Evaluation of Nutritional Status

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ABSTRACT

The assessment of nutritional status has become very popular, especially for patients undergoing stress (surgery) or potential parenteral nutrition. Evaluation of cancer patients is essentially the same as for other patients. Body fat reserves are approximated by subcutaneous skinfold measurements. Somatic protein (skeletal muscle) mass is decreased in marasmus (protein-calorie malnutrition) and is evaluated by anthropometric determinations, based upon age and sex or both. Instead of using relatively inadequate standards such as the 1959 Metropolitan Life Insurance tables for ideal weight, it is advocated to use the population percentiles derived from the Health and Nutritional Examination Survey (HANES) published in 1979. The visceral protein mass is decreased in kwashiorkor and is approximated by study of the liver transport proteins. A mixed-type of protein-calorie malnutrition may exist, e.g., cancer cachexia, with marked decrease of immunocompetence. A prognostic nutritional index, based on biologic measurements rather than true nutritional assessment, can predict the probability of complications and survival in severely ill patients. All such studies should be used to substantiate good clinical judgement, based on adequate history and physical examination with emphasis on the nutritional aspects.

Introduction

Hippocrates stressed the relationship between nutrition and disease. It is only in the past decade that there has been increased activity in the study of nutritional assessment; the evaluation of the nutritional status of the cancer patient is the same as for other patients.

Various anthropometric and biochemical measurements have been utilized in epidemiologic surveys to study the nutritional status of various population groups. Baron Quetelet is considered the father of anthropometry and is reported to have coined the term in 1835. Anthropometric measurements were determined in colleges by physical educators (primarily physicians) since the Civil War. Skinfold measurements for fat content, considered to be related to the nutritional status, were introduced in 1929. One or more skinfold measurements are used to assess body fat.

Skeletal muscle or somatic protein mass is evaluated by determining height, weight, mid-upper arm circumference, arm muscle area, and creatinine excretion. These measurements are simple, inexpensive, and can be performed in the
field without specialized equipment and personnel; they are valid measures of the mean nutritional state of a population. The marasmus type of protein-calorie malnutrition (PCM) or protein-energy malnutrition (PEM) is marked by a reduction of body weight (somatic protein mass).

Kwashiorkor-like malnutrition occurs when the diet contains adequate calories but insufficient protein, resulting in a reduction of the visceral protein mass. A severe deficiency of both calories and proteins results in the mixed form of malnutrition. It is more difficult to assess the visceral protein mass. Serum transport proteins (albumin, transferrin, thyroxin-binding prealbumin, retinal-binding protein, and so on) have been studied to evaluate liver function as an example of organ function. Protein-calorie malnutrition is often associated with a decrease of the host’s immune responsiveness. The total lymphocyte count is a static measure of the immune reserves and tests of delayed-type hypersensitivity reactivity are a measure of immune function. In addition, studies of skeletal and respiratory muscle function have been advocated. Strength tests, utilizing the dynamometer and spirometer, were popular from 1880 to 1915 in physical education. These tests are epidemiologically useful and correlate with morbidity and mortality, but no single measurement is of consistent value in an individual patient. The reports vary from claiming clinical judgement to be sufficient to various indices to predict the likelihood of malnutrition, operative morbidity, sepsis, and death.

Fat Reserves

Frisancho published percentile (5, 15, 50, 85, and 95) standards for white males and females under 44 years of age, using the data of the Ten State Nutrition Survey of 1968 to 1970. The standards for triceps skinfold (TSF) were updated with the data from the Health and Nutritional Examination Survey (HANES) of 1971 to 1974 for ages 1 to 74 years. Utilizing the same HANES data (published in 1979), but including black individuals, for ages 18 to 74 years, somewhat different values were published. The controversy over relatively minor aspects between these experts is seen in their letters to the editor. Some authors advocate using the subscapular skinfold as well or using the sum of the triceps and subscapular skinfolds. Published percentile values of benefit for clinical use are 5, 10, 25, 50, 75, 90, and 95. In general, the skinfold measurements should be done on the same side of the body,—usually the right side for nutritional assessment, although the left side has been used in epidemiologic surveys. No significant differences were noted between right and left arm measurements.

