Nutritional support before and after surgical operation

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The extent of the problem

There has been an increased awareness recently of the need to identify undernourished surgical patients (Bistrian *et al.* 1974) who are more likely to develop complications after major surgery. Mortality is also greater in the nutritionally depleted, particularly those with malignant disease of the upper gastrointestinal tract (Hill *et al.* 1977).

Recent advances in nutritional support techniques allow life to be maintained while tissue synthesis and repair continue in the presence of total alimentary failure. It is of the utmost importance, however, to identify those patients most likely to require nutritional supplements, either intravenously, or orally, as early as possible. The diet history as a tool for obtaining accurate information about food intake is valuable, despite its limitations (Burke, 1947). The diet history gives important information regarding patients' ability to cope with various forms of nutritional support.

A recent survey of over 100 underweight patients admitted to hospital showed that the majority were managing to take more than their theoretical requirements in the 2 weeks prior to admission and that the relative intake of protein was greater than carbohydrate. However, when the same patients were reviewed within 1 week of admission they were only receiving about 70–80% of their requirements. The only patients who were being provided adequately with nutrients were those with inflammatory bowel disease. There are many reasons for this reduced intake in hospital patients. Fear and apprehension in unfamiliar surroundings contribute to poor appetite, apart from the discomfort and symptoms of any underlying disease. The demands of daily investigative procedures on the gastrointestinal tract require quite long periods of starvation of 10 h or more and repeated investigation makes it more difficult to achieve an adequate food intake.

Assessment

The patient who is underweight deviates from the normal population in many respects as lean body mass and basal energy expenditure fall. Clinical nutritional assessment consists of both anthropometric and biochemical measurements. Bodyweight is a relatively inaccurate measurement due to the tendency of many ill patients to accumulate fluid in varying amounts from day to day, depending on the nature of either the underlying pathology or intravenous fluid administration. The body cell mass can be calculated with considerable accuracy from precise measurements of skinfold thickness and arm muscle circumference. Total body potassium measurements using a whole-body counter have been shown to correlate closely

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with calculated lean body mass from arm muscle and skinfold measurements in normal man.

Biochemical measurements are aimed initially at the assessment of hydration but thereafter they are not of themselves reliable indicators of changing nutritional status. Plasma protein levels can remain normal until very late in protein–energy malnutrition. A falling serum transferrin value is a more reliable indicator of declining nutrition.

The peripheral lymphocyte count falls in malnutrition and this is associated with a delayed or absent response to allergens such as DNCB or Tuberculin injected into the dermis. A state of anergy to foreign proteins indicates a decline in immunological competence at a time when there is a great need to resist infection particularly if cytotoxic drugs are being given or to combat the spread of malignant cells through the body.

The underweight hospital patient is thus identified on the basis of anthropometric measurements, a biochemical profile and a dietary history. The extent of nutritional support and the route of administration depends upon the nature and severity of any operation planned or complications such as sepsis which may ensue.

Energy demands after injury

The response to injury or elective surgery share some of the biochemical characteristics of starvation when there is a progressive reduction in the need for gluconeogenesis as keto acids displace glucose as a source of fuel and protein is spared as storage fat becomes more available. This adaptation occurs normally after many days. Similar changes, however, may occur more rapidly in injured undernourished patients.

It was found that undernourished patients could be divided into two groups on the basis of their fasting serum ketone body concentrations with hyperketonaemia defined as a combined value of acetoacetate and β hydroxybutyrate greater than 0·2 mmol/l in the blood. One-quarter of the patients, all of whom were similar in biochemical and anthropometric terms had fasting hyperketonaemia with glucose insulin and glucagon levels characteristic of starvation adaptation. These patients excreted significantly less N than the normoketonaemic group. The hormone and energy substrate profile was maintained by each patient followed through surgery into the post-operative period. The normoketonaemic group continued to excrete larger amounts of urinary N and depleted their lean body mass as measured by arm muscle circumference to a greater extent. Mortality was significantly higher in the group which could not produce a hyperketonaemic response to a 10 h fast. These findings have implications for intravenous nutritional support after injury. It has been suggested that the administration of isotonic amino acids intravenously will spare body protein in starved or nutritionally depleted patients due to the presence of endogenous ketones which will be available for protein synthetic purposes. These findings suggest that only about a quarter of such patients will have an adequate hyperketonaemia to allow amino acid utilization to proceed. More work

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is required to find the best way of providing appropriate energy for the normo-ketonaemic population during intravenous feeding.

