft-versus-host disease; IBD: inflammatory bowel disease; MRI, magnetic resonance imaging; PET, positron emission tomography.

Source: Data are from reference 34.

Identifying the etiology of malnutrition is only part of the ASPEN/AND assessment process. Once the malnutrition etiology has been identified, the severity of malnutrition can be elucidated as moderate or severe (see Figure 9-2). Two characteristics must be present to diagnosis malnutrition, and the gravity of these factors establishes the severity of malnutrition.

FIGURE 9-2 Practical Application Process to Determine Etiology and Severity of Malnutrition Using the ASPEN/AND Clinical Characteristics



*Severity of malnutrition determined by seriousness of characteristics, as defined by ASPEN and AND malnutrition criteria. AND, Academy of Nutrition and Dietetics; ASPEN; American Society for Parenteral and Enteral Nutrition.

Source: Data are from references 10, 14, and 35.

Characteristics used in the ASPEN/AND classification can sometimes be ambiguous; for instance, a characteristic may not be related to nutrition (eg, edema during heart failure) or may not be present in individuals who are at high nutrition risk (eg, a previously healthy patient who is experiencing a trauma event). For the severity of malnutrition to have a useful meaning to healthcare professionals and in research, the diagnosis requires a standardized methodology. In an attempt to improve objectivity and uniformity, ASPEN and AND developed 6 malnutrition clinical characteristics as part of their classification, which is built on the foundational principles of SGA. However, the ASPEN/AND approach has been criticized for its complexity, subjective interpretations of inflammation and disease burden, requirement of physical assessment skills, lack of recognition for body composition measures other than a physical examination, limitations of functional assessment, and the use of edema as a characteristic of malnutrition for this population. This method of diagnosing malnutrition has yet to be validated, but studies of this nature are on the horizon. Practice Scenarios 9-2 and 9-3 illustrate the clinical application of ASPEN/AND recommendations for malnutrition assessment.

Practice Scenario 9-2

Question: According to the American Society for Parenteral and Enteral Nutrition and Academy of Nutrition and Dietetics criteria for malnutrition,14 what etiology and severity of malnutrition best describes a patient who presents with anorexia nervosa?

Scenario: A 36-year-old woman was admitted to the hospital with a diagnosis of anorexia nervosa and a long-standing history of restrictive eating behavior without purging. Her typical intakes were described as being less than 500 kcal/d for at least the past year. She reported a highly active lifestyle and exercises in excess of 2 h/d. Upon admission, her clinical and laboratory criteria included the following: temperature, 37°C (normal: 36.1°C–37.2°C); resting heart rate, 50 bpm (normal: 60–100 bpm); albumin, 4.0 g/dL (normal: 3.9–4.9 g/dL); prealbumin, 25 mg/dL (normal: 17–36 mg/dL); C-reactive protein, 0.7 mg/dL (normal: <1.0 mg/dL); white blood cell count, 6200/mcL (normal: 3700–11,000/mcL); and fasting glucose, 75 mg/dL (normal: 65–100 mg/dL).

Upon admission, the patient was 66 inches (167.6 cm) in height and weighed 82 pounds (42 kg), with a body mass index (BMI) of 15. Four weeks prior, she weighed 97.9 pounds (44.5 kg), and 6 months ago, she weighed 123.6 pounds (56.2 kg). The nutrition-focused physical examination findings were as follows:

- Subcutaneous fat loss: severe orbital, triceps, and midaxillary line losses.
- Muscle loss: severe wasting in temporalis, pectoralis, deltoid, interosseous, latissimus dorsi, quadricep, and gastrocnemius muscles.
- Lanugo and dry mucus membranes.

- Marked underweight status was evident, and weight loss of 41.6 pounds (18.9 kg) had occurred over 6 months.

Intervention: The clinicians resuscitated the patient cautiously to avoid refeeding syndrome while continually reassessing her nutrition status. Establishing a baseline for serum markers and intake and ouput records is recommended to help with monitoring and managing refeeding syndrome (see Chapters 13 and 17). Suggested daily assessment includes, but is not limited to, orthostatic vital signs, daily weight, fluid retention and shifts, intakes and outputs, and laboratory indicators (sodium, potassium, phosphorus, and magnesium). The initial energy goal may be set at 1500 kcal/d for women or 1750 kcal/d for men. Providing this amount of energy, in conjunction with potassium and phosphorus supplementation, can help with stabilize electrolyte levels during refeeding.36

Answer: The etiology of this patient's malnutrition is social/behavioral/environmental circumstances. Based on her energy intake, muscle and fat wasting, and significant weight loss, her malnutrition is characterized as severe protein-energy malnutrition.

Rationale: History, clinical diagnosis, and laboratory markers determine the etiological framework of the patient's malnutrition. Anorexia nervosa is consistent with starvation without an inflammatory component. Restrictive eating behaviors and weight loss support this diagnosis. Review of the patient's laboratory test data finds no signs of active inflammation. In the absence of inflammation, albumin and prealbumin and most other laboratory results typically remain within normal ranges.

The patient's compromised energy and protein intake over the past year provided less than 50% of her needs for at least 1 month. Her weight loss is categorized as a severe loss because she lost 5.6% of her body weight over 1 month and 25% of her body weight over 6 months.14 Additionally, her BMI indicates underweight status. No edema was noted at the time of assessment. Orthostatic vital signs are indicative of malnutrition and dehydration. Dehydration is also suggested by her noticeably dry, cracked lips and mucus membranes, but dehydration alone cannot account for the patient's drastic weight decline over 6 months. The nutrition-focused physical examination of muscle and fat revealed severe muscle and fat wasting, which is consistent with anorexia nervosa.37 Furthermore, lanugo development is typically a result of loss of adipose stores.

Handgrip dynamometry is recommended to assess handgrip strength, which has been correlated to nutrition status,39 but it was not performed in this scenario because the patient had an active lifestyle and her functional status did not seem to be a relevant characteristic of her state of malnourishment.

<u>Practice Scenario 9-3</u>

Question: According to American Society for Parenteral and Enteral Nutrition (ASPEN) and Academy of Nutrition and Dietetics (AND) criteria for malnutrition,14 what etiology and severity of malnutrition best describes a multiple trauma victim early in his course of recovery?

Scenario: A previously healthy 38-year-old man experienced multitrauma secondary to a motor vehicle accident. A computed tomography (CT) scan revealed a ruptured spleen, grade III liver laceration, left femur fracture, and bilateral pulmonary contusions. He underwent damage control celiotomy, splenectomy, and packing of the liver and then was transferred on a ventilator to the trauma intensive care unit, where he continued to be resuscitated. Upon admission, his clinical and laboratory criteria for systemic inflammatory response syndrome included the following: temperature, 39.2°C (normal: >38°C or <36°C); heart rate, 112 bpm (normal: >90 bpm); respiratory rate, 26 breaths/min (normal: >20 breaths/min); white blood cell count, 2100/mcL (normal: >12,000/mcL); and partial pressure of carbon dioxide (PCO2), 30 mm Hg (normal: less than 32 mm Hg).

His family reported that the patient's usual body weight was 190 pounds (86.4 kg), and they said that he had not experienced any weight or diet changes prior to the injury. He was also fairly active in recreational sports when he was not at work.

He was markedly edematous, weighing 15 pounds (6.8 kg) more than his usual body weight with the bed scale reading 205 pounds. He was 73 inches (185.4 cm) in height, and his BMI was 25.1 (based on his family's report of a usual weight of prior to hospitalization). His open abdomen was dressed. The physical examination was limited because of hemodynamic instability (severe edema in the quadriceps and moderate edema in the gastrocnemius and interosseous muscles), body positioning, and the use of restraints. Muscle mass evaluation could only be performed in the temporal region and the upper chest and shoulder areas (muscles in these areas appeared normal). No subcutaneous fat loss was noted in the orbital area, and muscle loss was not seen in the temporalis, pectoralis, or deltoid muscles.

Indirect calorimetry showed that he had an increased metabolic rate with a resting energy expenditure of 2750 kcal/d. The family reported that the last time he ate was the evening before the injury. Because the medical team anticipated that oral nutrition intake would be compromised for a week or longer, enteral nutrition (EN) was started within 24 hours of admission. A complete nutrition assessment was unable to classify this patient's severity of malnutrition on hospital Day 2, but his Nutrition Risk in Critically Ill (NUTRIC) score was calculated to be 5, and a plan was initiated to provide EN via orogastric access.