Markedly decreased triceps skinfolds are presumably indicative of severely decreased fat reserves but the decision values vary,—less than 75 percent of the standard, 60 percent, or 50 percent of the standard. Blackburn and his colleagues utilize percentage relationships to the “normal” standards for all parameters,—down to 90 percent of standard is mild, 60 to 90 percent moderate, and less than 60 percent denotes severe depletion. When using the percentile values as a standard of reference, mild depletion of the fat depots is assumed if the value falls between the 35 to 40 percentiles, moderate if between the 25 to 35 percentiles, and severe if the value is below the 25 percentile. Body fat may be normal or even increased in spite of the presence of moderate to severe malnutrition.

Somatic Protein Mass

Body Weight

Ideal body weight has been used as a basis to determine obesity and, now,
malnutrition. The first set of standard height-weight insurance tables was published in 1912, based on measurements made in 1898 to 1905; the present-day set of insurance tables was published in 1959, based on measurements made in the period 1935 to 1953.49 The populations were not randomly selected (only those who were healthy and able to purchase an insurance policy were included), height was measured in two inch intervals with shoes, weight was with "indoor" clothing, and frame size was arbitrarily classified into small, medium, and large by dividing the frequency distribution into thirds.

The weight of an individual, if greater than the standard tables, was taken as a measure of obesity or fatness. Overweight or under-weight does not necessarily indicate an increased or decreased amount of body fat. Various indices have been used to describe the various somatotypes and the relative obesity of an individual. The indices that best correlate with weight (and least with height) and best predict body fat are W/H (Steet's index, 4 developed in 1874) and W/H²; 68 the W/H² index has had various names but was best known as Quetelet's index and, now, as the body mass index (BMI). 49 The BMI is easily calculated with the aid of a nomogram 66 or a table. 19 The most recent body mass index is W/Hᵖ or Benn's index, in which the exponent p is derived by multiplying the age, sex, and the population-specific regression coefficient of weight on height with the height-weight ratio. This index has been supported by some 50,51 and criticized by others. 36,57 Other indices, which are not as good predictors of body fat are W/H³ (Rohrer index), H⁵/W (leanness index), 61 H/√W (Sheldon index), and √W/H (Ponderal index). 52

Proper evaluation of frame size can be accomplished by use of the ratio of height to wrist circumference (in centimeters); the wrist circumference is measured just distal to the styloid process of the radius and the ulna. 38,41 The values for medium frames are 10.4 to 9.6 and 10.9 to 9.9 for males and females, respectively; higher ratios denote a small frame and lower values denote a large frame. 41 Grant et al 41 have modified the 1959 Metropolitan Life Insurance tables on the basis of these frame size measurements. Mathematical formulations ("HAT") have been derived to classify the body into small, medium, and large sizes; H represents height and AT the sum of the acromial and trochanteric diameters, all expressed in centimeters. 48 Equations for males and females yield numerical values to separate the three frame sizes. For males, differences in body weight between frame size groups was due to differences in lean body weight while fat weight per frame size remained constant; for females, however, there was some increase in fat weight but no increase in lean body weight per frame size. 48

The weight of an individual is usually compared to the ideal weight (for sex, height, and frame).

\[
\%\text{Ideal Body Weight} = \frac{\text{Current Weight}}{\text{Ideal Body Weight}} \times 100
\]

The ideal body weight may be obtained from published tables or calculated as follows: For men, 106 lb for five ft plus six lb for each inch above five ft and for women, 100 lb for five ft plus five lb for each inch above 5 ft. For small-framed individuals, 10 percent is subtracted, whereas 10 percent is added for individuals with a large frame. 54 For individuals over 50 years of age, 10 to 20 percent should be added since older people are healthy despite a large adipose mass. 47 Interpretations vary but a current weight of 80 to 90 percent of ideal is suggestive of mild caloric malnutrition, 70 to 80 percent moderate, and less than
70 percent severe caloric malnutrition. As mentioned under triceps skinfolds, Blackburn's values for the three categories are more than 90, 60 to 90, and less than 60 percent, respectively. Other values are greater than 90, 80 to 90, and less than 80 percent of the ideal weight. To counteract criticism that the insurance tables were out of date, revised tables are expected to be published in 1983; the new ideal weights will be 5 to 15 percent higher than the 1959 tables.

