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Nutritional Assessment

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Nutritional health is maintained by a state of equilibrium in which nutrient intake and requirements balance. Malnutrition occurs when net nutrient intakes (nutrient intake corrected for abnormally large fecal or urinary losses) is less than requirements. Malnutrition leads to a succession of metabolic abnormalities, physiologic changes, reduced organ and tissue function, and loss of body mass. Concurrent stress such as trauma, sepsis, inflammation, and burns accelerates loss of tissue mass and function. Ultimately, critical loss of body mass and function occur and result in death.

The evaluation of the nutritional status is a broad topic, and to be of clinical importance the ideal method should be able to predict whether the individual would have increased morbidity and mortality in the absence of nutritional support. In short, can it predict the occurrence of nutrition-associated complications and thus predict outcome? Unfortunately, disease and nutrition interact so that disease in turn may cause secondary malnutrition or malnutrition may adversely influence the underlying disease. Thus, patient outcomes are multifactorial, and attempting to formulate the influence of malnutrition on outcome based on single parameters or simple models fails to consider the many interacting factors. This complexity has been recognized in the recent recommendations by the American Dietetic Association.[1]

Traditional nutritional science was first developed in the field of agriculture, where the effect of nutrition was judged entirely by the amount of meat on the carcass of animals and the production of proteins by the liver. This approach was embodied in the initial attempts to assess nutritional status in humans as given under "traditional nutritional assessment indices." These techniques lacked the ability to predict outcome and to detect early changes in function that occur with nutritional support.

For nutritional assessment to be clinically useful, it is necessary to examine each of the proposed methods by asking the following questions:

1. Does the method specifically assess the risk of morbidity and mortality resulting from malnutrition?
2. Does it identify and separate the causes and consequences of malnutrition and disease in the individual patient?
3. Can the technique determine whether the patient will clinically benefit from nutritional support?

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TRADITIONAL NUTRITIONAL ASSESSMENT INDICES

Nutritional status has been traditionally defined by body composition, plasma-protein concentrations, immune competence, and multivariate analysis.[2,3]

Assessment of nutritional status based on body composition involves detecting the loss (or gain) of body components relative to previous measurements and relating the values in a given patient to normal standards. The former is affected by the reproducibility and error in the measurements themselves, and the latter is dependent on the normal range of values. A person who starts off at the upper end of the normal range may be classified as "normal" despite considerable changes in the measured value. Therefore, it is possible for a person to be in a negative nutritional state for a long time before anthropometric measurements fall below normal.

Body Weight and Weight Loss

Body weight is a simple measure of total body components and is compared to an "ideal" or desirable weight. This comparison can be made by using formulas such as the Hamwi formula or to tables. However, a simple approach that gives as much information as tables is the calculation of the body mass or Quetelet index (BMI). BMI is calculated as weight in kilograms divided by height in meters squared. A BMI of 14–15 is associated with significant mortality. However, measurements of body weight in patients in hospitals and intensive-care units and in those with liver disease, cancer, and renal failure are confounded by changes in body water due to underhydration, edema, ascites, and dialysate in the abdomen.

Unintentional weight loss greater than 10% is a good prognosticator of clinical outcome.[4,5] However, it may be difficult to determine true weight loss. Morgan et al.[6] showed that the accuracy of determining weight loss by history was only 0.67 and the predictive power was 0.75. Hence, 33% of patients with weight loss would be missed, and 25% of those who have been weight stable would be diagnosed as having lost weight. Furthermore, the

nutritional significance of changes in body weight can be confounded by changes in hydration status.