Over the next 7 days, the patient underwent various surgeries, procedures, and tests to address his complex medical issues. During that time, a CT scan found intra-abdominal fluid collection, which required drainage, and also showed diminished muscle mass at the lumbar 3 region. Enteral feeds, while tolerated, had been frequently turned on and off and provided an average of 65% to 70% of his estimated needs.

At a subsequent nutrition assessment, his clinical laboratory data were as follows: temperature, 38.9°C (normal: 36.1–37.2°C); heart rate, 98 bpm (normal: 60–100 bpm); respiratory rate, 26 breaths/min (normal: 12–20 breaths/min); white blood cell count, 16,500/mcL (normal: 3700–11,000/mcL); C-reactive protein, 11.6 mg/dL (normal: less than 1.0 mg/dL); albumin, 2.6 g/dL (normal: 3.9–4.9 g/dL); prealbumin, 11.0 mg/dL (normal: 17–36 mg/dL); fasting glucose, 180 mg/dL (normal: 65–100 mg/dL).

His physical examination found no subcutaneous fat loss in the orbital area, triceps, or midaxillary line. There was mild wasting in the temporalis and pectoralis muscles but none in the deltoids. Muscle loss elsewhere could not be assessed because of moderate or severe edema (interosseous, quadricep, gastrocnemius muscles) or body position (latissimus dorsi).

Intervention: Enteral feedings (an immune-modulating formula) were initiated within 24 hours of admission (see Chapters 10, 13, and 24).

Answer: Using the ASPEN/AND criteria, the etiology of this patient's malnutrition was acute illness/injury and indicated by inadequate nutrition intake and muscle loss. The malnutrition was of moderate severity.

Rationale: Multiple trauma requiring urgent surgical interventions and procedures is consistent with acute systemic inflammatory response. Further evidence of this heightened inflammatory response is seen in laboratory markers: leukocytosis, elevated C-reactive protein with depressed albumin and prealbumin levels, and hyperglycemia without a history of diabetes. Signs of severe acute systemic inflammatory response are caused by hormonal, metabolic, and immunological mediators that include cytokines. Nutrition intervention is intended to support vital immune system, wound healing, and organ system functions to help the patient through this phase of acute inflammatory response. Trauma victims are often not malnourished at baseline, but they are at risk of becoming severely malnourished due to acute metabolic dysregulation and associated catabolism.

Prior to his injury, the patient was eating normally. After injury, he was at risk for an extended duration of compromised nutrient intake during a time of significant catabolism, and clinicians therefore decided to initiate EN promptly. Despite this proactive decision, medical interventions took priority, and tube feeds were not consistently infused, so he was only able to receive an average of 65% to 70% of his estimated needs over the prior week. Even with aggressive nutrition support during this acute phase, trauma patients will likely remain in negative nitrogen balance and have low albumin and prealbumin due to the marked proinflammatory state.40 Provision of less than adequate EN contributes to a picture of malnutrition in this situation.

Determining accurate body mass changes over a specific time period was not feasible for this patient. Because of the appreciable edema, observed weight changes would not help the clinician to further support a diagnosis of malnutrition.

The patient's BMI before the injury was normal and may provide a generalized idea of his baseline physique. The patient did not appear wasted in the first examination, but it was difficult to fully assess muscle and fat stores. Further into his hospitalization, some signs of muscle wasting started to emerge at the clavicle and temporalis. This loss was confirmed by reviewing CT scans focusing on musculature at the L3 region. No decline in adipose tissue was obvious. It has been demonstrated that significant amounts of muscle mass can be lost during the first week in an intensive care setting.40

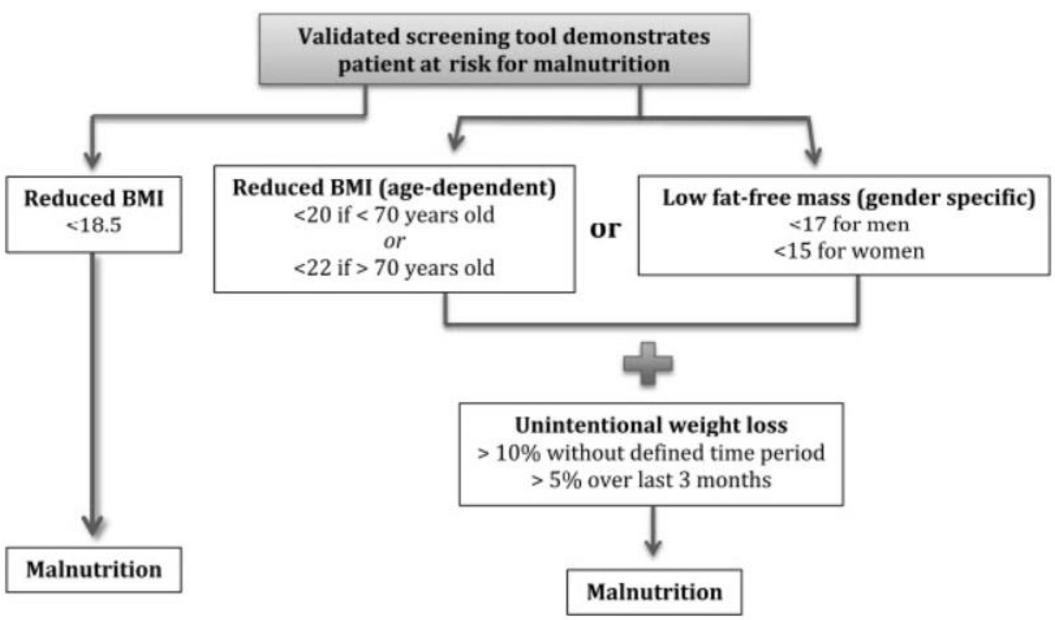
The initial physical examination revealed anasarca and pitting edema of the dependent areas and lower extremities, making muscle and fat store evaluation, as well as weight loss, quite difficult. At follow-up, the severity of upper body edema abated, while persisting in the lower extremities. Fluid accumulation of this magnitude and immediacy are indicative of the patient's medical problems and treatment course, not nutrition status.

Handgrip dynamometry is recommended to assess handgrip strength, which has been correlated to nutrition status,39 but grip strength and physical performance testing are not feasible in an acutely injured and sedated patient.

ESPEN Criteria

The initial ESPEN consensus statement aimed to characterize malnutrition clearly and simply, without regard for inflammation as an etiology, so that the characterization could be generally applied to all patients independent of setting.15 The ESPEN consensus established that (1) all criteria should be objective; (2) visceral proteins are not good prognostic indicators; (3) functional measures are not specific enough to assess nutrition; and (4) the final criteria would be few in number.15 The 3 criteria chosen for evaluating malnutrition are unintentional weight loss, low BMI (as established by the World Health Organization, with allowances for age-specific variations), and decreased fat-free mass index (FFMI)33 based on gender (see Figure 9-3 and Table 9-4).14,15,18,22 Specific cutoff points were proposed for each characteristic, with clinicians analyzing the variables if a validated screening tool indicated the patient was at nutrition risk.15 Further delineation for malnutrition severity was not described,15 but a grading system has been proposed for future use.18 The ESPEN consensus has been criticized as being overly restrictive, using parameters that are difficult to apply when assessing obese populations, and relying on body composition measures that are not universally available in all settings.18 Like the ASPEN/AND methodology, ESPEN's process has not yet been validated. Practice Scenario 9-4 illustrates the use of the ESPEN malnutrition assessment criteria in clinical practice.

FIGURE 9-3 Decision Tree to Determine Presence of Malnutrition Using the ESPEN Criteria



BMI, body mass index; ESPEN, European Society for Clinical Nutrition and Metabolism. Source: Data are from reference 18.

