

# Nutritional Assessment and Planning in Clinical Care

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### Goals and Objectives

- Discuss the role of nutritional assessment in a variety of health care settings.
- Describe techniques used for nutritional assessment in health care settings.

**Key Words:** albumin, body weight, body mass index, c-reactive protein, energy needs, health risks, ideal body weight, malnutrition, metabolic syndrome, nutrition, nutritional assessment, nutritional screening, nitrogen balance, prealbumin, protein, vitamins.

### Why Assess Nutritional Status?

Nutritional factors figure prominently in four of the ten leading causes of death in the United States: coronary heart disease, cancer, stroke and type 2 diabetes, conditions which account for more than 50% of the deaths that occur each year. Dietary habits also play an extensive role in the development of hypertension and obesity, both of which add considerably to the risk for chronic disease. (WHO, 2003).

In addition, it has long been recognized that morbidity and mortality increase when malnutrition accompanies acute illness. More than 150 clinical surveys conducted of hospitalized patients place the incidence of malnutrition between 20% and 50%, with estimates for elderly hospitalized and institutionalized patients being even higher (Heimbürger, 2006). Alterations in nutritional status account for as much as 50% of the variance in patient response to any given medical intervention (Seres, 2003). This problem also translates into higher medical costs, more frequent hospital admissions, and increased length of stay in hospitals. Appropriate nutritional intervention plays a role in offsetting the complications associated with poor nutritional status and improving clinical outcomes (Norman, 2008).

### Definitions

“Malnutrition”, a designation used frequently in discussions of nutritional assessment, is a broad and nonspecific term. In general, malnutrition refers to states of under-nutrition—conditions caused by a deficiency of nutrient intake or impaired nutrient absorption, but some definitions also include states of over-nutrition. (A.S.P.E.N., 2005). In view of the health implications of the current obesity epidemic, a definition that describes an *imbalance* between energy intake and utilization may be more appropriate (Marshall, 2008), while others have suggested that definitions of malnutrition acknowledge the role of inflammatory activity as well (Jensen, 2009).

### Goals of Nutritional Assessment

Regardless of the clinical setting, the obvious objective of nutritional assessment is to identify patients with poor nutritional status. Every nutritional assessment begins by taking into consideration age-specific nutrient requirements and developmental issues. Beyond that, the intermediate goals and even the method of assessment can vary, depending on the clinical status of the patient and the setting in which the assessment takes place.

Nutritional assessment in primary care, for example, centers on promoting optimal health and preventing nutrition-related disease. This process places emphasis on recognizing dietary and life style factors that affect health. Another key function of nutritional assessment in primary care is to determine the need for therapeutic dietary adjustments for patients with chronic disease. For hospitalized patients, the focus shifts toward identifying ways in which acute illness influences nutritional status and the impact of nutritional status on clinical outcomes. Information gathered through nutritional assessment in hospitalized patients should distinguish between the causes and consequences of malnutrition and help in selecting patients most likely to benefit from nutritional support (Bistran, 2007).

### Nutritional Screening

In most healthcare settings, nutritional assessment takes place in two steps; an initial nutritional screening followed by a more formal nutritional assessment when indicated. Routine

history and physical examinations incorporate many components for nutritional screening such as height, weight, blood pressure, blood glucose levels, and lipid profile. In addition, primary care also includes screening for cancer and osteoporosis, conditions in which nutrition or body weight plays a prominent role.

The Joint Commission also requires that nutritional screening be performed for patients in all types of healthcare settings. The screening process assigns a level of nutritional risk to patients based on their answers to a series of simple questions and helps prioritize intervention for patients with the most urgent need for nutritional support. Nutritional screening should be repeated at regular intervals, or whenever there is a change in clinical status.

### Nutritional Assessment Techniques

Nutritional assessment is a comprehensive process that combines objective measurements, a focused history and physical examination, and clinical judgment to arrive at a decision regarding a patient's nutritional status. In multidisciplinary care, the various components of the nutritional assessment may be divided among several disciplines or may be carried out by a single individual. Registered dietitians are frequently the most experienced in nutritional assessment but their availability may be limited in some healthcare environments such as primary care or in long-term care facilities.

### Objective Measurements

The objective data gathered as part of a nutritional assessment includes measurements of body composition as well as laboratory values. Evaluation of body composition encompasses a wide variety of diagnostic studies, some of which are relatively sophisticated and costly. Many of these techniques are useful in research studies but have only limited applicability as clinical tools (Russell and Mueller, 2007). Of all the measures of body composition included in nutritional assessment, however, body weight stands out as the best indicator for identifying malnutrition and measurement of abdominal obesity serve as discriminators of cardiovascular risk factors (Lee, 2008).