Anthropometry

Triceps and subscapular skinfold thicknesses provide an index of body fat, and mid-arm muscle circumference provides a measure of muscle mass. Although these measurements seem to be useful in population studies, their reliability in individual patients is less clear. The most commonly used standards for triceps skinfold thickness and mid-arm muscle circumference are those reported by Jelliffe,[7] which are based on measurements of European male military personnel and low-income American women, and those reported by Frisancho,[8] which are based on measurements of white males and females participating in the United States Health and Nutrition Survey between 1971 and 1974. The use of these standards to identify malnutrition in many patients is problematic because of the restricted database and the absence of correction factors for age, hydration status, and physical activity on anthropometric parameters. Several studies have demonstrated that 20–30% of healthy control subjects would be considered malnourished based on these standards[9,10] and that there is poor correlation between the standards of Jellife and by Frisancho in classifying patients.[10] Although attempts have been made to create standards for diseases in dialysis patients,[11] the validity of standards have been questioned and interpretation of the data may be limited by interrater variability.[12] Hall et al.[13] found considerable inconsistencies when anthropometric measurements were performed by three different observers. The coefficient of variation was 4.7% for arm circumference and 22.6% for triceps skinfold thickness. Therefore, a change in arm muscle circumference (arm circumference minus triceps skinfold thickness) of at least 2.68 cm was needed to demonstrate a true change in a given patient. These considerations in particular apply to patients in intensive-care units and in those with liver and renal disease where edema is a major problem in assessing skinfold and arm circumference.

Creatinine-Height Index

The excretion of creatinine in the urine is related to muscle mass. Normalized for height, the 24-h creatinine excretion is an index of muscle mass. In theory, it is a good and simple way of assessing the lean body mass. However, it is dependent on complete 24-h urine collections and urinary losses, or oliguria may result in an inappropriate diagnosis of malnutrition. Patients on diuretics such as those with cardiac and liver failure and those with renal disease are especially likely to have low excretions of creatinine.

Albumin

This protein is one of the most extensively studied, and over the past 30 y there have been about 19 000 citations to it in the *Index Medicus*! Several studies have demonstrated that a low–serum-albumin concentration correlates with an increased incidence of medical complications.[14–16] In addition, a low serum albumin is associated with increased mortality in general; examples include elderly nursing-home patients[17] and dialysis patients.[18] An understanding of albumin physiology clarifies the reason serum albumin concentration correlates with disease severity in hospitalized patients but may be inappropriate as a measure of nutritional status per se.[19] For example, albumin levels fail to increase in patients with cancer after 21 d of intensive nutritional therapy[20] and in nursing-home patients after enteral feeding through a gastrostomy.

Prealbumin

Prealbumin is a transport protein for thyroid hormones and exists in the circulation as a retinol-binding–prealbumin complex.[21] The turnover rate of this protein is rapid, with a half-life of 2–3 d. It is synthesized by the liver and is catabolized partly in the kidneys. Protein-energy malnutrition reduces the levels of prealbumin, and refeeding restores levels.[22] However, prealbumin levels fall without malnutrition in infections[23,24] and in response to cytokine[25] and hormone infusion.[26] Renal failure increases,[27] and liver failure may cause decreased levels. Although prealbumin is responsive to nutritional changes, it is influenced by several disease-related factors, making it unreliable as an index of nutritional status in patients.

Immune Competence

Immune competence, as measured by delayed cutaneous hypersensitivity (DCH), is affected by severe malnutrition. Although it is true that immune competence as measured by DCH is reduced in malnutrition, several diseases[28] and drugs influence this measurement, making it a poor predictor of malnutrition in sick patients. The following factors nonspecifically alter DCH in the absence of malnutrition: 1) infections (viral, bacterial, and granulomatous); 2) uremia, cirrhosis, hepatitis, trauma, burns, and hemorrhage; 3) steroids, immunosuppressants, cimetidine, warfarin, and perhaps aspirin; and 4) general anesthesia and surgery. Hence, in the critically sick patient, many factors can alter DCH and render it valueless in assessing the state of nutrition. Meakins et al.[29] showed that simply draining an abscess can reverse anergy. Therefore, immunity is neither a specific indicator of malnutrition nor is it easily studied.[30]

Serum Cholesterol

Low levels are seen in malnourished patients. However, very low levels are seen in patients with liver disease, renal disease, and malabsorption. In addition, low levels correlate with mortality.[31]

Discriminant Analysis

Buzby et al.[32] developed a prognostic nutritional index, calculated retrospectively from multiple parameters, to predict the occurrence of complications. It depends largely on the levels of plasma albumin and transferrin. In a prospective study, the prognostic nutritional index, measured in patients before gastrointestinal surgery, was found to provide a quantitative estimate of postoperative complications.