TABLE 9-4 Comparison of SGA, ASPEN/AND, and ESPEN Nutrition Assessment Methods

	SGA[22]	ASPEN/AND[14]	ESPEN[15]
Laboratory markers	• Not used	• Used to determine presence of inflammation	• Not recommended
Physical examination	• Muscle wasting: – Quadriceps – Deltoids • Fat depletion: – Triceps – Chest • Nutrition-related edema: – Ankle – Sacral area – Ascites	• Muscle wasting: – Temporalis – Pectoralis – Deltoids – Scapular – Interosseous – Quadriceps – Gastrocnemius • Fat depletion: – Orbital – Triceps – Midaxillary at the iliac crest • Fluid accumulation: – Nutrition-related edema – Effect on weight	• FFMI: – Men: <17 – Women: <15 • BMI: – <18.5 or – <20 for persons age <70 y – <22 for persons age ≥70 y
Medical history	• Weight changes • Nutrition intake • GI symptoms • Functional capacity • Metabolic stress from disease	• Unintentional weight loss • Nutrition intake • Functional capacity • Chronic illness, acute illness, or social/behavioral /environmental circumstances	• Unintentional weight loss (also inclusive of decreased food intake, appetite loss, nutrient requirement/intake imbalances)

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition; BMI, body mass index; ESPEN, European Society for Clinical Nutrition and Metabolism; FFMI, fat-free mass index; GI, gastrointestinal; SGA, Subjective Global Assessment.

Source: Data are from references 14, 15, and 22.

Practice Scenario 9-4

Question: According to the European Society for Clinical Nutrition and Metabolism (ESPEN) consensus,15 would an elderly patient who presents to clinic with obesity and frailty be considered malnourished?

Scenario: A 70-year-old woman presented for a follow-up clinic appointment with long-standing obesity, osteoarthritis, type 2 diabetes, hypercholesterolemia, and metabolic syndrome. Her medications included a statin, a diabetes oral agent, and a nonsteroidal anti-inflammatory. Her chief complaint was worsening knee pain and swelling that interfered with her mobility. She lived in her own home but was generally house-bound. An adult daughter accompanied the patient and reported that her mother had been running a low-grade fever intermittently at home over the past week.

Vital sign and laboratory tests revealed the following: temperature, 37.9°C (normal: 36.1–37.2°C); resting heart rate, 96 bpm (normal: 60–100 bpm); blood pressure, 135/85 mm Hg (normal: <120/<80 mm Hg); albumin, 3.2 g/dL (normal: 3.9–4.9 g/dL); C-reactive protein: 3.1 mg/dL (normal: <1.0 mg/dL); white blood cell count, 14,100/mcL (normal: 3700–11,000/mcL); fasting glucose, 142 mg/dL (normal: 65–100 mg/dL); glycated hemoglobin A1C, 7.0% (normal: 4%–5.6%); cholesterol, 180 mg/dL (normal:

<200 mg/dL); high-density lipoprotein cholesterol, 45 mg/dL (normal: 40–59 mg/dL); and triglycerides, 125 mg/dL (normal: <150 mg/dL).

The daughter checked on her mother once a week and brought meals during those visits. The patient described feeling disinterested in food, getting full quickly, and experiencing occasional nausea for the past 3 to 4 weeks. She estimated food consumption of one-half to two-thirds of her usual meal intake during that time. She indicated that she might have lost 10 to 20 pounds (4.5 to 9 kg) over the past 6 months without trying and said her pants fit more loosely than usual.

Upon evaluation, her height was 62 inches (157.5 cm), weight was 180 pounds (81.8 kg), and body mass index (BMI) was 33. A review of her medical records confirmed a 20-pound (9-kg) weight loss since her last visit 6 months ago and documented a usual weight of 200 pounds. The patient had difficulty pulling herself from a seated position in the chair and ambulating. Furthermore, she reported feeling less energetic for the past 2 months, which she associated with worsening knee discomfort. An intake nurse used the Mini Nutritional Assessment–Short Form (MNA-SF) to screen this patient, which resulted in a low score.

Physical examination revealed truncal adiposity with a waist circumference of 90 cm (35.4 inches). The physical examination elicited limited information about muscle and fat stores; although the patient insisted she was thinner than usual, only mild muscle loss could be observed in the temporalis and along her clavicle bone. Her fat-free mass index (FFMI) was calculated to be 12 based on results from a recent bioelectric impedance analysis (BIA).

Intervention: Clinicians encouraged the patient to follow a consistent carbohydrate diet regimen with regular, high-quality meals and snacks (see Chapter 34) and supplement with a daily multivitamin with minerals. In view of her lipid profile on statin therapy, additional restriction of cholesterol or fat did not seem warranted while addressing her other nutrition problems. Family engagement was encouraged, and social services were consulted about participation with Meals on Wheels and a diabetes management team.

Answer: According to the ESPEN consensus statement, this patient is malnourished (see Figure 9-3) due to weight loss and a low FFMI.

Rationale: The patient's decreased food intake over the past month, occasional nausea, early satiety, and disinterest in food contributed to the patient's low MNA-SF score during the nutrition screen. These issues could further be compounded by her homebound status and limited resources. Her reports of lower-than-usual food intakes, in the context of weight loss and physical symptoms of muscle loss, are concerning.

Although the patient unintentionally lost 10% of her usual body weight over the last 6 months, her BMI and waist circumference at presentation were consistent with obesity. Individuals who are obese may be at risk for malnutrition or malnourished (see Chapter 35).41,42 In this case, the patient's BMI did not reflect a diagnosis of malnutrition according to the ESPEN consensus criteria; however, her unexpected weight loss, which occurred as a result of diminished nutrition intake, did.15

Based solely on physical examination, it is difficult to subjectively quantify changes in total adiposity in individuals with obesity; however, the patient stated that her pants were looser, which likely indicated losses along the midaxillary line. Loss of muscle mass can also be difficult to observe and palpate in obese patients, but information provided by BIA allowed for better quantification of FFMI deficits than BMI alone would have provided.43 While FFMI attempts to distinguish whether tissue is muscle or adipose, it is important to note that fat-free mass includes organs, connective tissue, and bone, along with skeletal and nonskeletal muscle.31 According to ESPEN consensus, women whose FFMI is below 15 can be considered malnourished if accompanied by a significant amount of weight loss (5% in the last 3 months or 10% over an undefined period of time).15 Other body composition measures, such as computed tomography, dual-energy x-ray absorptiometry, or magnetic resonance imaging, may be used to demonstrate loss of muscle and to confirm sarcopenic obesity.

Nutrition Screening

The Joint Commission requires nutrition screening programs for most US healthcare facilities (ie, acute and long-term care) for the purpose of systematically identifying individuals at nutrition risk.4 Many screening tools share similar elements, despite the lack of standards establishing the essential components or the qualifications of the person using the screen.6 The screening process typically involves use of an instrument, such as the Malnutrition Screening Tool (MST) or NUTRIC score29 or a set of standardized criteria that aids in quickly determining whether additional information is required to warrant a nutrition intervention. During the nutrition screen, the individual is assigned a level of nutrition risk based on a set of standardized guidelines. Risk levels guide how quickly the individual must be rescreened or assessed. According to a 2014 survey,6 most facilities screen patients on admission or within 24 hours of admission. Nurses perform screens most frequently, but it is not uncommon for dietitians to screen patients also. In this survey, 38% of respondents indicated that a validated screening tool was used, and the most frequently reported tools were MST, Nutrition Risk Classification, Simple Screening Tool, and SGA.6 Refer to Table 9-5 for a list of commonly used screening tools that have been assessed and validated.

