TABLE 97-3 NUTRITIONAL DEFICIENCY: THE HIGH-RISK PATIENT

Underweight (body mass index <18.5) and/or recent loss of ≥10% of usual body mass
Poor intake: anorexia, food avoidance (e.g., psychiatric condition), or NPO[a] status for more than ~5 days
Protracted nutrient losses: malabsorption, enteric fistulas, draining abscesses or wounds, renal dialysis
Hypermetabolic states: sepsis, protracted fever, extensive trauma or burns
Alcohol abuse or use of drugs with antinutrient or catabolic properties: glucocorticoids, antimetabolites (e.g., methotrexate), immunosuppressants, antitumor agents
Impoverishment, isolation, advanced age

[a]Nil per os (nothing by mouth).

Nutritional History Elicitation of a nutritional history is directed toward the identification of underlying mechanisms that put patients at risk for nutritional depletion or excess. These mechanisms include inadequate intake, impaired absorption, decreased utilization, increased losses, and increased requirements for nutrients.

Individuals with the characteristics listed in Table 97-3 are at particular risk for nutritional deficiencies.

Physical Examination Physical findings that suggest vitamin, mineral, and protein-energy deficiencies and excesses are outlined in Table 97-4. Most of the physical findings are not specific for individual nutrient deficiencies and must be integrated with historic, anthropometric, and laboratory findings. For example, follicular hyperkeratosis on the back of the arms is a fairly common, normal finding. However, if it is widespread in a person who consumes few fruits and vegetables and smokes regularly (increasing ascorbic acid requirements), vitamin C deficiency is likely. Similarly, easily pluckable hair may be a consequence of chemotherapy but suggests acute malnutrition/kwashiorkor in a hospitalized patient who has poorly healing surgical wounds and hypoalbuminemia.

Anthropometric Measurements Anthropometric measurements provide information on body muscle mass and fat reserves. The most practical and commonly used measurements are body weight, height, triceps skinfold (TSF), and midarm muscle circumference (MAMC). Body weight is one of the most useful nutritional parameters to follow in patients who are acutely or chronically ill. Unintentional weight loss during illness often reflects loss of lean body mass (muscle and organ tissue), especially if it is rapid and is not caused by diuresis. Such weight loss can be an ominous sign since it indicates use of vital body protein stores for metabolic fuel. The reference standard for normal body weight, body mass index (BMI: weight in kilograms divided by height, in meters, squared), is discussed in Chap. 416. BMI values <18.5 are considered underweight; <17, significantly underweight; and <16, severely wasted. Values of 18.5–24.9 are normal; 25–29.9, overweight; and ≥30, obese.

Measurement of skinfold thickness is useful for estimating body fat stores, because ~50% of body fat is normally located in the subcutaneous region. This measurement can also permit discrimination of fat mass from muscle mass. The triceps is a convenient site that is generally representative of the body's overall fat level. A thickness <3 mm suggests virtually complete exhaustion of fat stores. The MAMC can be used to estimate skeletal muscle mass, calculated as follows:

$$\text{MAMC (cm)} = \text{upper arm circumference (cm)} - [0.314 \times \text{TSF (mm)}]$$

Laboratory Studies A number of laboratory tests used routinely in clinical medicine can yield valuable information about a patient's nutritional status if a slightly different approach to their interpretation is used. For example, abnormally low serum albumin levels, low total iron-binding capacity, and anergy may have a distinct explanation, but collectively they may represent kwashiorkor. In the clinical setting of a hypermetabolic, acutely ill patient who is edematous and has easily pluckable hair and inadequate protein intake, the diagnosis of acute malnutrition/kwashiorkor is clear-cut. Commonly used laboratory tests for assessing nutritional status are outlined in Table 97-5. The table also provides tips to avoid the assignment of nutritional significance to tests that may be abnormal for nonnutritional reasons.

ASSESSMENT OF CIRCULATING (VISCERAL) PROTEINS The serum proteins most commonly used to assess nutritional status include albumin, total iron-binding capacity (or transferrin), thyroxine-binding prealbumin (or transthyretin), and retinol-binding protein. Because they have different synthesis rates and half-lives (the half-life of serum albumin is ~21 days, whereas those of prealbumin and retinol-binding protein are ~2 days and ~12 h, respectively), some of these proteins reflect changes in nutritional status more quickly than do others. However, rapid fluctuations can also make shorter-half-life proteins less reliable.

Levels of circulating proteins are influenced by their rates of synthesis and catabolism, "third spacing" (loss into interstitial spaces), and, in some cases, external loss. Although an adequate intake of calories and protein is necessary for optimal circulating protein levels, serum protein levels generally do not reflect protein intake. For example, a drop in the serum level of albumin or transferrin often accompanies significant physiologic stress (e.g., from infection or injury) and is not necessarily an indication of malnutrition or poor intake. A low serum albumin level in a burned patient with both hypermetabolism and increased dermal losses of protein may not indicate malnutrition. However, adequate nutritional support of the patient's calorie and protein needs is critical for returning circulating proteins to normal levels as stress resolves. Thus low values by themselves do not define malnutrition, but they often point to increased risk of malnutrition because of the hypermetabolic stress state. As long as significant physiologic stress persists, serum protein levels remain low, even with aggressive nutritional support. However, if the levels do not rise after the underlying illness improves, the patient's protein and calorie needs should be reassessed to ensure that intake is sufficient.

ASSESSMENT OF VITAMIN AND MINERAL STATUS The use of laboratory tests to confirm suspected micronutrient deficiencies is desirable because the physical findings for those deficiencies are often equivocal or nonspecific. Low blood micronutrient levels can predate more serious clinical manifestations and also may indicate drug-nutrient interactions.

ESTIMATING PROTEIN AND ENERGY REQUIREMENTS

A patient's basal energy expenditure (BEE, measured in kilocalories per day) can be estimated from height, weight, age, and sex with the Harris-Benedict equations:

$$\text{Men: BEE} = 66.47 + 13.75W + 5.00H - 6.76A$$
$$\text{Women: BEE} = 655.10 + 9.56W + 1.85H - 4.68A$$

In these equations, W is weight in kilograms, H is height in centimeters, and A is age in years. After these equations are solved, total energy requirements are estimated by multiplying BEE by a factor that accounts for the stress of illness. Multiplying by 1.1–1.4 yields a range 10–40% above basal that estimates the 24-h energy expenditure of the majority of patients. The lower value (1.1) is used for patients without evidence of significant physiologic stress; the higher value (1.4) is appropriate for patients with marked stress such as sepsis or trauma. The result is used as a 24-h energy goal for feeding.

When it is important to have a more accurate assessment, energy expenditure can be measured at the bedside by indirect calorimetry. This technique is useful in patients who are thought to be hypermetabolic from sepsis or trauma and whose body weight cannot be ascertained accurately. Indirect calorimetry can also be useful in patients who have difficulty weaning from a ventilator and whose energy needs therefore should not be exceeded to avoid excessive CO_2 production. Patients at the extremes of weight (e.g., obese persons) and/or age are good candidates as well, because the Harris-Benedict equations were developed from measurements in adults with roughly normal body weights.

Because urea is a major by-product of protein catabolism, the amount of urea nitrogen excreted each day can be used to estimate the rate of protein catabolism and determine whether protein intake is adequate to