BEDSIDE CLINICAL ASSESSMENT—SUBJECTIVE GLOBAL ASSESSMENT

A clinical method for evaluating nutritional status, termed *subjective global assessment* (SGA), encompasses historical, symptomatic, and physical parameters.[33,34] This approach defines malnourished patients as those who are at increased risk for medical complications and who will presumably benefit from nutritional therapy. The basis of this assessment is to determine whether nutrient assimilation has been restricted because of decreased food intake, maldigestion, or malabsorption, whether any effects of malnutrition on organ function and body composition have occurred, and whether the patient's disease process influences nutrient requirements.

The history used in the SGA focuses on five areas. The percentage of body weight lost in the previous 6 mo is characterized as mild (<5%), moderate (5–10%), and severe (>10%). The pattern of loss is also important, and it is possible for a patient to have significant weight loss but still be considered well nourished if body weight (without edema or ascites) recently increased. For example, a patient who has had a 10% body weight loss but regained 3% of that weight over the past month would be consid-

ered well nourished. Dietary intake is classified as normal or abnormal as judged by a change in intake and whether the current diet is nutritionally adequate. The presence of persistent gastrointestinal symptoms such as anorexia, nausea, vomiting, diarrhea, and abdominal pain, which have occurred almost daily for at least 2 wk, is recorded. The patient's functional capacity is defined as bedridden, suboptimally active, or full capacity. The last feature of the history concerns the metabolic demands of the patient's underlying disease state. Examples of high-stress illnesses are burns, major trauma, and severe inflammation such as acute colitis. Moderate-stress diseases might be a mild infection or limited malignant tumor.

The features of the physical examination are noted as normal, mild, moderate, or severe alterations. The loss of subcutaneous fat is measured in the triceps region and the midaxillary line at the level of the lower ribs. These measurements are not precise but are merely a subjective impression of the degree of subcutaneous tissue loss. The second feature is muscle wasting in the temporal areas and in the deltoids and quadriceps, as determined by loss of bulk and tone detectable by palpation. A neurologic deficit will interfere with this assessment. The presence of edema in the ankle and sacral regions and the presence of ascites are noted. Coexisting disease such as renal or congestive failure will modify the weight placed on the finding of edema. Mucosal and cutaneous lesions are recorded, as are color and appearance of the patient's hair.

The findings of the history and physical examination are used to categorize patients as being well nourished (category A), having moderate or suspected malnutrition (category B), or having severe malnutrition (category C). The rank is assigned on the basis of subjective weighting. Equivocal information is given less weight than definitive data. Fluid shifts related to onset or treatment of edema or ascites must be considered when interpreting changes in body weight. In general, a patient who has experienced weight loss and muscle wasting but is currently eating well and is gaining weight is classified as well nourished. A patient who has experienced moderate weight loss, continued compromised food intake, continued weight loss, progressive functional impairment, and has a moderate-stress illness is classified as moderately malnourished. A patient who has experienced severe weight loss, continues to have poor nutrient intake, progressive functional impairment, and muscle wasting is classified as severely malnourished independent of disease stress. Baker et al.[35] and Detsky et al.[36] found that the use of SGA in evaluating hospitalized patients gives reproducible results, and there was more than 80% agreement when two blinded observers assessed the same patient.

Case 1

A 60-y-old woman was admitted to the hospital for elective resection of a colon carcinoma. She had lost 10% of her initial weight over 8 mo before admission. However, she recently gained weight after therapy with nutritional supplements was initiated. She continued to work and was active. On physical examination, there was no loss of muscle or fat. She is SGA A.