TABLE 9-5 Selected Nutrition Screening Instruments and Their Characteristics

Instrument	Nutrition-Related Indicators	Severity of Illness Indicators	Intended Population, Validity, and Reliability
MNA-SF[25,26,44,46]	• Unintentional weight loss • Appetite • Food intake problem	• Disease severity • Homebound • Dementia/depression	• Ambulatory and subacute patients: – 98%–100% sensitivity – 70%–100% specificity – Reliability: no data • Hospitalized, elderly patients:[a] – 100% sensitivity – 52.8% specificity – AUC: 0.95
MST[44–46]	• Appetite • Unintentional weight loss	• Not applicable	• Oncology patients: – 100% sensitivity – 81%–92% specificity – Reliability: κ = 0.83–0.88 • Acute, hospitalized patients: – 74%–93% sensitivity – 76%–93% specificity – Reliability: κ = 0.84–0.93 • Hospitalized, elderly patients:[a] – 90.3% sensitivity – 84.7% specificity – AUC: 0.92
MUST[44,45,47]	• BMI • Unintentional weight loss • Problems with food intake	• Disease severity	• Hospitalized, medical-surgical patients: – 61% sensitivity – 76% specificity – Agreement between MUST and SGA: κ = 0.26 • Hospitalized, elderly patients:a – 87.1% sensitivity – 86.1% specificity – AUC: 0.89
Simple, 2-Part[44]	• Unintentional weight loss • Subcutaneous fat loss	• Not applicable	• Acute, hospitalized patients: – 63% sensitivity – 97% specificity – Reliability: no data
NST/BAPEN[44]	• Unintentional weight loss • Appetite • Weight • Height • Food intake problem	• Not applicable	• Acute, hospitalized patients: – 86% sensitivity – 95% specificity – Reliability: κ = 0.66
NRS-2002[44,45,48]	• Unintentional weight loss • BMI	• Disease severity • Impaired general condition • Age >70 years	• Acute, hospitalized patients: – 39%–70% sensitivity – 83%–85% specificity – Agreement with SGA: 79.2% – Agreement with MNA: 84.6% • Hospitalized medical-surgical patients: – 62% sensitivity – 93% specificity – Agreement with SGA: κ = 0.48 • Hospitalized, elderly patients:[a] – 90.3% sensitivity – 83.3% specificity – AUC: 0.89
SNAQ[45,49–51]	• Unintentional weight loss • Decreased appetite • Use of supplemental drinks/tube feeds	• Not applicable	• Hospitalized, medical-surgical patients: – 76%–88% sensitivity – 83%–91% specificity – AUC: 0.85 – Reliability: κ = 0.69 • Hospitalized, medical-surgical patients: – 81.5% sensitivity – 76.4% specificity • Hospitalized, elderly patients:[a] – 79% sensitivity – 90.3% specificity – AUC: 0.93
NUTRIC Score[29,52,53]	• Not applicable	• APACHE II • SOFA (with or without IL-6) • Number of comorbidities • Days from hospital to ICU admission	• Critically ill patients: – Predictive of 28-day mortality (C-index 0.783) – Among 28-day survivors, strongly associated with days observed on mechanical ventilation (P <0.0001) – Recommended to assist with identification of critically ill patients most likely to gain from aggressive nutrition interventions

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; BMI, body mass index; C-index, concordance index; ICU, intensive care unit; IL-6, interleukin 6; MNA-SF, Mini Nutrition Assessment–Short Form; MST, Malnutrition Screening Tool; MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutritional Risk Screening 2002; NST/BAPEN, Nutrition Screening Tool/British Association of Parenteral and Enteral Nutrition; NUTRIC, Nutrition Risk in Critically Ill; SGA, Subjective Global Assessment; SNAQ, Short Nutrition Assessment Questionnaire; SOFA, sequential organ failure assessment. [a]Compared with SGA.

Source: Data are from references 25, 26, 29, and 44–53.

Nutrition Assessment

Nutrition assessment is an in-depth, systematic process that aims to integrate and interpret various forms of data about a patient to identify nutrition-related problems.54 The elements of a nutrition assessment include anthropometrics, client history (medical and surgical history, family and social history, and medication review), current clinical presentation, biochemical data, nutrient intake data, nutrition-focused physical examination findings, and functional status. These considerations are all important when thoroughly evaluating the nutrition status of a patient.55 The amount and type of information obtained will be influenced by the health status of the patient, clinical setting, use of evolving evidence-based practices, and whether the evaluation is an initial assessment or a reassessment.54 Multi-item assessment instruments (Table 9-5) have been developed to assist in identifying indicators of nutrition status.

Anthropometric Data

The anthropometric measures used in nutrition assessment are relatively simple physical measurements that provide information about body size and composition. Findings are compared with standards (for the same gender and age) and/or with previous measurements of the same individual. Trends can be particularly useful in assessment.

Height

Accurate measurement of height is indicated because a variety of anthropometric measures are standardized for height. When individuals are able to stand without assistance, height should be measured in a standing position, without shoes, using a wall-mounted stadiometer. For adults who are unable to stand, height can be estimated by doubling the arm span measurement (from the patient's sternal notch to the end of the longest finger). Stature in older persons can also be estimated from knee height measured with a caliper device, as follows:

Men: Stature (cm) = [2.02 × Knee Height (cm)] – [0.04 × Age (y)] + 64.19

Women: Stature (cm) = [1.83 × Knee Height (cm)] – [0.24 × Age (y)] + 84.8

Body Weight

Actual measured body weight and weight change trends are particularly important components of nutrition assessment. Weight should be measured on admission to a clinical area, then re-evaluated frequently throughout the duration of the stay.14 To improve accuracy and reliability of body weight measures, individuals who can stand should be weighed in a consistent manner, without shoes or overgarments. Chair and bed scales are available for those who cannot stand. These instruments should be used according to manufacturers' guidelines for the most accurate results.

Clinicians need to interpret weights as part of the larger clinical presentation. For example, among individuals with substantial disease burden, measures of weight can be erroneously skewed by factors such as dehydration, excessive fluid accumulation, or presence of tumors.

Reference tables of standards for ideal body weight relative to height, such as the Metropolitan Height and Weight Tables,58 are not routinely recommended for use because they suffer notable limitations, including subjective interpretation of frame size and inadequate availability of reference data for many population groups. Ideal body weight may be of use for specific disease states and conditions as a means to determine energy and protein needs for certain patients, but there is no agreement on the consistent use of this parameter for nutrition assessment. For patients who are ill, usual body weight is a more suitable parameter than ideal body weight.

Body Mass Index

BMI is a ratio of body weight to height:

BMI = Weight (kg)/Height (m)2

It is a practical measure of body size and an indirect measure of body adiposity, but it does not account for sex, age, race, fitness levels, or variations in abdominal adiposity and therefore should be interpreted cautiously. Flegal and colleagues have shown that mortality rate sharply increased when BMI was less than 18.5 or greater than 35.61 Persons categorized into the highest or lowest BMI ranges may also be at heightened risk for malnutrition. The ESPEN consensus statement included low BMI as a defining characteristic of malnutrition, but ASPEN and AND did not include BMI as a malnutrition clinical characteristic because malnutrition can occur at any BMI.

The National Institutes of Health guidelines for interpretation of BMI in adults are as follows:

- BMI less than 18.5: underweight
- BMI 18.5 to 24.9: normal weight
- BMI 25 to 29.9: overweight
- BMI 30 to 34.9: class I obesity
- BMI 35 to 39.9: class II obesity
- BMI equal to or greater than 40: extreme (class III) obesity

Weight History

One of the most important historical elements in a nutrition assessment is prior weight loss (specifically, nonvolitional weight reduction). This information can be obtained from the medical record, the patient, a caregiver, or family member. Weight loss should be interpreted through an evaluation of other confounding factors—such as whether the loss was intentional, the presence of edema or dehydration, and the length of time in which change occurred—and in comparison with the individual's typical or usual body weight. The clinical relevance of weight loss varies according to its degree and duration. Significant, unintentional weight loss is a highly substantiated marker of malnutrition. Both SGA and the ESPEN consensus consider weight loss when defining malnutrition. As described by the ASPEN/AND characteristics, severity of malnutrition is influenced by the percentage of weight lost compared with an individual's usual weight during a defined length of time. Table 9-6 outlines the time frames and percentages of meaningful weight lost for each malnutrition etiology in the ASPEN/AND classification.

TABLE 9-6 Weight Loss Characteristics That Support a Diagnosis of Malnutrition Using the ASPEN/AND Methodology

	Weight Loss Over Time	
Malnutrition Etiology	Nonsevere/Moderate Malnutrition	Severe Malnutrition
Acute illness/injury	• 1%–2% in 1 week • 5% in 1 month • 7.5% in 3 months	• >2% in 1 week • >5% in 1 month • >7.5% in 3 months
Chronic illness	• 5% in 1 month • 7.5% in 3 months • 10% in 6 months • 20% in 1 year	• >5% in 1 month • >7.5% in 3 months • >10% in 6 months • >20% in 1 year
Social/environmental circumstance	• 5% in 1 month • 7.5% in 3 months • 10% in 6 months • 20% in 1 year	• >5% in 1 month • >7.5% in 3 months • >10% in 6 months • >20% in 1 year

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition.

Source: Data are from reference 14.

Client History

Medical, surgical, family, and psychosocial histories, along with the current clinical status of a patient, are known to affect an array of nutrition abnormalities.54,55 Clinicians who conduct nutrition assessments must understand how diseases, medical conditions, and surgical interventions can alter digestion, absorption, ingestion, and metabolism of micro- and macronutrients. Likewise, an understanding of how nutrients affect disease processes is essential.