Method	Evaluation of Body Composition Description	Limitations
<b>Body Weight</b>	Evaluation of weight in relation to height and changes from usual weight	Accuracy of measurements are affected by frame size and alterations in body water.
<b>Anthropometric Measurements</b>	<p><b>General:</b> for adults, determination of skinfold thickness in the triceps and subscapular area and measurement of mid-arm muscle circumference. (Used as an indicator fat stores and muscle mass.); For infants: length, head circumference, and chest circumference.</p> <p><b>Waist Circumference:</b> men: &lt; 40 in women &lt; 35 in</p> <p><b>Waist-hip ratio:</b> A technique used to assess distribution of body fat; desirable WHR: 0.8 for women and 0.95 for men.</p>	<p>Requires precision in technique for accurate measurements</p> <p>Available reference tables are not widely applicable to hospitalized patients.</p> <p>Waist circumference and elevated WHR, indicators of abdominal obesity, are associated with increased health risks.</p>
<b>Bioelectrical Impedance Analysis (BIA)</b>	Analysis of fluid volumes and fat free body mass based on differences in resistance to an electrical current.	May have use in athletics; not fully validated for use in disease states.
<b>Dual-Energy Xray Absorptiometry (DEXA)</b>	Originally developed for measurement of bone density; may help determine fat and lean body compartments.	No available data suggesting DEXA can predict clinical outcomes.

## Body Weight

Weighing patients is a simple and inexpensive procedure that serves as a reliable index of nutritional status. In contrast to other techniques for evaluating body composition, measurements of body weight give only general information regarding lean muscle mass or fat stores. Body weight, however, has a strong correlation with the development of disease and, in some cases, prognosis. Deviation of weight from ideal levels, changes in weight over time, and the relationship of weight to height each provide useful information regarding current nutritional status.

### Ideal Body Weight

A weight that is 20% over or under ideal levels places patients at nutritional risk (Hammond and Wessel, 2005). This simple comparison of current weight to desirable weight allows clinicians to judge the degree of over-nutrition or under-nutrition and to set targets for weight gain or loss. Published standards of ideal body weight are available, but lack of ready access to the tables limits their usefulness in clinical practice. As an alternative, many clinicians use the Hamwi Formula, as shown below, to determine ideal body weight.

#### The Hamwi Formula for Determining Ideal Body Weight (Hamwi, 1964)

**Male:** 106 lb/5ft plus 6 lb for every inch over 5 feet  $\pm$  10% based on frame size

**Female:** 100 lb/5ft plus 5 lb for every inch over 5 feet  $\pm$  10% based on frame size

The primary limitation of this formula is its inability to account for differences in frame size, requiring instead, that a subjective estimate of frame size be added to the calculation. Despite this shortcoming, the formula is a quick and practical way of obtaining a reasonably accurate estimate of ideal body weight. Ethnic and cultural differences influence views regarding ideal body weight. African Americans, for example, generally display a willingness to accept a larger body types, whereas Caucasian Americans tend to place greater emphasis on thinness (Baskin, et al, 2001). This information carries important implications for clinicians who must tailor messages and develop interventions for patients who are overweight or, as is the case with eating disorders, severely below ideal body weight.

### Weight Changes

Because degree of obesity and distribution of body fat are key indicators of health risks, much attention in primary care focuses on maintaining a healthy weight. Patients should be weighed at each office visit and results documented in a way that allows trends to be tracked easily. The growth charts used for pediatric patients serve this purpose but a similar standardized tool does not exist for adults. Counseling and intervention should begin early, as soon as a trend toward excessive weight gain is detected. The distribution of body weight is also an important consideration, with abdominal obesity associated with a greater risk of cardiovascular disease.

Regardless of whether body weight is over or under ideal standards, changes in weight from usual levels carry important prognostic value. For adults, unintentional weight loss is more serious than weight gain during illness and for infants and children a downward shift in percentile ranking is cause for concern even if weight gain continues. Both the amount of weight lost and the time frame in which the weight loss occurred are significant variables. A loss of 10% of usual body weight over 6 months is considered severe. Involuntary weight loss typically carries a greater nutritional risk than intentional weight loss, as long as the patient followed a weight loss plan based on sound nutritional practices. The current popularity of some fad diets raises the likelihood that even intentional weight loss may be associated with nutritional deficits and poor clinical outcome.

