Diagnosing malnutrition

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SUMMARY The measurement of selected anthropometric, biochemical and immunological variables, and clinical judgment can be used to assess nutritional state. Nutritional assessment has three main aims: to define the type and severity of malnutrition; to identify high risk patients; to monitor the efficacy of nutritional support. The problems associated with the various methods to assess the nutritional state and the applications of nutritional assessment in clinical practice are presented and discussed.

There are now many studies which have suggested that malnutrition is one of the major causes of increased morbidity and mortality in inpatients.¹⁻⁴ In reality such a conclusion may be an oversimplification, particularly when malnutrition occurs as a direct result of the underlying disease process. Thus it could equally be argued that outcome is influenced more by the underlying disease than by nutritional state. Does it matter, therefore, that a considerable proportion of medical and surgical inpatients suffer from protein energy malnutrition secondary to their underlying disease, and why do we believe that clinicians should be able to diagnose malnutrition? The fact is that as a group, malnourished patients suffer increased morbidity and mortality, and what is required is a test or a combination of tests that will allow high risk patients to be identified, not only so the clinician can be alerted to the need for nutritional support, but also so that research can be performed in conjunction with the administration of nutritional support in these patients.

Various anthropometric, biochemical, and immunological variables have been used as indicators of protein energy malnutrition, and this paper reviews these tests. Unfortunately, the relative value of each of these measurements has not been clearly defined, and few studies have, as yet, taken nutritional assessment to its logical conclusion: the application of the information gained to change patient management. At present, nutritional assessment has three aims. The first is to define the type and severity of malnutrition; the second is the identification of high risk patients; and the third is to monitor the efficacy of nutritional support.

Defining the type and severity of malnutrition

Anthropometric and biochemical measurements are usually performed to define type and severity of malnutrition. Body weight, weight:height ratio, triceps skinfold arm circumference, arm muscle area and arm fat area are the most commonly used variables. The major difficulty encountered in the evaluation of anthropometric data is the definition of normality or referral values, or both.⁵ For anthropometric data the most commonly used standards are the "Davenport Table," the Metropolitan Life Insurance Company Table, and in the United States of America the Table adapted from the Health and Nutrition Examination Survey.

The values used for skinfold, arm circumference and derived areas have been those proposed by individual experts, based mostly on their personal experience, which varies from one population to another because of racial differences. This raises the question of whether there can be useful standards for international population studies. It has been suggested that they must be national, or even better, regional,⁵ if there are great differences in a nation. A broad panel of biochemical variables has also been advocated to provide useful nutritional information. No single indicator has proved better than any other; nevertheless, serum albumin concentration is the most widely used determination. A recent survey of 13 European centres with recognised experience in surgical nutrition showed that the biochemical variables determined were predominantly serum albumin concentration (100%) and transferrin (85%). To a lesser extent, the concentrations of prealbumin, retinol binding protein, and ceruloplasmin were also used.¹

Plasma fibronectin has recently been included in the nutritional assessment of undernourished patients.⁶ It is an opsonic glycoprotein of molecular

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weight 440 000. It modulates reticuloendothelial clearance of non-bacterial test particles, fibrin monomer, and some bacterial species.⁷ Fibronectin depletion correlates with reticuloendothelial phagocytic clearance depression, and restoration of circulation concentrations is associated with restoration of reticuloendothelial function.⁸ Opsonic fibronectin deficiency exists in septic injured patients with host defense failure.⁹ It has been shown that during starvation serum fibronectin values fall by 25–30%, and after refeeding increase to normal values.¹⁰ For this reason this protein also has been proposed as a sensitive index of nutritional depletion and repletion.

All these biochemical evaluations should be critically interpreted as their variations are not always secondary to decreased synthesis derived from undernutrition but could be the result of abnormal distribution in the extravascular space, or increased catabolism, or net loss, or a combination.¹¹

Identification of high risk patients

The prognostic importance of nutritional assessment is another important factor in the evaluation of nutritional state. In fact, many studies have documented the associations between malnutrition, morbidity, and mortality.^{1–4} Nevertheless, standardised nutritional variables are not yet available in clinical practice for identifying high risk patients. No single variable has been shown to have a predictive value by itself, whereas different workers have proposed the calculation of different prognostic indexes by combining several different markers of nutritional state.

Buzby and Mullen¹² identified four factors related to nutritional state (serum albumin, serum transferrin, triceps skinfold thickness, and delayed hypersensitivity), which have a prognostic value in identifying those patients at risk. This formula has been modified and abbreviated by Simms,¹³ who used a population of patients from the Sheffield area to identify with equal success patients at risk of postoperative complications. Klidjian has shown that reduced arm muscle circumference and impaired skeletal function measured by forearm muscle dynamometry have also been positively correlated with an increased risk of postoperative complications.¹⁴ Ingenbleek and Carpentier recently proposed a new prognostic inflammatory and nutritional index for categorising critically ill patients, which is based on the determination of the two most sensitive acute phase reactants (orosomucoid and C-reactive protein).¹⁵ In their hands the scoring system provided a reliable tool for the

diagnosis and prognosis of critically ill patients. Several immunological variables have been proposed to identify the patient prone to infection.^{16–18} Absolute blood lymphocyte counts and delayed hypersensitivity skin testing are the more commonly used tests,¹⁷ but the results obtained with these indicators are conflicting and debatable.¹⁹

In our centre the delayed hypersensitivity of preoperative cancer patients was studied to evaluate possible associations between delayed hypersensitivity reactions, malnutrition, and postoperative infections.¹⁸ The skin from 177 patients with the preoperative diagnosis of cancer was tested before surgery with recall antigens (purified protein derivative, trichophyton, candida, and streptokinase-streptodornase) and with epicutaneous sensitisation and challenge with the primary antigen DNCB. The overall responses were graded as normoergic, hypoergic, or anergic. To identify possible causes of anergy and infection the other variables considered were preoperative serum albumin concentration, tumour stage, duration of anaesthesia, and operative contamination.