A review of medications is part of a comprehensive nutrition assessment. Practitioners should be familiar with the potential nutrient interactions of drugs that are commonly used to treat their patients. A pharmacy consult can be helpful. Nutrition status may be adversely affected by medications that interfere with food intake (eg, by causing anorexia or taste changes) or with the absorption, metabolism, and excretion of nutrients. Drug levels may also be altered by foods and nutrients that modify drug absorption, metabolism, and excretion. During the assessment, clinicians should also investigate the patient's use of herbal supplements and complementary medicine products.55 See Chapters 18 and 19 for further discussion of drug-nutrient interactions and dietary supplements, respectively.

Biochemical Data

Laboratory assays can be used as supportive evidence regarding nutrition status, particularly organ/system function and the magnitude of inflammation. Indeed, the principle purpose of laboratory assays is to help evaluate physiological and metabolic abnormalities related to disease and trauma. Traditional use of nutrition laboratory biomarkers, such as the negative phase proteins, are notably more useful for their role as indicators of inflammatory conditions than as primary predictors of nutrition status (see Tables 9-7 and 9-8).10,14,29,65–84 Clinical history and physical examination data provide more accurate information than serum laboratory markers for assessing nutrition status. Laboratory findings are useful as supportive data for nutrition deficiencies, but they should be interpreted with caution because they lack specificity and sensitivity as direct indicators of nutrition status. As previously noted, although laboratory markers are beneficial for evaluating inflammation, they must be used in conjunction with other assessment data, such as clinical history, physical examination, and functional assessment, to diagnose malnutrition. Indicators such as leukocytosis, C-reactive protein elevation, cytokines, and hyperglycemia may suggest inflammatory response.10 Refer to the disease-specific chapters in Part III of this book for further information on interpreting laboratory test data.

TABLE 9-7 Laboratory Tests Traditionally Used to Detect Malnutrition

Test	Description	Interpretation	Recommendations for Use as an Indicator of Nutrition Status
Albumin[10,14,29,66–71]	• Maintain colloidal osmotic pressure of plasma; binds to many other sources • Negative acute-phase reactant • Half-life: 14–20 days	• Indicator of inflammatory condition; proxy measure for underlying injury, disease, or inflammation • A predictor for morbidity and mortality • Reflection of acute-phase response • Lack of consistent change with loss of weight, reduced energy intakes, or nitrogen balance • Lacks sensitivity and specificity for malnutrition • Affected by hydration, infection, disease, and other inflammatory conditions	• Does not accurately represent nutrition status in ICU setting • Should not be used as marker of nutrition status
Prealbumin[29,67,69–75]	• Major plasma protein; binds thyroxin • Plays a role in metabolism of vitamin A • Carrier of retinol-binding protein • Negative acute-phase reactant • Half-life: 2–3 days	• Sensitive to short-term changes in inflammation • Affected by hydration, infection, disease, and other inflammatory conditions	• Should not be used as marker of nutrition status • Reflection of acute-phase response; does not accurately represent nutrition status in ICU setting
Transferrin[29,67,70–78]	• Iron transport • Indirectly assessed as TIBC • Negative acute-phase reactant • Half-life: 8–10 days	• Sensitive to short-term changes in inflammation • Lacks sensitivity and specificity for malnutrition • Affected by hydration, infection, disease, and other inflammatory conditions • Altered by perturbation in iron status	• Should not be used as marker of nutrition status • Reflection of acute-phase response; does not accurately represent nutrition status in ICU setting
Retinol-binding protein[29,69,71,79,80]	• Binds to prealbumin • Vitamin A transport • Negative acute-phase reactant • Half-life: 12 hours	• Also affected by vitamin A and zinc deficiency and renal disease	• Should not be used as marker of nutrition status • Reflection of acute-phase response; does not accurately represent nutrition status in ICU setting

ICU, intensive care unit; TIBC, total iron-binding capacity.

Source: Data are from references 10, 14, 29, and 66–80.

TABLE 9-8 Laboratory Tests Used to Detect Inflammation

Test	Description	Interpretation	Recommendations for Use
C-reactive protein[29,68,69,81,82]	• Has proinflammatory and anti-inflammatory roles • Positive acute-phase reactant	• Assists in evaluation of inflammatory conditions along with negative acute-phase reactants • Has proinflammatory and anti-inflammatory roles	• Still investigational; should not be used as surrogate marker of nutrition status
White blood cell count[83]	• Found in the lymphatic system • Some diseases and conditions may elicit elevated laboratory values as a response to inflammation • Suppressed levels may indicate a condition that suppresses the immune system	• Assists in evaluation of inflammatory conditions along with negative acute-phase reactants • Intense exercise or severe emotional or physical stress can increase a white blood cell count; test is not used to evaluate these conditions	• Inflammatory marker
Cytokines (interleukins, interferons, tumor necrosis factor α)[29,83,84]	• One of a group of proteins that assist in regulation and/or promotion of an immune response	• Prognostic use of cytokine measurements as indicators of inflammatory status is being investigated • Can be impaired (along with insulin signaling) by muscle atrophy	• Still investigational; should not be used as surrogate marker of nutrition status

Source: Data are from references 29, 68, 69, and 81–84.

Nutrient Intake Data

Assessment of nutrient intake can be used to detect imbalanced nutrition consumption, which can help identify nutrient deficiencies or excesses. Inadequate energy intake, impaired digestion, and impaired absorption play key roles in the development of malnutrition.86 Therefore, clinicians should thoroughly assess a patient's nutrient intake, including oral food and beverage consumption, enteral feedings, and parenteral infusions. Then, the intakes can be compared with estimated energy, protein, fluid, and micronutrient requirements for that individual. Detailed discussion of energy and protein needs for patients can be found in Chapters 2 and 4, respectively, as well as in the disease- and condition-specific chapters in Part III.

The SGA, ESPEN, and ASPEN/AND criteria for malnutrition all include nutrient intake data, albeit nonuniformly. For example, the ASPEN/AND characteristics focus on energy provision and suggest reporting intakes as a percentage of estimated energy requirements over time (see Table 9-9).

TABLE 9-9 Energy Intake Characteristics That Support a Diagnosis of Malnutrition Using the ASPEN/AND Methodology

Malnutrition Etiology	Nonsevere/Moderate Malnutrition	Severe Malnutrition
Acute illness/injury	<75% of estimated energy requirement for >7 days	≤50% of estimated energy requirement for >7 days
Chronic illness	≤75% of estimated energy requirement for ≥1 month	≤75% of estimated energy requirement for ≥1 month
Social/environmental circumstance	<75% of estimated energy requirement for ≥3 months	≤50% of estimated energy requirement for ≥1 month

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition.

Source: Data are from 14.

Clinicians should consider several elements when attempting to obtain an accurate representation of nutrition intake. They should be cognizant of natural, random variations in daily nutrient and energy intake of humans.87 Determining specific food quantities is appropriate but can be complicated because clinicians and patients may not share a mutual understanding about portion sizes.88 Certain populations are also prone to underreport food intake.88–90 Clinicians should also pose questions about therapeutics, weight reduction, vegetarian or macrobiotic diets, cultural/religious practices, fad diets, food intolerances and allergies, and other dietary restrictions. Thorough evaluation of nutrition intake also considers types and quantities of supplements, including vitamins, minerals, protein supplements, probiotics, and nutrition drinks and shakes. Alternate sources of nutrition should also be reviewed, including enteral and parenteral nutrition, intravenous fluids, calorically emulsified medications, beverages, and alcohol. Furthermore, it is prudent to discuss the availability and financial affordability of food, the individual's ability to prepare foods, and any other social/behavioral practices that may influence the individual's nutrient intake. In some cases, caregivers can be used as a proxy to report dietary intake.

Multiple nutrient intake assessment methods are available, and the appropriate method to choose depends on the population of interest, availability of resources, skills of the healthcare professional, feasibility, and purpose. Table 9-10 describes common methods.