#### Interpreting Involuntary Weight Loss

Timeframe	Severe Weight Loss
1 week	> 2%
1 month	> 5%
3 months	> 7.5%
6 months	> 10%

## Body Mass Index

Body Mass Index (BMI), a ratio of weight to height, is another way of evaluating body weight that is coming into wide use in clinical practice. Current guidelines for weight gain in pregnancy, for example, are based on the woman's pre-pregnancy BMI. BMI provides an indication of the degree of adiposity present. Elevated BMI has a strong correlation with cardiovascular disease and other chronic diseases including diabetes, cancer, hypertension, and osteoarthritis. The calculation for BMI appears below:

		Calculating Body Mass Index	
	Formula		Interpretation
Metric:	BMI = $\frac{\text{Weight (Kg)}}{\text{Height (Meters)}^2}$	18.5-25	Normal
		25-29.9	Overweight
		30-34.9	Obesity (grade 1)
		35-39.9	Obesity (grade 2)
		$\geq 40$	Obesity (grade 3)
		17-18.4	PEM * (grade 1)
		16-16.9	PEM (grade 2)
		< 16	PEM (grade 3)

(PEM = Protein-Energy Malnutrition)

BMI is used differently in children than in adults to account for gender and age related variations in body fat that occur as children grow. In children, BMI does not increase in a direct linear fashion. Instead, BMI declines in the preschool years and then increases through adolescence and adulthood. Therefore, BMI for children is plotted on a chart similar to the commonly used growth charts and expressed as a percentile ranking. These percentile rankings can be used for adolescents through puberty to the age of 20 (CDC, 2001).

Although BMI is an improvement over standard weight-for-height measurements, the calculation does have some shortcomings. BMI tends to overestimate body fat for muscular athletes, for example, and underestimate fat stores in older persons and others who have experienced significant muscle wasting. In addition, BMI does not take into account ethnic variations in body composition and the impact this has on health risk. For instance, a 10% increase in mortality occurs for white females with a BMI of 25-28 but no elevation in risk occurs for African American women with a BMI in this range (Baskin, 2001). Further research may lead to BMI formulas for specific patient populations or to the development of cut-off points for overweight and obesity that more closely reflect health risks for a given ethnic group.

## Laboratory Values

In primary care settings, the lipid profile is perhaps the most frequently ordered laboratory test with nutritional implications. Other routine laboratory tests, such as a complete blood count, blood glucose, and electrolyte levels also provide valuable nutritional information. These measures remain important for hospitalized patients, but nutritional assessment during acute illness also places much emphasis on evaluating the status of serum protein concentrations.

## Serum Protein Concentrations

The most widely used laboratory tests used in the nutritional assessment of hospitalized patient are measurements of serum protein concentrations, specifically albumin, transferrin, and prealbumin. These circulating proteins are often referred to as visceral proteins to distinguish them from muscle protein mass. Visceral proteins are synthesized by the liver and act as transport proteins in a variety of metabolic processes.

Studies show a strong association between low serum albumin levels and increased risk of complications and mortality. Unfortunately, serum albumin is not a reliable indicator of nutritional status during illness. Numerous clinical variables such as hydration status, organ function, infection, and metabolic stress influence serum albumin levels, making this protein a better marker of severity of illness than nutritional status (Dennis, 2008; Hall, 2006; Seres, 2005). The long half-life of albumin (14-20 days) prevents the use of this protein in monitoring response to intervention. Transferrin has received less study than albumin but it has a shorter half life (8-10 days).

Prealbumin, the third protein often used in nutritional assessment, is a transport protein for thyroid hormones. Prealbumin has a very short half-life, only 2-3 days, potentially increasing its role

in monitoring changes in nutritional status. Although prealbumin levels respond to variations in nutritional intake, concentrations are also strongly influenced by clinical factors, an issue that makes interpretation of laboratory results difficult (DeLegge, 2007)

Serum levels of visceral proteins fall in response to an inflammatory process regardless of nutritional status. During inflammation, the liver preferentially produces acute phase proteins, reducing synthesis of visceral proteins. Some investigators have suggested that comparing the level of an acute phase protein, such as C-reactive protein, in conjunction with visceral protein values can help determine whether low protein levels are related to an inflammatory process or the result of poor nutritional status.

### **Nutrient Levels**

Although nutritional assessment does not routinely include measurement of nutrient levels, clinical circumstances may warrant a more in-depth investigation of the status of specific nutrients. Iron studies, for example, may be in order for patients with a microcytic anemia. Similarly, the presence of peripheral neuropathy warrants an evaluation of B<sub>12</sub> and folate levels. Zinc levels may be in order for patients with chronic diarrhea. In each case, information gained from the patient's history and findings of the physical examination guide the decision regarding the need for further laboratory testing.