Case 2

A 40-y-old man with an acute exacerbation of Crohn's disease had lost 10% of his body weight within the previous 2 wk and was ingesting mostly liquids to avoid gastrointestinal discomfort. He was ambulatory but was not going to work. On physical examination, he had slight loss of subcutaneous tissue manifested by a reduced buccal fat pad and loose skin folds over the arms. He is SGA B.

Case 3

A 67-y-old man with esophageal cancer had minimal food intake for almost 3 mo. He lost 15% of his body weight during the previous 4 mo and is continuing to lose weight. He was able to move around the house but had marked muscle weakness and fatigue and did not walk outdoors. On physical examination, he lacked subcutaneous tissue and had hollow temples, deltoid wasting, and mild pitting edema. He is SGA C.

How does SGA compare with traditional methods described above? To make a meaningful comparison, Detsky et al.[37] compared the predictive accuracy of the different techniques done on the same individuals in a prospective analysis of 59 surgical patients. In that study, preoperative SGA was a better predictor of postoperative infectious complications than serum albumin, serum transferrin, delayed cutaneous, hypersensitivity, anthropometry, creatinine-height index, and the prognostic nutritional index. Combining SGA with some of the "traditional" markers of nutritional status increased the ability to identify patients who developed complications (from 82 to 90%) but also increased the percentage of patients identified as malnourished but who did not develop a postoperative complication (from 25 to 30%). Therefore, increasing assessment sensitivity also increases the number of patients who might receive unnecessary nutrition support. How does SGA perform in predicting complications in conditions other than preoperative patients? In studies done by others, it has been used and shown to predict complications in general surgical patients,[38] patients on dialysis,[39–41] and liver transplant patients.[42,43]

At present, there is no "gold standard" for evaluating nutritional status, and the reliability of any nutritional assessment technique as a true measure of nutritional status has never been validated. No prospective controlled clinical trials have demonstrated that providing nutrition support to patients judged to be malnourished influences clinical outcome. However, a retrospective subgroup analysis of a large multicenter trial found that parenteral nutrition given preoperatively to patients diagnosed as severely malnourished by SGA or a nutritional risk index (based on serum-albumin and body-weight change) decreased postoperative infectious complications (Veterans Administration study). I recommend that nutritional assessment involve a careful clinical evaluation with additional laboratory studies as needed to help determine specific nutrient deficiencies or severity of illness. This information should be used in a prognostic fashion to decide which patients might benefit from nutritional therapy.

FUNCTIONAL TESTS OF MALNUTRITION

SGA identifies patients at risk of complications by clinically assessing changes in intake of food and in body composition and function. Functional impairment in malnutrition has been studied by examining changes in immune function[30] in ability to perform work in an ergometer,[44] and of heart rate during maximal exercise.[45] The use of exercise tolerance by ergometers and measurement of heart rate are useful for population studies but difficult for sick patients with cardiorespiratory impairment and for patients under intensive care. They also are dependent on the previous exercise status of the individual. An early study showing the role of impaired function in predicting postoperative complications was performed by Klidjian et al.[46] They showed that the strength of the hand grip was predictive of the development of postoperative complications. However, the direct relation of dietary intake to function as a measure of the effect of nutritional manipulation was shown by Russell et al.[47] To study critically ill patients, it was necessary to develop a method that did not require the cooperation of the patient and was not non-specifically affected by sepsis, drugs, trauma, surgical intervention, and anesthesia. To do this, a method developed by Edwards[48] was selected to study muscle fatigue. It consisted of measuring the contraction of the adductor pollicis muscle in response to an electrical stimulus of the ulnar nerve at the wrist. When the nerve is stimulated at this site with unidirectional square-wave pulses lasting only 50–70 μs at a range of frequencies from 10 to 50 Hz, there is a progressive increase in