TABLE 9-10 Nutrition Intake Assessment Methods

Method	Procedure	Characteristics	Limitations
Prospective			
Diet record/food diary	• Self-recorded food and beverage intake, usually for a brief time (3–7 days).	• Food portions may be weighed or estimated using household measurements. • Can be used to record compliance to a diet regimen or to self-monitor food intake. • Does not rely on self-recall. • Provides information on food preparation and meal timing. • Usually used in outpatient settings.	• Captures recent intake which may or may not reflect usual intake. • High participant burden. • Act of recording can influence food intake. • Analysis can be cumbersome. • Data collection influenced by literacy skills and participants' ability to judge/record portion sizes. • Quality declines as duration lengthens.
Nutrient intake analysis	• Direct observation; clinician does a visual analysis of meal before and after being served to estimate food intake. Nutrients from enteral and parenteral sources are also documented. • Recommended duration is ≥72 hours.	• Typically used with hospitalized patients or those in residential facilities. • Includes a "calorie count" to assess whether subject is likely meeting nutrient needs. • Cost-effective; quick.	• If meal tray is removed/discarded before clinician can observe, food intake cannot be estimated. • Relies on clinician ability to estimate portion size. • 1 or 2 meal evaluations may not provide realistic portrayal of usual intakes. • Inaccurate/incomplete records are commonplace.
Retrospective			
24-hour recall	• Self-recall of exact food and beverage consumption for previous 24 hours.	• Low participant burden. • Trained interviewer using prompts can collect more detailed information. • Can be administered via telephone or in-person. • Can be inexpensive and quick. • Does not influence food intake.	• Accuracy depends on participant's ability to recall and estimate portion size. • Multiple recalls may need to be conducted to capture usual food intake. • Influenced by language barriers. • Tendency to exaggerate low intakes.
Food frequency questionnaire	• Self-reported frequency of consumption from selected list of foods.	• Provides assessment of long-term (6–12 months) diet intake patterns. • May or may not query portion size. • Low subject burden. • Is easily self-administered. • Commonly used with large-scale populations. • Easily standardized. • Focuses on consumptions of food groups. • Must be culture-specific.	• Use with special populations should be validated. • Intake is often misreported. • Language barriers affect results. • Food intake during times of illness is usually significantly different from usual intakes, and recorded data may not be representative of current situation. • No meal pattern data. • Accuracy depends on knowledge of portion sizes. • Not designed for current intake assessment.
Prospective and retrospective			
Diet history	• Original approach included 3 elements: detailed interview about food intake, checklist of foods, and 3-day diet record.	• Often modified in clinical settings. • The 3 elements can be used to cross-check reported intake.	• High interviewer burden/time-consuming. • Relies on participant recall and portion size estimation.

Source: Data are from references 54 and 90.

Both the 24-hour recall method and a modified version of the diet history are commonly used in clinical settings to evaluate a specific individual's intake. Originally developed by Burke and Stuart, the diet history, obtains information about an individual's past diet and can include queries of information about the types and frequency of intake of various foods. The original Burke diet history method included a detailed interview about usual food intake, a food frequency checklist, and a 3-day diet record, but this level of detail is often omitted in the clinical setting, where a modified diet history is obtained. Querying patients for a history of nutrition intake practices is a fundamental part of any nutrition assessment.

Once dietary intake data has been collected, it can be entered into a nutrition software program that provides an analysis of the energy and nutrients of the diet. It is important that the food database software contains data on foods and preparation methods relevant to the target population. The analysis is typically based on information from a database with values for food ingredients derived from the US Department of Agriculture National Nutrient Database for Standard Reference. Among the more widely used programs are Nutritionist Pro (Axxya Systems, Stafford, TX), Nutrition Data System for Research (University of Minnesota, Nutrition Coordinating Center, Minneapolis, MN), and Food Processor (ESHA Research, Salem, OR). Selection of diet analysis software will depend on cost, system requirements, usability, and available features.

Reports of nutrient intake generated by the diet analysis software can then be compared with recommendations and calculated estimations. The Dietary Reference Intakes (DRIs)92 are a set of nutrient recommendations established by the Health and Medicine Division (formerly Institute of Medicine) of the National Academies of Sciences, Engineering and Medicine. The DRIs include Adequate Intakes, Recommended Dietary Allowances, Tolerable Upper Intake Levels, and Estimated Average Requirements. DRI values are intended to define amounts that support most healthy individuals. Therefore, clinicians should exercise caution when using them to evaluate nutrient intakes of individuals with diseases.

Nutrient intake data can be highly subjective and may provide limited insight into a patient's overall consumption of nutrients.89 The data should be used in combination with other components of a nutrition assessment to evaluate the patient's nutrition status. Measurement of nutrient intake is complex, and each approach to nutrient intake assessment is subject to both systematic errors (eg, the subject's ability to recall intake or accurately estimate portion size) and random errors (eg, misreporting of true intake by certain population groups). Because potential sources of error cannot be eliminated entirely, practitioners must understand the nature of the errors and how they may affect analysis and interpretation of the data.

Nutrition-Focused Physical Examination

Compared with other techniques or the use of laboratory indexes, clinical history and physical examination can provide more accurate information about the nutrition status of patients.85 Malnutrition and micronutrient abnormalities can broadly affect organs and tissues resulting in physical sequela that may be readily detected by the trained practitioner with the use of a nutrition-focused physical examination (NFPE).

NFPE is an easy-to-learn, economical, and efficient way to confirm the presence of malnutrition or another nutrition problem.35 Unlike physical examinations conducted by nurses or physicians, an NFPE focuses primarily on changes to muscle, fat stores, fluid retention, and/or other physical signs that can result from micronutrient deficiencies or excesses.35 Tables 9-11 and 9-12 provide guidelines for evaluating subcutaneous fat and muscle with this technique.35 Although not part of the ASPEN/AND clinical characteristics to diagnose malnutrition, an NFPE should also evaluate the various parts of the body where high cell turnover occurs (eg, hair, skin, mouth, tongue) because they are among the most likely to rapidly show signs of possible nutrient deficiencies (refer to Chapter 8 for further information about micronutrient deficiencies). Symptoms of nutrition abnormalities tend to be nonspecific; therefore, other possible causes must be considered.35 For example, peripheral edema is often associated with reduced albumin in the setting of inflammatory response, but this issue may or may not be related to nutrition adequacy. Table 9-13 identifies how information from an NFPE is interpreted according to the ASPEN/AND methodology. Figure 9-1 details its use in SGA.

TABLE 9-11 Characteristics of Muscle Status Used in Nutrition Assessment

Muscle Status	Upper Body	Lower Body[a]
Normal	• Temporalis muscle is well defined; easy to see and palpate. • Pectoralis major protrudes or is flat; clavicle is visible but not sharply defined in women; not typically seen in men. • Deltoid muscle, around the shoulders and upper arms, looks curved. • Trapezius, supraspinatus, and infraspinatus muscles, around the neck base and above the scapula, show no signs of hollowing; scapular bones are not prominent. • Interosseous and dorsal side of thumb muscles bulge or look flat.	• Muscles around knee are visible/palpable and well-rounded; patella is not prominent. • Quadriceps and gastrocnemius muscles (posterior calf) are developed and rounded; may appear less developed if person is not very active.
Mild to moderate loss	• Temporalis muscle is slightly depressed. • Pectoralis major is diminished; clavicle is moderately prominent in women; visible in men. • Shoulder blades and acromion process become more evident as deltoid diminishes. • Trapezius starting to look hollow; scapular bones and upper spine are somewhat prominent. • Interosseous muscles are slightly depressed; may also be characteristic of aging.	• Patella is slightly prominent, yet rounded. • Inner thigh starts to appear concave; may see gap between thighs when knees pressed together. • Gastrocnemius muscles look less developed than normal.
Severe loss	• Temporalis muscle is depressed, hollow-looking; facial bones prominent. • Clavicle sharply protrudes, minimal pectoralis muscle palpable. • Deltoid muscle not readily palpable around shoulders, upper arms; scapula and acromion process edges are sharply angular. • Trapezius has deeply hollowed appearance; scapular bones are well defined with sharp angles; upper spine is clearly visible. • Dorsal muscle between forefinger and thumb is deeply concave; bones between interosseous muscles are prominent.	• Patella is sharply prominent with little sign of surrounding muscle. • Quadriceps with prominent concave shape between thighs; lack definition. • Posterior calves are thin and lack muscle definition.

[a]Area is less sensitive to change than upper body muscle.

Source: Data are from reference 35.

TABLE 9-12 Characteristics of Subcutaneous Fat Status Used in Nutrition Assessment

Subcutaneous Fat Status	Body Region		
	Orbital Area[a]	Upper Arm	Thoracic and Lumbar Region/Midaxillary Line
Normal	• Fat pads protrude slightly or are flat.	• Gentle pinch of skinfold underneath triceps with fingers yields ample fat tissue.	• Iliac crest does not protrude. • Ribs are not visible.
Mild to moderate loss	• Faintly dark circles are visible around eyes. • Area surrounding the eye is moderately concave.	• Gentle pinch of skinfold underneath triceps with fingers yields some fat tissue; finger tips closer together.	• Iliac crest is visible. • Ribs are visible but without marked depressions between them.
Severe loss	• Dark circles are visible around eyes. • Eye socket is extremely concave. • Skin is loose.	• Gentle pinch of skinfold underneath triceps results in fingers touching; little to no fat tissue.	• Iliac crest and ribs are protruding. • Sharp depressions seen between ribs.