### **Medical History**

While laboratory tests help detect nutritional deficiencies, thoughtful questioning of the patient often uncovers the mechanisms underlying the problem. A health history focused on nutritional assessment includes medical, social, and nutritional components, each providing insight into the causes and contributing factors of nutritional problems. Aspects of the patient's medical condition that are relevant to nutritional assessment include the effect of the disease process on metabolic requirements and the impact of organ function on nutrient tolerance and utilization. Social factors that impact nutritional status must also be evaluated. Many of the categories included in the history component of a nutritional assessment are similar to those asked in any patient interview. In this case though, the focus of the questioning shifts to gaining specific information about actual or potential nutritional deficits and to gauge the impact of alterations in nutritional status on clinical outcomes.

### **Diet History**

A detailed diet history serves as a valuable tool that can provide much information about eating habits, nutritional imbalance, potential deficiencies, and reasons for inadequate intake during illness. In acute care settings, a registered dietician is the member of the healthcare team most skilled in this process. Unfortunately, few primary care settings have this resource available. At a minimum, the patient interview should include questions aimed at detecting dietary habits closely associated with increased health risks.

### **Physical Examination**

Standard physical assessment procedures are used in evaluating nutritional status. Severe malnutrition produces a variety of physical manifestations (Russell and Mueller, 2007). The most notable effects occur on the skin, mucous membranes, and hair. Rashes, petechiae, bruises, and other lesions of the skin, changes in the lips, gums, and tongue, and alterations in the appearance of the hair may all be evidence of nutrient deficiency. These signs of malnutrition are often non-specific. Therefore, the appearance of suspicious physical signs requires correlation with the patient's history and clinical condition, and whenever possible, confirmation through diagnostic tests.

Physical manifestations of nutrient deficiency typically indicate a state of advanced depletion. In clinical settings, signs of deficiency for specific nutrients occur far less frequently than evidence of a more general deficit of protein and energy intake. As a result, the focus of the physical examination often rests less with identification of specific nutrient deficiencies than with acquiring a more global impression of current nutritional status and the impact of nutritional factors on the patient's medical condition. Muscle wasting, poor skin integrity, and loss of subcutaneous tissue are typical findings associated with long-standing protein and energy deficits. Obesity, an increasingly common condition, is strong evidence of nutritional imbalance as well as increased health risk.

## **Establishing Energy and Protein Requirements**

### **Determining Calorie Requirements**

Numerous methods for determining energy expenditure exist, though none are ideal in all situations. The options include a technique known as indirect calorimetry, regression equations for calculating metabolic rate, and using simple weight-based calculations to establish a general range for caloric intake. The clinical setting and patient characteristics determine which of these methods is most appropriate to use. A key factor in choosing a method to establish energy expenditure is the degree of accuracy required. Each technique relies on professional judgment to account for clinical variables that impact energy expenditure, a factor that influences the accuracy of each method available for determining energy expenditure.

### **Weight-Based Calculations**

Many clinicians rely on a simple “rule of thumb” that gives a general range for caloric intake based on body weight. For adults in clinical settings, a range of 25-30 kcal/kg provides a reasonable estimate of energy expenditure. Although this approach is convenient and easy to use, the calculation makes no attempt to account for variations in age, gender, or body composition and may have a wide margin of error for individuals who are not at ideal weight or who are undergoing a high degree of metabolic stress. Despite these drawbacks, this simple calculation provides a reasonable starting point for determining energy goals.

### **The Harris-Benedict Equations**

Although numerous formulas for predicting energy expenditure exist, the Harris-Benedict Equations (Harris and Benedict, 1919) as shown below, remain the most widely used method for calculating REE:

$$\text{Male: REE} = 66 + 13.75(W) + 5.0(H) - 6.78(A)$$

$$\text{Female: REE} = 655 + 9.6(W) + 1.8(H) - 4.68(A)$$

(W: weight in kg; H: height in cm; A: age in years)

The number obtained using a Harris-Benedict Equation must be multiplied by factors designed to adjust for activity and the stress of illness :

Activity Factor:	REE x 1.25
Simple Starvation:	REE x 0.85
Sepsis:	REE x 1.2 to 1.4
Multiple Trauma:	REE x 1.40
Systemic Inflammatory Response:	REE x 1.50

Research has shown that the Harris-Benedict Equations tend to overestimate energy expenditure by as much as 15% (Russell and Mueller, 2007). However, alternative equations developed in an effort to correct for this problem also contain unexplained error. Clinicians must use professional judgment in applying stress factors and in establishing energy goals based on the Harris-Benedict Equations.