Forty one per cent of the patients were normoergic, 50% hypoergic, and 9% anergic. One or more infectious episodes occurred in 36% of the normoergic patients, in 49% of the hypoergic patients, and in 86% of the anergic patients. The incidence of infection in anergic patients was significantly higher than that in normoergic or hypoergic patients. Albumin concentration was significantly lower in anergic than in normoergic patients. No correlation was found between the response to the skin tests and the stage of tumour. The incidence of respiratory infection was significantly higher when the duration of anaesthesia was longer than two hours. In normoergic patients the degree of operative contamination was associated with a significantly higher incidence of infection, whereas in anergic patients the incidence of infection did not differ between clean and contaminated procedures. It is clear, therefore, that patients with cancer who are preoperatively anergic to skin tests present a higher risk of developing postoperative infections, regardless of the degree of contamination. This study also indicated that nutritional deficiency may influence some aspects of the immunological process, which may contribute to the development of infection, or its progression.

One of the most consistent features of the body's response to tissue damage is represented by a transient but substantial change in the concentration of several plasma proteins. Post-traumatic metabolic changes do not acutely affect all proteins,²⁰ but some of them (mainly glycoproteins) increase in the plasma and, therefore, they have been defined as

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acute phase proteins. About 30 acute phase proteins have been identified either in man or in experimental animals. Acute phase proteins are heterogeneous from the point of view of their physicochemical and biological properties (molecular weight, site and rate of synthesis, half life, electrophoretic migration), and they present many different and sometimes opposite biological effects.^{11 21} Experiments by Miller and John²² showed that liver synthesis of plasma proteins is finely regulated by nutritional and hormonal factors. These authors showed that in the isolated perfused rat liver the combination of amino acids, glucose, and insulin was necessary to obtain positive nitrogen balance; moreover, the optimal conditions for the maximum synthesis of acute phase proteins (fibrinogen, α -1-acid glycoprotein, and haptoglobin) were found when the liver came from a fed donor animal and when a nutritionally complete intravenous solution was infused.

The synthesis of albumin is also known to be depressed during malnutrition and under catabolic conditions: it has been shown experimentally, however, that after a six day fasting period albumin synthesis is proportionately more depressed than that of acute phase proteins.^{23 24} It may, therefore, be speculated that in catabolic states the synthesis of acute phase proteins has priority, and this might partly account for some of the features of the plasma protein profile observed during the acute phase response after injury. It is well known that malnutrition negatively affects protein synthesis, and it has been shown in man that nutrition is probably the single most important factor regulating albumin synthesis.²³

Almost all of the proposed indices have some value in predicting those patients at risk of developing major postoperative complications, even if no clear scientific evidence has proved that these formulae are any better than the clinical judgment of an expert physician.²⁵ Another possible criticism of most of those studies that try to correlate predictive indices and postoperative septic complications is the discrepancy shown by different authors in defining infectious complications and in scoring their severity. It has recently been proposed that systems to score severity of sepsis should be used in all the clinical studies that consider infectious complications in surgical patients.²⁶⁻²⁸

To collect information on the predictive value of each of the many nutritional variables for identifying high risk surgical patients we used a mathematical approach, applying a cluster analysis technique.²⁹ Using this method, it is possible to identify four nutritional states, which could be depicted in a multidimensional graph and regarded as reference

groups, allowing the classification of patients to be made, depending on their nutritional conditions. In this multidimensional model the position of a new patient can be obtained by measuring the euclidean distance between each determination of the reference states and each determination of the patient. Thus the nature and degree of nutritional imbalance can be quantified by its absolute distance from a given reference state. As no patient is exactly similar to the patient represented in the reference chart, for practical purposes, a patient is considered to belong to a group to which he or she is found to be closest on the euclidean distance.

Monitoring the efficacy of the nutritional support

Monitoring the efficacy of nutritional support is probably the most complicated and controversial application of nutritional assessment. Different methods of monitoring are used in different centres, the choice of variables depending on the type and severity of disease, the metabolic conditions of the patient, and the duration of nutritional support.³⁰ Nevertheless, a few basic criteria should be followed in these patients. Firstly, before starting any type of nutritional support the clinician should evaluate the major functions (renal, hepatic, cardiovascular) to prevent possible complications and he or she should have baseline reference data. Monitoring should be more intensive in the early phases of artificial nutrition to ensure the tolerance of the substrates and their complete utilisation. Evaluation of the efficacy of the treatment is difficult to obtain, and varying approaches are used by different institutions. An increase in the serum concentration of selected biochemical variables, such as albumin concentration, prealbumin concentration, transferrin value, retinol binding protein value and fibronectin are used to determine if a patient is responding to the nutritional support programme. Maintenance of a positive nitrogen balance and a weight gain of $\frac{1}{2}$ lb to 1 lb/day are regarded as adequate in clinical practice.

Other determinations such as skin tests, indirect calorimetry, and total body potassium and nitrogen values should be used selectively for investigative protocols.

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