[a]Loss may be obscured by fluid retention.

Source: Data are from reference 35.

TABLE 9-13 Muscle and Fat Characteristics That Support a Diagnosis of Malnutrition Using the ASPEN/AND Methodology

Malnutrition Etiology	Fat or Muscle Loss Severity	
	Nonsevere/Moderate Malnutrition	Severe Malnutrition
Acute illness/injury	Mild	Moderate
Chronic illness	Mild	Severe
Social/environmental circumstance	Mild	Severe

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition.

Source: Data are from reference 14.

Pathophysiological Changes of Muscle and Fat

Lean muscle mass and adipose stores play a defining role in the nutrition status of individuals. Both the stress response and starvation affect nutrient utilization and the breakdown of body components, but stress-related inflammation and starvation affect fat stores and muscle mass at different rates and to varying degrees of severity.96 Therefore, clinicians performing an NFPE to assess muscle mass and fat stores must recognize the differences between these 2 metabolic pathways (starvation vs inflammation) and understand their implications for patients' rates of recovery and nutrition status.14

During starvation, preservation of lean body mass is the ultimate goal. Initially, glycogen is used as the primary energy source, but these reserves are quickly depleted, forcing the body to use amino acids to make glucose and support energy requirements. Eventually, further adaptation occurs and resting energy expenditure decreases as fat becomes the main energy source, providing ketones as fuel as a means to preserve muscle mass.

In contrast, the metabolic pathway of the stress response is characterized by extreme catabolism and negative nitrogen balance, driven by a storm of hormones and cell mediators to mount an immune defense and repair tissues during injury and illness. All of these reactions accelerate muscle breakdown to generate energy. Amino acids are displaced from muscles and used for gluconeogenesis. Additionally, cytokines act to inhibit repair and synthesis of new muscle tissue, promote muscle breakdown, and affect muscle function. Muscle degradation continues unabated while the condition persists, creating a much faster rate of skeletal and lean muscle loss than seen in starvation. The stress response mechanisms also work against nutrition interventions aimed at preservation.

Evaluation of Muscle Mass and Adipose Tissue

Losses of lean mass and adipose tissue have long been recognized as a means to identify malnutrition, although evaluation of such losses is not universally part of routine nutrition assessment. Loss of lean mass is strongly correlated with functionality, increased hospital length of stay, and mortality in patients with chronic and acute illness, regardless of their weight or BMI. Individuals who present to the hospital with preexisting diminished muscle mass and minimal fat stores are also noted to have slower recovery and rehabilitation after hospitalization.

Muscle atrophy is a loss of bulk and tone that is detectable by palpation. The upper body is more often used than the lower body to help identify fat and muscle loss because the upper body is typically less affected by edema, is more accessible to the clinician, and has been identified as a good reflection of overall muscle mass. Tables 9-11 and 9-12 describe how to assess muscle and fat during a physical examination. Routine monitoring of these body components during hospitalization helps detect potentially related changes in nutrition status.

Sarcopenia is defined as the age-related loss of muscle mass and has been associated with a decline in function. The etiology of sarcopenia can be related to various factors, including inflammatory and cytokine-driven oxidative stress10 as well as protein synthesis and neuromuscular integrity. Sarcopenic obesity refers to reduced muscle mass, and perhaps muscle quality, that is disproportionate to fat mass. Sarcopenic obesity may further aggravate the catabolic process of cachexia and muscle loss. From the ages of 20 years to 80 years, muscle mass declines by approximately 30%. These changes in muscle size do not always correlate with changes in strength, but it is suggested that the quality of muscle may also change. The European Workgroup on Sarcopenia in Older People recommends defining sarcopenia using the inclusion of low muscle mass and either low strength and/or low muscle function and performance. Conditions affecting sarcopenia include but are not limited to lack of muscle use, chronic disease, insulin resistance, and poor nutrition.

Cachexia is defined as loss of muscle mass, irrespective of adipose tissue changes, which accompanies underlying illnesses and is often associated with inflammation, insulin resistance, decreased appetite and intake, and protein catabolism. Because of its multifaceted and profound inflammatory state, cachexia is not responsive to nutrition support; however, symptom management (eg, psychological, oral, GI, pharmacological, and metabolic interventions) is imperative. An individual found to be cachectic will also meet the criteria for sarcopenia, but the sarcopenic individual is not always cachectic.101

In obese and overweight individuals, weight changes may not identify individuals with underlying cachexia, particularly in cancer-related cachexia. These individuals have been noted to have lean muscle changes and associated comorbidities, comparable with those of their underweight counterparts.104 See Chapter 35 for additional information on overweight and obesity.

Body Composition Assessment Tools

Body composition can be measured in several ways. Anthropometric measurements such as skinfolds and body part circumferences are easy to obtain, noninvasive, and inexpensive, but they have had limited practical applications in inpatient care settings. These methods tend to be insensitive and presume that subcutaneous adipose tissue thickness has a constant compressibility. Additionally, comparative standards for these measurements are based on states of balanced hydration, and measurements may not correlate well with whole lean body mass or muscle loss in critically ill patients.

Several body composition assessment instruments that are used in research require specialized equipment or are not widely available or practical for routine clinical applications at the bedside. Examples of these instruments include labeled water–isotope dilution techniques, 3-dimenstional body surface imaging, air displacement plethysmography, total body count of naturally occurring potassium isotope, and water displacement (or hydrodensitometry). Tools used more routinely in clinical practice to differentiate lean soft tissue and fat mass include bioelectrical impedance analysis, dual-energy x-ray absorptiometry, magnetic resonance imaging, computed tomography (CT), and ultrasound.

Long-standing staples in diagnostics, CT and bedside ultrasound have emerged over the last several years as body composition assessment tools used in the clinical setting by physicians and registered dietitians. Analyzing CT images at the third lumbar vertebrae (L3) region is a precise and valid means to quantify and distinguish between lean and adipose tissue. In certain clinical scenarios, such as cancer treatment or intensive care of the critically ill, serial CT scans can demonstrate changes in lean tissue over time.31 However, CT scans are not available for all patients, emit high doses of radiation, and are costly. Analyzing and interpreting the CT results can be achieved by specialized software packages108 or by collaborating with a radiologist.

Investigators have studied the use of bedside ultrasound to quantify muscle layer thickness in mid–upper arm, forearm, and quadriceps muscles of hospitalized and critically ill patients.109–112 The quadriceps muscle has been shown to be indicative of overall lean body mass,22,113 and it is relatively accessible for ultrasound examination in most hospitalized and ICU patients. Bedside ultrasound is not as accurate as CT scans, and the measurement can be subject to errors related to the selection of reliable site, repeatability among different clinicians, patient edema, and force of compressibility.114 Clinicians should therefore exercise caution when considering whether ultrasound results indicate malnutrition; however, given the ease, accessibility, and safety of bedside ultrasound in critically ill patients, its use shows promise as a quantifiable tool to assess lean body mass in an ICU setting. Refer to Table 9-14 for more information about body composition tools.