force, with a maximal force attained at 50 Hz. The plotted results constitute a force-frequency curve. In addition, when the nerve is stimulated at 20 Hz for 2 s and then the stimulus is switched off, the muscle relaxes after the initial contraction, and the rate of this relaxation can be measured. If the stimulus at 20 Hz is continued, any loss of power represents fatigue of an objective nature (not due to voluntary relaxation). By studying two pure models of human starvation and refeeding, namely the starving obese subject and the anorexic patient being refed, we showed that starvation causes the ratio of the force at 10 Hz to 50–100 Hz to double and the relaxation rate to slow from a mean of about 10% of maximal force lost every 10 ms to 5–6%. In addition, we showed the development of fatigue. Refeeding corrected these changes before gain in body nitrogen.[49] In other studies, Lenmarken et al.[50] considered the relaxation rate to be a good index of the nutritional status. More importantly, Zeiderman and McMahon[51] showed that in a group of preoperative surgical patients the combination of an abnormal force-frequency curve and slow relaxation rate was the most specific and sensitive predictor of nutritionally associated complications when compared with other parameters of nutritional status such as hand-grip strength, arm-muscle circumference, and albumin and transferrin levels. Windsor and Hill[52] recently showed that muscle function including hand grip, respiratory muscle strength, and relaxation rate of the adductor pollicis were the main indicators of surgical complications rather than weight loss. In patients with inflammatory bowel disease, Christie and Hill[53] confirmed our earlier observation that muscle function is restored before body composition. They showed early restoration of muscle function before significant increase in body protein. Furthermore, Chan et al.[54] demonstrated that intravenous feeding rapidly restores muscle function in preoperative malnourished patients.

It is clear from these findings that there is good evidence that muscle function is an index of nutritional changes and of the risks of complications in the sick individual. Preliminary studies suggest that the function changes rapidly on feeding; however, it is not clear whether the restoration of function is associated with an improvement in outcome. Studies by Hill et al. suggest that grip strength, respiratory muscle strength, and function by electrical stimulation all demonstrate changes with nutrition. The question is, Which one or ones should be used for assessment? The studies by Ziederman and McMahon[51] suggest that electrical stimulation has greater predictive power than grip strength. Also, respiratory muscle strength needs elaborate instrumentation in a pulmonary function laboratory, good cardiorespiratory status, and cooperation. Therefore, we feel that the relaxation rate of single twitches may be a simple, non-invasive, and reproducible way of studying function in sick patients.

MEASUREMENT OF BODY COMPOSITION

The body consists of compartments or components. There are more than 35 well-recognized components, and these are organized into five levels of increasing complexity: atomic, molecular, cellular, tissue system, and whole body. In healthy weight-stable subjects, there are relatively constant relationships between these components, which are correlated with each other. For example, the atomic-level component nitrogen is 16% of the molecular-level component protein.

Isotope Dilution

Total body water, measured by isotope dilution, is usually the largest molecular-level component. Water maintains a relatively stable relationship to fat-free body mass; thus, measured water-isotope-dilution volumes allow prediction of fat-free body mass and fat (i.e., body weight minus fat-free body mass). The relation between total body water and other body-composition components may change with disease, and this should be considered when interpreting data from hospitalized or chronically ill patients. The usual approach is to measure a dilution volume with one of three isotopes: tritium, deuterium, or of 18O-labeled water. This first step allows estimation of a dilution volume of one of the three isotopes. In the second step, it is assumed that the proportion of fat-free body mass to water is constant at 0.732, which allows calculation of fat-free body mass and fat. The relation to outcome has not been studied.