The number of patients who require complete intravenous nutrition for more than a few days is less than 5% of all hospital admissions to an acute general hospital.

Alimentary failure may be acute and temporary, or chronic and permanent, requiring daily intravenous feeding on an outpatient basis.

The most obvious example of acute alimentary failure is an enterocutaneous fistula of the small intestine. It is a simple matter to maintain the nutritional status of such patients intravenously, the rate of spontaneous closure of intestinal fistulas has increased significantly and mortality has fallen since the introduction of intravenous nutrition along with other forms of support.

Meeting the requirements

The combination of starvation, injury and major sepsis continues to present a challenge, due to extensive protein catabolism of the body cell mass. The provision of adequate nutrients for such a situation, particularly in undernourished patients, remains difficult as the metabolic demands in terms of energy are considerable.

Supplemental intravenous feeding should be given before operation to patients who fulfil the criteria of undernutrition, particularly those with upper gastro-intestinal cancer.

Enhanced wound healing, reduced post-operative complications and more rapid convalescence are the objectives of such support. The appropriate controlled studies to confirm that these objectives are attainable have not been performed and will be difficult to carry out.

After operation intravenous feeding should be commenced if adequate oral feeding is not possible between 72 and 96 h after surgery. The net daily loss of lean body mass during complicated post-operative recovery may be as much as 500 g/d without intravenous support.

There is good evidence that intravenous feeding has an important role in the treatment of acute episodes of granulomatous disease of the bowel, and perhaps also of acute ulcerative colitis.

Intravenous nutrition can be provided at two levels and by two routes, and this has been the cause of some confusion.

Simple nutritional support can be provided by the use of isotonic solutions of amino acids and dextrose plus fat emulsions using peripheral veins. A daily intake of approximately 6·69 MJ (1600 kcal) can be given through peripheral veins, and this support is of value as short-term supplementary feeding in post-operative patients.

Total parenteral nutrition through a catheter placed in a large central vein is indicated when treatment is likely to be required for more than a week and the oral intake is negligible. The central venous catheter allows the introduction of hypertonic solutions. Hypertonic solutions cannot be given into peripheral veins due to the reaction of the vein endothelium and thrombosis. Patients who are septic need around 40–45 kcal/kg body-weight daily to maintain positive N balance. Long-term support should include intravenous fat emulsions. The proportion of energy intake coming from intravenous fat may be as much as 15%.

The peripheral infusion of isotonic amino acids alone has been advocated as an effective method of protein sparing (Blackburn *et al.* 1973). The relative efficacy of amino acids, glucose or fat emulsions as the sole energy substrates to spare lean body mass remains controversial whether after starvation, injury or during severe trauma complicated by sepsis (Greenberg *et al.* 1976). The effects of isoenergetic amounts (2·51 MJ) of glucose, amino acids or soya-bean oil emulsion were compared with those of fasting in four groups of male patients during uncomplicated recovery from vagotomy and pyloroplasty (Craig *et al.* 1977).

Patients given glucose excreted less N than the fasting patients but N sparing was greatest in the group given amino acids alone. There was no evidence of any N sparing when fat was the source of energy. There was no difference in blood glucose free fatty acids and insulin concentrations among the groups. Ketone bodies rose in the fasting and fat-fed groups but remained low in the groups who received glucose and amino acids. The protein sparing effect of amino acids alone in these particular patients appears to be a function of the amino acids alone and is not related to the degree of fat mobilization. There is evidence that most of the amino acids infused were converted to glucose.