Similar comparisons can be made of the current weight contrasted to the usual weight (obtained from patient recall and subject to some error).

\[
\% \text{ Usual Body Weight} = \frac{\text{Current Body Weight}}{\text{Usual Weight}} \times 100
\]

Mild, moderate, and severe caloric malnutrition are indicated by current/usual weights of 85 to 95, 75 to 84, and less than 75 percent, respectively. Blackburn et al consider a loss of 10 percent or more of body weight over any period (except for conscious dieting) or even smaller losses over short periods, e.g., five percent in one month, as clinically significant.

\[
\% \text{ Weight Change} = \frac{\text{Usual Weight} - \text{Current Weight}}{\text{Usual Weight}} \times 100
\]

Percentage of ideal weight is not as good as percent of usual weight lost; the former will underestimate actual nutritional depletion since extracellular fluid increases in malnutrition. A significant recent weight loss will result in the individual being unable to withstand relative starvation (hospital setting), especially in the presence of stress.

Studies of weight, skinfolds, arm muscle circumference, and creatinine-height ratio are usually graded in comparison to age and sex standards. Thus values 5 to 15 percent below the standard are considered to be evidence of mild malnutrition, 15 to 25 percent moderate, and more than 25 percent below the standard as severe malnutrition.

The data from the HANES study relate body weight for age and sex to population percentiles; the data had not been analyzed for height and frame size and not intended to indicate any "ideal" weights. The same large population had percentile rankings for skinfold thickness (triceps, subscapular, and sum of both), mid-upper arm circumference, and mid-upper arm muscle area. Grant et al utilize the percentile rank of the individual's usual weight; one would predict the skinfold values and arm measurements to be at about the same percentile values. They consider a decrease of 15 to 20 percentiles from the "predicted", for the current weight, skinfolds, and arm measurements to be significant and an indication of increased risk of complications owing to malnutrition. Evaluation of percentile changes of triceps skinfolds was much better than using a percent change from a standard.

**Other Anthropometric Values**

The mid-upper arm circumference (MAC), determined at the same level as the triceps skinfold (TSF), and the arm muscle area (MAMA) are used to estimate skeletal muscle (protein) mass. Similarly, the arm fat area (AFA) may be used as an estimate of "calorie" nutrition. Certain assumptions are being made: bone area atrophies in proportion to muscle and can be neglected, arm and arm muscle areas are circular, TSF is twice the average peripheral fat thickness, and fat compressibility is the same in both sexes and in the obese. Mid-upper arm circumfer-
ence values that are between the 35 to 40 percentiles are considered typical of mild marasmus, 25 to 34 moderate, and less than the 24 percentile as severe marasmus.8,34,41

The mid-upper arm muscle circumference (MAMC) can be calculated from equation 4

\[
\text{MAMC} = \text{MAC} - \pi \text{TSF} \quad (4)
\]

in which all measurements are expressed in centimeters (the TSF is usually reported in millimeters). If the MAMC is down to 90 percent of the standard, mild nutrition is present; values of 70 to 90 percent and less than 70 percent represent moderate and severe malnutrition, respectively.47 Values for MAMC are also available as percentiles.8,34 The arm muscle area (MAMA) can be calculated from equation 5

\[
\text{MAMA} = \frac{(\text{MAC} - \pi \text{TSF})^2}{4 \pi} \quad (5)
\]

in which the TSF is again expressed in centimeters and the area is in terms of square centimeters. A simple nomogram to calculate MAMA has been published,43 and tables of percentiles are available.34,41 The nomogram43 also has values for the total arm area so subtracting the muscle area from the arm area gives the area of fat, for which percentile values are available.34

Using computerized tomography, Heymsfield et al46 showed that MAMA is overestimated by 20 to 25 percent and thus tends to underestimate the amount of muscle atrophy. They have derived correction factors to obtain the absolute amount of fat-free mid-arm muscle area: for men and women, 10 and 6.5 is subtracted, respectively, from equation 5.45 Normal ranges for corrected MAMA values are 35 to 68 and 17 to 39 cm² for men and women, respectively. The mass of muscle tissue remaining when death resulted in patients with protein-calorie malnutrition was considered to be metabolically unavailable; death usually resulted when the corrected arm muscle area fell below 9 to 11 cm².45 This minimum value of 9 cm² is also subtracted from the corrected MAMA to yield the “available” arm muscle area. The available MAMA is obtained by subtracting 19 (10 + 9) or 15.5 (6.5 + 9) for men and women, respectively, from equation 5; death resulted when the available MAMA values fell to zero levels.45

The adipomuscular ratio (AMR) is determined by dividing the skinfold thickness by the circumference of the extremity, both values determined at the same location on the arm or thigh.18 Normal biceps ratios for males and females are 0.21 and 0.48, respectively; the respective femoral ratios are 0.19 and 0.63. The ratio of the biceps and femoral values gives a quantitative index of the relative amount of fat in the upper versus the lower part of the body.18 Equal fat distributions are seen in males (android obesity) whereas the female distribution (gynoid obesity) has a predominance of fat in the femoral area.