Bioimpedance Analysis

Bioimpedance analysis is a method of estimating body fluid volumes by measuring the resistance to a high-frequency, low-amplitude alternating electric current (50 kHz at 500 to 800 mA). The amount of resistance measured is inversely proportional to the volume of electrolytic fluid in the body and, to a lesser extent, on the proportions of this volume. A regression equation is then developed between a reference measurement of fat-free body mass (i.e., isotope dilution) and the measured resistance, height, and other variables. Recent research in this area is focused on separate measurements of extra- and intracellular water. In healthy adults, it is possible to predict total body water within 2–3 L. Many more variable results are observed in diseased patients, in part because of the population specific nature of bioimpedance analysis. The relation to outcome has not been studied in hospitalized patients, and the method has not been fully validated for use in all disease states.

Dual-Energy X-ray Absorptiometry

Dual-energy x-ray absorpiometry (DXA) is a method developed originally for the measurement of bone density and mass. Systems today also quantify soft-tissue composition, and it possible to measure total and regional fat, bone mineral, and bone-mineral-free lean components with DXA. The method is based on the attenuation characteristics of tissues exposed to x-rays at two peak energies. Mathematical algorithms allow calculation of the separate components using various physical and biological models.

Software can be used to measure regions separately, if desired. A typical whole-body scan takes approximately 30 min and exposes the subject to approximately 1 mrem of radiation. The method provides the first accurate and practical means of measuring bone-mineral mass and offers a new opportunity to study appendicular muscle mass. There are no data indicating whether DXA can predict outcome in hospital patients.

Whole-Body Counting/Neutron Activation

The elements K, N, P, H, O, C, Na, Cl, and Ca can be measured with a group of techniques referred to as whole-body counting/in vivo neutron activation analysis. Shielded whole-body counters can count the γ-ray decay of naturally occurring 40K. The method is safe and can be used in children and pregnant women. The 40K counts can be used to estimate total body potassium, which in turn can be used to calculate body-cell mass and fat-free body mass. Prompt γ-neutron activation analysis can be used to measure total body N and H. Nitrogen can be used to calculate total body protein. Delayed γ-neutron activation measures total body Ca, Na, Cl, and P. These elements can be used to calculate bone-mineral mass and extracellular fluid volume. Lastly, inelastic neutron scattering methods measure total body O and C. Carbon is useful in models designed to quantify total body fat. Whole-body counting neutron activation methods are important because they provide a means of estimating all major chemical components in vivo. These methods are considered the standard for evaluating the body-composition components of nutritional interest, including body-cell mass, fat, fat-free body mass, skeletal muscle mass, and various fluid volumes. Refeeding the malnourished subject by

mouth or by total parenteral nutrition results in a rapid increase in TBK but not TBN. Animal studies have shown that this increase in TBK is the result of improved membrane voltage and an increase in the intracellular ionic potassium. The findings are consistent with improved cell energetics demonstrated by NMR spectroscopy and the improved muscle function shown concurrently. Loss of TBK is a good predictor of poor outcome in a variety of conditions associated with malnutrition.[55–58]

Computerized Axial Tomography and Magnetic Resonance Imaging

These methods measure components at the tissue-system level of body composition, including skeletal muscle, adipose tissue, visceral organs, and brain. Computerized axial tomography systems measure x-ray attenuation as the source and detector rotate in a perpendicular plane around the subject. Magnetic resonance imaging systems measure nuclear relaxation times from nuclei of atoms with magnetic moments that are aligned within a powerful magnetic field. Clinical systems are based on hydrogen, although it is possible to create images and spectrographs from phosphorus, sodium, and carbon. The collected data are transformed into high-resolution images, and this allows quantifying whole-body or regional-body composition. A large number of studies in phantoms, cadavers, and in vivo has validated these methods. There are no studies of imaging methods in relation to outcome.

CONCLUSIONS

The term *malnutrition* describes a continuum that starts when the patient fails to eat enough to meet needs and progresses through a series of functional changes that precede any changes in body composition related to the duration of reduced intake and its severity. To base the definition of malnutrition on any one of these changes is inappropriate. Only by recognizing the different facets of malnutrition can we define its various manifestations in relation to our clinical objectives. At present, SGA combined with selected objective parameters provide the best clinical way of meeting these objectives. In the future, muscle function may be useful in determining optimal nutrient intake early in the course of feeding. Techniques such bioimpedance analysis, DEXA, and magnetic resonance imaging combined with spectroscopy may provide powerful tools in the future.