It is of interest that the administration of intravenous fat had no effect on N balance compared to the control group. This suggests that perhaps a period of adaptation is required in normally nourished subjects before intravenous fat can be utilized as an energy source.

These studies should not be confused with the observations in starved nutritionally depleted subjects where there is good evidence of important N sparing when isotonic amino acids alone are infused. Intravenous fat is also a readily available source of energy in such patients who are starvation adapted.

The formulation of amino acid solutions still depends on the early recommendations of Rose in relation to healthy subjects.

It is, however, possible to use some clinical situations to make recommendations on the amino acid ratios to be provided in solutions designed for clinical use. Tweedle *et al.* (1972) have compared the utilization of various amino acid mixtures in the immediate post-operative period. The total intake of N and the energy:nitrogen values were similar in the infusions for each group but the effect on N balance and the amino acid excretion in the urine was quite different. The solution which was associated with larger N losses had a higher content of glycine and alanine. Further studies are required in different clinical situations to enable the formulation of amino acid mixtures to be adjusted for specific nutritional needs. There is reason to believe, for example, that the amino acid requirements of the newborn are quite different from a malnourished adult.

Muscle is the main cellular tissue which is broken down during increased catabolism after injury and there is evidence of significant changes in cytoplasmic amino acids in muscle cells after injury. Vinars *et al.* (1975) have provided information on free intracellular amino acids in different clinical situations. The relationship between plasma amino acid levels and intracellular measurements has yet to be established, but studies along these lines may help in the formulation of further amino acid mixtures for particular clinical problems.

There is no simple biochemical measurement of amino acid turnover to give guidance as to the development of protein deficiency. It is hoped that studies of amino acid levels in plasma might provide pointers to appropriate composition of solutions or infusion rates during intravenous feeding. The effect of differing degrees of surgical stress, anaesthesia and post-operative nutrition on plasma amino acid levels were studied before, during and after surgery of varying severity (Dale *et al.* 1977). There is a fall in the plasma concentration of most amino acids immediately after operation; the non-essential amino acids (glutamate, proline, glycine, alanine, histidine and arganine) continue to fall during the second post-operative day, whereas the essential amino acids (isoleucine, leucine, phenylalanine and lysine with tyrosine) are at a higher concentration after 48 h than immediately after surgery. Comparisons of patients undergoing surgery of moderate severity such as vagotomy and pyloroplasty with the more severe procedure of resection of aortic aneurysm indicate that these changes in amino acid concentrations are not related to the severity of the trauma although cystine levels were somewhat lower and phenylalanine levels were higher in the major surgery group. The changes were not found to be related to the effect of anaesthesia alone.

When the energy intake after surgery was increased by giving intravenous glucose the plasma alanine levels rose and methionine levels fell. Studies of plasma amino acid profiles after injury suggest that cystine and tyrosine may become essential amino acids at that time in man. Rises in phenylalanine and methionine in injured patients may indicate some degree of liver dysfunction.

The provision of intravenous nutrition for the maintenance of the body protein economy in normally nourished subjects is not too difficult with the currently available solutions of crystalline amino acids, fat emulsion and glucose solutions.

However, in the rapidly changing situation in septic, ill and injured patients the situation can be very complex.

There may be as many as thirty variables to be considered in calculating the daily requirements of fluid, energy, N and electrolytes.

Computer programs have been produced to assist in the estimation of the needs of all patients based on the assumptions associated with healthy individuals. Preliminary studies have shown that these programs are effective and indicate that the tendency for clinicians to provide too much water and sodium and too little N and energy can be corrected.

Nutritional support is now provided in many hospitals by teams of clinicians, dieticians, pharmacists, backed up by clinical biochemists. Many lives have been saved and recovery from illness speeded up by carefully planned and administered intravenous nutrition.

Information obtained during the care of the critically ill using intravenous nutrients has provided valuable information on starvation adaptation and the utilization of energy sources of the body for the purpose of whole-body protein synthesis. Information obtained on the acute phase of the response to trauma could well be helpful in solving nutritional problems at any time during growth and development or adult life.

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