Creatinine Excretion

In contrast to the anthropometric studies to evaluate somatic protein, the 24 hour urinary excretion of creatinine, derived from muscle creatine, is the most widely used biochemical marker. Discounting the problem associated with accurate 24 hour urine collections, creatinine excretion can predict lean body mass (LBM) as measured by ⁴²K dilution, ⁴⁰K body counting, or total body water.41 Formula 6 expresses the lean body mass in kilograms with the urinary creatinine excretion (Cr) as milligrams per day.29

\[
\text{LBM} = 7.38 + 0.02909 \text{Cr} \quad (6)
\]

Recently it was reported that a high protein diet, especially with meat diets containing creatine, resulted in increased
excretion of creatinine in normals. In children of 2 to 6 years of age, significant correlations were shown between mean creatinine excretion and height, weight, and arm circumference; the highest correlation, however, was seen with arm muscle area.

Bistrian et al had proposed a part anthropometric—part biochemical test, the creatinine-height-index (CHI), as a measure of somatic protein depletion. The expected creatinine excretion was obtained by multiplying the “mean” excretion (23 and 18 mg per kg per d for young males and females, respectively) and the “ideal” weight for “medium” frames for the height of the individual. The CHI values of 60 to 80 percent of the standard represented moderate somatic protein depletion and severe depletion was evident by values less than 60 percent. No percentile standards are available for CHI. No standards are available for the elderly; creatinine excretion normally decreases with age, resulting in values falsely suggestive of malnutrition. The CHI is more difficult to interpret in growing children since chronic malnutrition affects both weight and linear growth. The height of an individual should be verified (rather than obtaining a verbal response) since there is a decrease of about one cm per decade after age of 20 years; such decreased height is also accelerated by bone diseases.

Respice

The study of posture is one of the oldest objectives in physical education; this was probably based on the high incidence of tuberculosis at the turn of the century. The preoccupation of good posture reflecting good health interested the general public in the 1920s and 1930s. The public and private schools were concerned with selecting the most serious cases of malnutrition and undernourishment for thorough examination by a physician. The age-height-weight tables were shown to be a rather poor measure of nutritional status. The width-height tables were better predictors of nutritional status; normal weights were listed for each height and age, depending upon the bi-iliac diameter (width of pelvic crest).

The measures of children that offered an adequate picture of soft tissue in relation to skeletal build were hip width, chest depth, chest width, height, weight, arm girth, and subcutaneous tissue over the upper arm. The ACH index of nutritional status utilized three values: the sum of the circumference of the upper arm in the flexed and relaxed positions (A); the sum of the circumference of the chest in inspiration and expiration (C); and the width of the hips or bi-iliac diameter (H). All values were in centimeters and the arm and chest values for each age were compared to a series of hip values. Thus, children could be selected for referral to a physician for a study of their nutritional status.

Visceral Protein Mass

Albumin

Serum albumin (ALB) has been used in large population studies and a low level is usually associated with decreased dietary protein intake. In the clinical setting, however, it is not an accurate reflection of the nutritional state during the acute phase of infection, trauma, or stress, and the albumin is also decreased in such conditions as hepatic disease, renal failure, and a leak of protein from the gut. The sluggish response is due to the relatively long half-life (20 days) and a relatively large extracellular body pool. In addition, starvation for four to six days results in decreased blood pressure with less extravasation of albumin into the extracellular fluid space. A cut-off value of 3.0 g per dl has been used, as proposed...
for the presence of early kwashiorkor, to distinguish the possibility of sepsis, anergy, and death in hospitalized patients. In general, the serum values for mild, moderate, and severe visceral protein depletion are 2.8 to 3.5, 2.1 to 2.7, and less than 2.1 g per dl, respectively. Serum albumin values are influenced by the method of determination, water balance, state of ambulation, and time of day.