TABLE 9-14 Body Composition Tools Commonly Used in Hospital and Ambulatory Settings

Test	Description	Advantages	Disadvantages
Skinfold and circumference measurements[32,116,117]	• Body composition measurements. • Skinfold calipers measure the percentage of subcutaneous fat. • Atape measure is used to measure waist, hip, and neck circumferences.	• Typical coefficient of variation is ≥10%. • Accessible, noninvasive.	• Clinicians require training to reliably measure skinfolds and circumferences. • Low degree of precision. • Reliability and validity of estimations of overall body fat are questionable because of comorbidities associated with centralized obesity.
Bioelectrical impedance[31,32,118–120]	• Based on differential resistance of body tissues. • Measures conductivity of water, with results used to estimate fat-free mass and lean mass.	• Can be accurate in healthy, nonobese individuals. • Easily accessible, benign technique available to clinicians. • Equipment is portable. • Accurately measures body water. • Requires population-specific validation of regression equations.	• Subject to error in a clinical setting. • Most formulas underestimate fat. • Affected by hydration status.
Dual-energy x-ray absorptiometry[121–124]	• Often used to evaluate bone density, but can be used for soft tissue measurements with appropriate x-ray absorptiometry software. • Can compare truncal and appendicular components.	• Precise differentiation between tissues. • Content-specific to measured areas. • Noninvasive, repeatable. • Can be used in outpatient/ambulatory setting for long-term follow-up.	• Modest radiation exposure. • Measurements affected by hydration status. • Impractical in most clinical settings.
Magnetic resonance imaging[31]	• Whole body, cross-sectional images are developed via the alignment of protons generated by a strong magnetic field.	• Most accurate method for visualizing all body compartments. • Safe, does not use radiation.	• Highly specialized. • Costly. • Requires patient participation.
Computed tomography[31,32,40,102,125]	• Imaging technique that uses high-dose radiation to differentiate adipose tissue, skeletal muscle, bone, visceral organs, and bone.	• At the L3 vertebrae, can precisely provide qualitative and quantitative evaluation of skeletal muscle and adipose tissue.	• High radiation exposure. • Expensive. • Requires specialized training to accurately identify muscle/fat stores at L3 region. • Specific software needed.
Ultrasound[31,32,111,115,126]	• High-frequency sound waves travel from a transducer through the skin and bounce back at different frequencies to differentiate among tissues (muscle, adipose, bone).	• Due to ease, availability, low cost, and noninvasiveness, an emerging bedside tool to measure muscle mass. • Can be used serially to determine changes in muscle mass.	• Subject to technical errors. • Accuracy of image can be affected by edema.

Source: Data are from references 31, 32, 40, 102, 111, and 115–126.

Fluid Accumulation/Edema

Fluid accumulation affects changes in weight, and ASPEN/AND consider it to be a characteristic that can be used to support a diagnosis of malnutrition. Edema, an excess of interstitial fluid accumulation, can be caused by a variety of diseases, conditions, and medications, but it is rarely the direct result of malnutrition. Therefore, clinicians should exercise caution when using this characteristic to justify the presence of malnutrition in a patient. Ordinarily, the human body is a very capable fluid and electrolyte regulator. Abrupt changes in fluid and sodium intake from the diet do not disrupt biological functionality and cause edema, as long as the heart and kidneys are relatively healthy. Edema may be present during cases of volume depletion where interstitial and intravascular fluids shift into the surrounding tissues because of oncotic pressure changes and capillary leak syndrome. Prolonged periods of time with frank deficiencies in protein consumption, as well as the physiological response to refeeding syndrome, can also result in edema. When assessing edema, clinicians should seek to identify the underlying cause. Table 9-15 shows the severity of edema and how it correlates with the ASPEN/AND malnutrition criteria.

TABLE 9-15 Fluid Accumulation Characteristics That Support a Diagnosis of Malnutrition Using the ASPEN/AND Methodology

	Degree of Fluid Accumulation	
Malnutrition Etiology	Nonsevere/Moderate Malnutrition	Severe Malnutrition
Acute illness/injury	Mild	Moderate to severe
Chronic illness	Mild	Severe
Social/environmental circumstance	Mild	Severe

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition.

Source: Data are from reference 14.

Routine observation of signs and symptoms with a physical examination is as important as monitoring weight fluctuations to evaluate for the presence of, or changes in, edema. Table 9-16 illustrates a technique to evaluate the severity of edema in the lower extremities, such as over the tibia bone or ankle.132 Clinical manifestations of fluid retention may not be noticeable until it accounts for at least 10% of body weight or when interstitial fluid volume increases by 2.5 to 3 liters. In many situations, fluid accumulation diminishes the accuracy of weight changes and can impede physical examination of muscle and fat stores. Additionally, extra fluid in the lungs or around the heart, or small pockets of ascites, might only be visible on imaging studies. Therefore, fluid retention can be present without being appreciable on a physical examination. Alternate indications of the presence of edema include distended neck veins, increased blood pressure, ill-fitting rings or shoes, declining serum sodium levels, and rapid weight increase.

TABLE 9-16 Assessing the Degree of Edema

	Edema Classification	Depth and Rebound Time	Severity of Edema
	0	No distortion occurs after pressure applied; bone structure is readily identifiable.	None
 2 mm or less	1+	Depression is barely noticeable; rebound occurs immediately.	Mild
 2–4 mm	2+	Applied pressure causes deeper pit; rebound occurs after a few seconds.	Moderate
 4–6 mm	3+	Pitting is even more pronounced; rebound occurs after about 10–12 seconds.	Severe
 6–8 mm	4+	Pressure causes very deep pit; rebound generally takes longer than 20 seconds.	Severe

Source: Data are from reference 132. Artwork reprinted with permission, Cleveland Clinic Center for Medical Art & Photography

Micronutrient Abnormalities

Physical signs associated with micronutrient deficiencies or excesses must be interpreted carefully because they might be caused by environmental factors, diseases, or infections and do not necessarily indicate a micronutrient problem. Oral intake data, assessment by dermatologic examination, or laboratory findings can help confirm or rule out possible abnormalities identified in the NFPE. Micronutrient irregularities are covered more extensively in Chapter 8.

Functional Status

Measures of strength and functional status have been recognized as an important component of the nutrition assessment, but they are widely underused.136 Functional status is a measurement of the capacity of an individual to perform usual activities. Muscle function and strength can be affected by inflammatory conditions, acute and chronic diseases, atrophy from lack of use, and sensory-loss from neuromuscular damage. Muscle function, as assessed by handgrip, shows a direct relationship with measures of functional status and physical components of quality of life.137 Anthropometry, measurements that focus on size and proportions of bodily muscle and fat, has limitations as it does not reflect muscle function and strength. The development of useful and practical techniques for assessing functional status is a current topic of interest and research.136

The use of a handgrip dynamometer to gauge muscle strength is a validated tool for determining functional status of an individual94,138 and can be useful in nutrition assessment.136 The handgrip dynamometer may not be available or practical in all clinical settings because the patient must be correctly positioned and able to use bilateral, upper-extremity strength.138 Alternatively, manual muscle testing has shown some reliability as a strength and muscle function assessment tool.139 Other measures of physical performance that are being investigated for use and practicality include the 30-second chair stand; stair climb test; 4- × 10- meter, fast-paced walk; timed up-and-go test; and 6-minute walk test.

Self-evaluation of physical performance and functioning has been part of validated nutrition assessment tools and quality-of-life measures. Obtaining a patient's perspective regarding his/her functional status may be useful if a handgrip dynamometer is not available.27,136 Validated nutrition assessment tools that include self-evaluation of functional status include the SGA,22 the Dialysis Malnutrition Score,27,140 and the Patient-Generated Subjective Global Assessment.27 The ASPEN/AND malnutrition clinical characteristics also incorporate functional status into the assessment of malnutrition (see Table 9-17).14 Quality-of-life measures that evaluate functional ability include the Katz Index of Independence in Activities of Daily Living, Lawton Instrumental Activities of Daily Living, Karnofsky Performance Scale Index, and Eastern Cooperative Oncology Group Performance status tool.

TABLE 9-17 Functional Status Characteristics That Support a Diagnosis of Malnutrition Using the ASPEN/AND Methodology

Malnutrition Etiology	Nonsevere/Moderate Malnutrition	Severe Malnutrition
Acute illness/injury	N/A	Measurably reduced functional status
Chronic illness	N/A	Measurably reduced functional status
Social/environmental circumstances	N/A	Measurably reduced functional status

AND, Academy of Nutrition and Dietetics; ASPEN, American Society for Parenteral and Enteral Nutrition.

N/A, not applicable.

Source: Data are from reference 14.

Conclusion

This chapter has introduced various approaches to understanding adult malnutrition that highlight the importance of the inflammatory process along with some practical nutrition screening and assessment methods suitable for routine clinical applications. Initiatives to globally refine and validate a means to diagnose and define malnutrition are ongoing and will likely be updated as new information emerges.

Currently, no single clinical or laboratory measure provides a comprehensive assessment of nutrition status. Therefore, a complete assessment of nutrition status should include a review of the client's anthropometrics, medical and surgical history, family and social history, medication use, clinical presentation, and biochemical data; additionally, the clinician should obtain nutrient intake data and perform an NFPE (including a functional status assessment). All of these components are integral to confirm the presence of malnutrition and generate an appropriate care plan.