### **Indirect Calorimetry**

Indirect calorimetry provides the most accurate method for determining energy expenditure. Although this technique has limited use in primary care settings, indirect calorimetry helps to establish energy needs for critically ill patients and in situations where the impact of illness is difficult to gauge. With indirect calorimetry, an instrument is used to measure oxygen consumption and carbon dioxide production to provide a value for energy expenditure. The primary advantage of indirect calorimetry in clinical settings is that the measurement reflects the changes in metabolic rate produced by illness. In most cases the study is performed for a fixed period of time, with the patient in a fasting state and at rest. Under these conditions, indirect calorimetry measures the patient's resting energy expenditure (REE). Clinicians must multiply the REE by factors designed to account for variations in metabolic rate that occur outside the study period. Activity and changes in body temperature associated with illness account for much of the fluctuation in metabolic rate that takes place throughout the day. Food

consumption also boosts metabolic rate by 5% to 10%. Indirect calorimetry captures this diet-induced increase in metabolic rate for patients receiving enteral or parenteral nutrition during the study.

### Protein Requirements in Health and Illness

Because injury and illness can dramatically alter protein needs, accurately determining protein requirements is a key aspect of planning nutritional care during illness. Once protein needs are determined, the allocation for non-protein calories can be made more easily.

Current guidelines recommend that healthy adults with normal renal function receive 0.8 grams of protein per kilogram each day, although protein needs may decline somewhat with age. On the other hand, the metabolic stress associated with illness and injury can greatly increase protein requirements. The table below provides guidelines for protein intake for various clinical conditions.

Guidelines for Protein Intake for Adults	
Clinical Condition	Recommended Intake (g/kg/d)
Healthy adult, normal organ function	0.8
Post-operative	1.0—1.5
Sepsis	1.2—1.5
Multiple Trauma	1.3—1.7
Major Burn	1.8—2.5

### Nitrogen Balance

Nitrogen balance provides an indication of the adequacy of protein intake by comparing nitrogen intake with nitrogen excretion. Positive nitrogen balance is a state in which nitrogen intake exceeds nitrogen excretion, suggesting that nutritional intake is sufficient to promote anabolism and to preserve lean body mass. Negative nitrogen balance, on the other hand, is characterized by nitrogen excretion that exceeds intake. In this situation the excess nitrogen output reflects erosion of muscle tissue. Nitrogen intake is determined by dividing protein intake (in grams) by 6.25. Ascertaining nitrogen output requires the analysis of a 24-hour urine collection for urea nitrogen content (UUN), which accounts for most of the body's nitrogen losses. An additional 4 grams of nitrogen is added to the urinary nitrogen output to account for non-urea nitrogen losses. Because nitrogen excretion varies with severity of illness, nitrogen balance studies are most helpful when repeated at regular intervals. The formula for calculating nitrogen balance appears below:

$$N_2 \text{ balance} = \frac{\text{protein intake (grams)}}{6.25} - \text{UUN output} + 4g \text{ } N_2 \text{ (non-urea } N_2 \text{ losses)}$$

### Developing a Plan of Care

Establishing measurable nutritional goals and incorporating these goals into the patient's plan of care constitutes the final phase of nutritional assessment. The nutritional plan must be congruent with broader therapeutic goals and with the wishes and beliefs of the patient. To be truly useful, the nutritional plan of care must include an outline of nutritional interventions aimed achieving the established goals. Dietary modifications, specific nutrient requirements, routes and methods for nutritional support, and educational needs are examples of items included in a comprehensive nutritional plan. The plan should also state whether weight gain, reduction, or maintenance is expected, identifying a target for body weight when possible.

### Summary

As the interplay between nutrition and illness becomes better understood, assessing the nutritional status takes on greater importance in patient care. In primary care settings, nutritional assessment provides information regarding the quality of the patient's diet and risk for developing chronic disease. During acute illness, the focus of nutritional assessment places less emphasis on measuring degrees of malnutrition than with identifying the causes of nutritional problems and developing strategies to improve clinical outcomes. Nutritional assessment provides a fuller understanding of the risks for unfavorable clinical outcomes and forms the framework for developing a therapeutic plan. The educational needs uncovered during nutritional assessment present a challenge that demands the attention of the entire healthcare team.

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