In a series of patients with renal failure, serum albumin values below 3.4 g per dl were correlated to a longer hospital stay and to infection. In critically ill patients, comparison of weight to ideal weight and the CHI failed to discriminate between survivors and non-survivors; however, a serum albumin of less than 2.5 g per dl correctly separated 93 percent of the patients in terms of survival prognosis. The serum albumin appears to be a poor index of nutritional response in cancer patients receiving total parenteral nutrition since the albumin did not increase unless exogenous albumin was administered.

Transferrin

Serum transferrin is a β-globulin that transports practically all the iron in the plasma. The half-life of transferrin (TFN) is about 8.8 days. An induction of transferrin synthesis occurs in iron deficiency, infection, and stress. It can be determined by radial immunodiffusion. Normal ranges reported are 180 to 260, 200 to 400, and 240 to 410 mg per dl. Values for transferrin representative of mild, moderate, and severe depletions are 150 to 200, 100 to 150, and less than 100 mg per dl, respectively. Transferrin is usually approximated with the total iron binding capacity (TIBC). Iron is added to saturate the transferrin and the iron concentration is then determined (TIBC). One molecule of transferrin can bind with two atoms of iron so that 100 mg of the fully saturated protein can transport 124 μg of iron, resulting in the theoretical formula 7.

\[ \text{TFN} = 0.8 \times \text{TIBC} \]  

Blackburn et al derived equation 8.

\[ \text{TFN} = 0.8 \times \text{TIBC} - 43 \]  

Formula 8 overestimates transferrin depletion and is not applicable to malnourished patients, and in cirrhosis and iron overload. A more direct relationship between TFN and TIBC is achieved with formula 9 and formula 10.

\[ \text{TFN} = 0.7 \times \text{TIBC} + 24 \]  
\[ \text{TFN} = 0.87 \times \text{TIBC} + 10 \]  

Other formulas have been derived. Each laboratory, therefore, should establish its own formula, equating its TIBC procedure with the direct method for transferrin. The discrepancies, however, will remain proportional, allowing usage of the derived transferrin values for serial evaluations.

Prealbumin

Prealbumin (PA) binds thyroxin and is a carrier protein for retinol-binding protein, with a half-life of two days. Various reported normal ranges are 16 to 30 and 20 to 36 mg per dl. Mild, moderate, and severe visceral protein depletion is indicated by values of 10 to 15, 5 to 10, and less than 5 mg per dl, respectively. It is rapidly depressed in acute situations such as trauma or infection. Though not good for prognostic values, it did show a rapid increase after nutritional support by parenteral nutrition.

Retinol-Binding Protein

This protein (RBP) of relatively low molecular mass, which transports Vitamin A in its alcoholic form (retinol) from the liver to the epithelial tissues, is bound in a constant molar ratio with
prealbumin to form a high molecular weight complex. It has a half-life of about 10 to 12 hours. It is usually determined by radial immunodiffusion but a latex immunoassay has been described. Normal values are 2.6 to 7.6, 2.5 to 6.7, and 5 to 10 mg per dl. After delivery of Vitamin A to the target cells, RBP loses its affinity for prealbumin and is filtered via the kidney, reabsorbed, and catabolized in the proximal tubular cells. Thus, serum levels may be raised in renal disease. Low levels are associated with protein-calorie malnutrition, Vitamin A deficiency, chronic liver diseases, hyperthyroidism, and cystic fibrosis.

**Fibronectin**

Fibronectin is a high molecular weight glycoprotein found in plasma, on many cell surfaces, and in most connective tissue and basement membranes. The plasma fibronectin can be distinguished from the cellular form. It has a half-life of about four hours and is believed to be the primary non-specific circulating opsonin. Plasma levels, determined by immunoassay, are depressed after physiological insults such as shock, burns, trauma, or infection. Though not derived from the liver, fibronectin responds much more rapidly than the liver markers previously discussed. In studies on obese individuals, starved for 21 days, the fibronectin levels fell significantly within the first week and remained low whereas the albumin levels did not change after 21 days of starvation. The fibronectin levels were back to normal within five days of refeeding, while the body weight was still significantly decreased.

**Immunocompetence**

Increased susceptibility to infection is one of the major complications of malnutrition. Study of immunocompetence has been advocated since impaired immunocompetence frequently precedes infection. However, the threshold of clinically relevant immunodeficiency is not too clear. Even though the results of various tests denote malnutrition, the incidence of normal reactivity in such patients in sufficiently high that prediction of skin test reactivity in an individual patient is not reliable. Various trace elements and other factors have been implicated in immunocompetence. Mice fed a diet moderately deficient in zinc had offspring with depressed immune function through the first six months of life; more striking was the fact that the second and third filial generations had some decrease of immunocompetence even though fed a normal diet.

