**TABLE 68-1 COMMON CAUSES OF PROTEIN-ENERGY MALNUTRITION AND MICRONUTRIENT DEPLETION IN MEDICAL PATIENTS WITH ACUTE OR CHRONIC ILLNESSES**

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| Decreased spontaneous food intake due to anorexia from chronic or acute illness, gastrointestinal symptoms (e.g., nausea, vomiting, abdominal pain), or depression and anxiety |
| Restricted food intake required for surgical operations or diagnostic or therapeutic procedures and gastrointestinal dysfunction after these procedures |
| Abnormal macronutrient and micronutrient losses from the body due to malabsorption (e.g., celiac sprue, short gut syndrome, inflammatory bowel disease, cystic fibrosis, diarrhea), maldigestion (e.g., pancreatitis), emesis, polyuria (e.g., in diabetes), wound drainage, or renal replacement therapy |
| Periods of increased energy expenditure (caloric needs), protein requirements, and micronutrient needs (e.g., critical illness, increased inflammation) |
| Catabolic effects of counterregulatory hormones (e.g., cortisol, catecholamines, glucagon), release of pro-inflammatory cytokines from stimulated immune cells and endothelial and epithelial cells such as interleukins (e.g., IL-1, IL-6, IL-8) and tumor necrosis factor-α (TNF-α), and peripheral tissue resistance to the anabolic hormones insulin and insulin-like growth factor-I (IGF-I). |
| Bedrest, decreased ambulation, and chemical paralysis during mechanical ventilation (skeletal muscle wasting due to impaired protein synthesis) |
| Administration of drugs that induce skeletal muscle breakdown, gastrointestinal injury, or loss of electrolytes and water-soluble vitamins (e.g., corticosteroids, chemotherapeutic agents, diuretics, antirejection regimens) |
| Socioeconomic deprivation, inadequate caregivers, ambulation difficulties in the home setting |
| Inadequate provision of calories, protein, and essential micronutrients (vitamins, minerals, trace elements) during hospitalization |

medical and surgical course, fluid drainage sites and amounts, physical examination findings, history of body weight change (degree and temporal aspects), dietary intake pattern, use of nutritional supplements including prior administration of specialized enteral nutrition (EN) or parenteral nutrition (PN), evaluation of current organ function and fluid status, and determination of selected vitamin, mineral, and electrolyte concentrations in blood (E-Table 68-1). In the intensive care unit (ICU) setting, measured body weight typically reflects recent intravenous fluid administration and is typically much higher than recent "dry" or preoperative body weight, which is the best parameter to use.

Integration of the factors outlined in E-Table 68-1 provides important information on whether patients are likely to be adequately nourished; to have mild, moderate, or severe protein-energy malnutrition; or to have depletion or deficiency of specific vitamins, minerals, or electrolytes. Patients who have experienced an involuntary body weight loss of 5% to 10% or more of their usual body weight in the previous few weeks or months, those who weigh less than 90% of their ideal body weight (IBW), and those who have a body mass index (BMI) lower than 18.5 kg/m$^2$ should be carefully evaluated, because these individuals are likely to be malnourished.

Among hospitalized patients, especially those in the ICU, circulating concentrations of proteins (e.g., albumin, prealbumin) are often quite low and not useful as protein nutritional status biomarkers given their lack of specificity. Plasma concentrations of albumin and prealbumin typically fall during active inflammation or infection, in critical illness, and after traumatic injury (due to deceased synthesis by the liver and catabolism of blood proteins).They are markedly affected by non-nutritional factors, including fluid status, capillary leak, decreased hepatic synthesis, and increased clearance from blood. Because of the long circulating half-life of albumin (18 to 21 days), concentrations in blood remain low despite adequate feeding and are slow to respond to nutritional repletion, irrespective of other confounding factors. Prealbumin has a much shorter circulating half-life (several days), and serial blood levels can be used as a general indicator of protein status in clinically stable outpatients. E-Table 68-2 illustrates physical examination findings that may be observed in associated with depletion of specific nutrients.

Energy requirements can be estimated with the use of standard equations, such as the Harris-Benedict equation, which incorporate the patient's age, gender, weight, and height to determine basal energy expenditure (BEE) (see E-Table 68-1). Physical activity and the thermic effect of macronutrient administration can be added to the BEE to arrive at the energy prescription to maintain current body weight; for most hospitalized patients and outpatients, this is estimated as 1.2 to 1.3 times the BEE, unless energy needs are decreased because the patient is sedated or on bedrest (common in the ICU). The estimated maintenance energy requirement is approximately 1.3 times BEE in ambulatory subjects. Typically, lower amounts of calories are now given in ICU patients (as discussed later). Use of data obtained from a bedside metabolic cart machine (indirect calorimeter), which measures expired breath to determine oxygen consumption and carbon dioxide production, provides accurate actual energy expenditure in most settings and can be very useful (see E-Table 68-1).

A simple and relatively accurate method to estimate energy needs is simply to use 20 to 25 kcal/day per kilogram of actual weight, dry weight, or IBW in most patients. Values for IBW are obtained from standard tables or equations. This estimation assumes that the body weight used does not reflect intravenous fluid administration or capillary leak syndromes (discussed earlier). In ICU patients, even lower caloric doses (equivalent to 15-20 kcal/kg dry weight/day) have been advocated by some, based on known complications of overfeeding (see later discussion) and limited data on clinical outcome as a function of energy dose. In clinically stable, malnourished, non-ICU patients who require nutritional repletion, higher doses of calories (up to 35 kcal/kg/day) appear to be generally well tolerated if refeeding syndrome is avoided (see later discussion). In obese subjects (defined for these calculations as patients with body weight >20% to 25% greater than ideal), an adjusted body weight value should be used for calculation of energy and protein needs, as determined by the following equation:

$$\text{Adjusted body weight} = (\text{current weight} - \text{IBW}) \times 0.25 + \text{IBW}$$

Guidelines for protein or amino acid administration are given in E-Table 68-3. Studies in nonburned ICU patients indicate that protein loads of more than 2.0 g/kg/day are not efficiently utilized for protein synthesis, and the excess may be oxidized, contributing to azotemia. In most catabolic patients requiring specialized feeding, a recommended protein dose is 1.5 g/kg/day for individuals with normal renal function. This is about twice the recommended dietary allowance (RDA) for healthy adults of 0.8 g/kg/day. The administered protein dose should be adjusted downward as a function of the degree and tempo of azotemia (in the absence of dialysis therapy) and of hyperbilirubinemia (see