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Malnutrition, Disease, and Outcome

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DEFINITION—MALNUTRITION AND DISEASE

The lack of a standard definition of malnutrition has given rise to much confusion in the literature, particularly that concerning the benefits of nutrition support. *Malnutrition* is a broad term that can be used to describe any disorder of nutrition, from the diseases of the developed world caused by overnutrition to the extremes of undernutrition found in our hospitals or marasmus and kwashiorkor in recent African famines. It can also be used to describe unbalanced nutrition with one or more micronutrient or mineral deficiencies.

The present discussion is confined largely to the subject of undernutrition, and I propose to adopt a practical clinical definition: "A state of energy, protein or other specific nutrient deficiency which produces a measurable change in body function, and is associated with a worse outcome from illness as well as being specifically reversible by nutritional support." Even this definition is incomplete, in terms of clinical practice, because it excludes conditions of "suboptimal nutrition." Supposing a normal individual, without disease or prior malnutrition, fasts for 24 h and is then called upon to undertake some major athletic event. His diminished glycogen stores will result in diminished muscular performance. Similarly, Ljungqvist and his colleagues[1,2] showed that overnight preoperative fasting in a previously well-nourished individual causes increased postoperative insulin resistance and negative nitrogen balance. Conversely, a glucose drink, given 2 h before operation, reduces postoperative insulin resistance and catabolic response and improves clinical outcome and reduces hospital stay. In both these situations, fasting produces changes that cause no problem unless the subject is faced with a metabolic challenge. The term *suboptimal nutrition* may also be used to describe those extremes of critical illness or trauma in which the endogenous supply of substrates such as glutamine become rate limiting. Such substrates can then become conditionally essential. Supplements of these substrates are not given to correct any state of prior malnutrition but to help the patient surmount an unusual metabolic challenge. Improved outcome from the use of glutamine[3,4] and so-called immune-enhancing diets[5] have been described in these circumstances. Another condition in which, despite the absence of significant current undernutrition, the patient is nonetheless at nutritional risk occurs with the onset of an acute disease that threatens normal food intake for a prolonged period. This may occur, for example, after major abdominal injury, in stroke with dysphagia, or when complications occur after abdominal surgery. The careful monitoring of nutritional intake under these circumstances will reveal its adequacy or otherwise and help to determine early intervention to prevent malnutrition developing.

The definition of malnutrition is made even more confusing in the literature when nutrition parameters such as weight loss are combined with values of parameters such as hemoglobin and serum albumin, which reflect severity of illness, in so-called nutrition indices.[6] Undoubtedly these indices predict surgical risk and therefore should be termed *risk* rather than *nutrition* indices.[7] Indeed, the serum albumin is an independent predictor of mortality in a wide range of clinical conditions,[8] although it is quite possible to die of pure starvation, e.g., from anorexia nervosa, with a normal serum-albumin concentration. The distinction between malnutrition and disease severity is further illustrated by Tucker's audit review of malnutrition in American hospitals,[9] in which he showed that patients with a high nutrition-risk score had a hospital stay 5 to 6 d longer than those at low risk and, further, that 80% of the difference related to disease severity and only 20% to malnutrition per se. Despite this finding, his data showed the benefit of early nutrition intervention with a 1-d reduction in hospital stay for every 2 d earlier intervention after hospital admission.

The recently published Danish Guidelines for Nutrition in Hospitals[10] proposes a system of nutrition-risk assessment in which nutrition and disease factors are scored from 0 to 3 separately but then are combined to give a risk score with a maximum of 6. This recognizes the interrelationship and vicious circle of nutrition and disease in which moderate malnutrition, which may

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