**Total Lymphocytes**

The total lymphocytes are depressed as malnutrition progresses. The value is usually obtained from a routine complete blood count and differential; the total white blood count (WBC) is multiplied by the percentage of lymphocytes. Mild, moderate, and severe depletion are represented by counts of 1200 to 2000, 800 to 1200, and less than 800 lymphocytes, respectively.

**Rosette-forming T Lymphocytes**

T lymphocytes can be quantitated when mixed with sheep red blood cells (SRBC) treated with neuraminidase at 4°C, by counting the number of "E rosettes" (a lymphocyte with more than three SRBC attached). A new, much simpler direct immunofluorescence staining technique on whole blood, without leukocyte separation, utilizes monoclonal antibodies to identify the T cells but not the B cells. In the normal peripheral blood, about 70 to 80 percent of the lymphocytes are T cells. The proportion and absolute number of T cells are reduced by protein-energy malnutrition and rapidly reversed after nutritional supple-
EVALUATION OF NUTRITIONAL STATUS

Circulatory B cell lymphocytes can be counted when stained with fluorescein-tagged antiimmunoglobulins. 

**Delayed Hypersensitivity**

Delayed hypersensitivity (DH) is a slowly developing increase in cell-mediated (T lymphocytes) immune response to a specific antigen; the reaction requires the individual to have had prior sensitization. Therefore, a battery of antigens is employed on the assumption that most patients are likely to have reactions against at least one of the antigens. The positive reaction usually occurs 24 to 48 hours after injection of the antigen. Almost all normal individuals react positively to Candida extract; others commonly used are purified protein extract of tuberculin, histoplasm, streptokinase-streptodornase preparations, mumps vaccine, and tetanus toxoid. If none of the antigens causes a response, deliberate immunization is attempted with dinitrochlorobenzene or keyhole limpet hemocyanin. Complete absence of reaction (anergy) is a significant abnormal finding; relative anergy is probably of little consequence.

There is no consensus regarding the interpretation of reactivity. An inflammatory induration of at least five mm in diameter is considered a positive (normal) response. Mullen and his colleagues grade the delayed hypersensitivity as zero for nonreactive (anergy), one if the induration is less than five mm, and two if the induration exceeds five mm in any of three recall antigens. Skin testing may be unreliable if the patient has had recent anesthesia and surgery or is receiving corticosteroids or immunosuppressive drugs. Anergy may also result from old age, cancer, sepsis, shock and major trauma.

**Prognostic Index**

Various laboratory studies plus the anthropometric and biochemical studies discussed previously were done on a group of 71 cancer patients and 21 younger controls (benign lesions and minor surgery). There were significant differences between the two groups; however, among the cancer patients who developed postoperative infection, only ceruloplasmin and delayed hypersensitivity reactions were significantly different.

In general, caloric restriction decreases tumor incidence whereas obesity and high dietary fat are associated with an increased incidence; but no study has documented acceleration of tumor growth in a human by nutritional support. Although protein stores are depleted in cancer patients, they can conserve nitrogen unless stress is superimposed. Mullen and coworkers were able to isolate four parameters to formulate a prognostic nutritional index (PNI) which could predict the probability of a patient having a major complication (mostly infections) or not surviving. The prognostic index, expressed as percent (Equation 11, written with parameters in decreasing order of importance), has albumin in grams per deciliter, transferrin in milligrams per deciliter, delayed hypersensitivity graded as 0, 1, or 2, and triceps skinfold in millimeters.

\[
PNI = 158 - 16.6 \text{ALB} - 0.2 \text{TFN} - 5.8 \text{DH} - 0.78 \text{TSF}
\]

Classification as to risk was as follows: low risk, PNI less than 40 percent, intermediate 40 to 49, and high risk equal to or greater than 50 percent. In another publication, their classification for predicted outcome is less than 30, 30 to 59, and equal to or greater than 60 percent for the low, intermediate, and high risk predictions. These parameters are biological measurements and not a nutritional assessment per se. The PNI does provide a strong basis for recommending nutri-
tional intervention in severely ill patients.47 Nutritional support of the malnourished cancer patient is safe, is effective in countering some of the cancer cachexia, and produces an improved quality of life.23

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References