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Disease and malnutrition in British hospitals

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The development of disease may be accompanied by the loss of appetite, metabolic changes leading to tissue wasting and, in some cases, intestinal malfunction associated with the impaired absorption of nutrients. Thus, in many patients there is an inadequate supply of nutrients which, in combination with the influence of inflammatory mediators, leads to tissue wasting and defective organ function. This process is characterized by the term malnutrition.

Unfortunately, satisfactory tools for the measurement of malnutrition in the clinical context are not yet available. Reliance is placed on structural change determined by anthropometry. Laboratory markers such as the concentration of serum proteins and immunological indices are influenced by other factors, not least of which is the activity of the disease process. Consequently, many of these variables reflect the severity of illness rather than the degree of nutritional depletion (Sitges-Serra & Franch-Arcas, 1995). Impaired organ function may precede measurable changes in structure (Lopes *et al.* 1982; Jeejeebhoy, 1988). Whereas there are some clinical measurements of function, such as muscle dynamometry (Webb *et al.* 1989), the variability and lack of specificity for nutritional depletion limit their value in nutritional assessment, although they do correlate with increased surgical risk.

Malnutrition is common in hospital patients (Bistran *et al.* 1974; Bastow *et al.* 1983a; Larsson *et al.* 1990; McWhirter & Pennington, 1994). There is a lack of awareness of the importance of the problem amongst clinical staff (McWhirter & Pennington, 1994; Lennard-Jones *et al.* 1995). Consequently it escapes recognition in the majority of affected patients (Hill *et al.* 1977; McWhirter & Pennington, 1994). Many malnourished patients are deprived of treatment from which they may benefit and increasing nutritional depletion is common during hospital stay.

The effect of malnutrition on the patient and the outcome of disease is significant and sometimes fatal. Reduced muscle strength and stamina affects muscles of respiration as well as muscles of locomotion (Arora & Rochester, 1982). Reduced immune function (Hill, 1992; Animashaun & Heatley, 1994) exposes the patient to increased risk of infection. Increased surgical mortality has long been recognized in the malnourished patient.

Techniques for nutritional support are now available for the prevention or treatment of malnutrition. Reversal of nutritional depletion may not be possible in all patients, especially in patients who are stressed on account of sepsis, burns, or trauma, at least until the underlying disease process has been treated or controlled (Askanazi *et al.* 1980). Even

in these patients nutritional support prevents or retards further tissue wasting and organ impairment and, thus, buys time for effective therapeutic intervention.

The use of nutritional support has been shown to improve patient outcome and reduce hospital stay when given to malnourished patients (Bastow *et al.* 1983*b*; Von Meyenfeld *et al.* 1992). It is often inadequately supervised, thus exposing the patients to the unnecessary hazards of potentially-avoidable complications associated with nutritional-support techniques (McWhirter *et al.* 1995*a*). Thus, there remains a need to make nutritional support more widely available and to improve the quality of treatment.

THE RECOGNITION OF MALNUTRITION

There is evidence that malnutrition escapes recognition in many, even in the majority, of affected patients. In an early study of 105 surgical patients only twenty-two had a comment on their nutritional state in their case record, and only seventeen had been weighed at any time during their hospital stay (Hill *et al.* 1977). A recent study of 500 consecutive hospital admissions revealed that 104 of 200 malnourished patients had no nutritional information recorded in their case notes (McWhirter & Pennington, 1994). This suggests that the recognition of nutritional impairment is regarded as unimportant, a view supported by a study in which 450 nurses and 319 junior doctors in seventy hospitals were surveyed. Only 34% of the doctors knew if the patients had been weighed, 60% of the remainder considered weight to be unimportant (Lennard-Jones *et al.* 1995). The failure to recognize that patients are malnourished is the reason why affected patients are not referred for nutritional support. Only ten of fifty-five malnourished patients who had been in hospital for more than 1 week were referred for nutritional assessment and treatment (McWhirter & Pennington, 1994).

Recognition is made more difficult by the lack of suitable clinical indices of malnutrition and consequent functional impairment. A range of factors are used to assess nutritional status.

Clinical assessment

Malnutrition is a term that may be applied to a range of disorders including obesity. Indeed, weight loss in the obese patient may be regarded as an advantage which makes them more healthy. However, for many patients, especially those who are in hospital with significant illness, weight loss denotes the loss of important muscle tissue rather than predominantly fat stores as might occur in the otherwise healthy subject. This is more difficult to detect in the obese patient who may be at greater risk from the problems associated with unrecognized malnutrition. In this context malnutrition refers to unintentional weight loss with nutrient deficiency which may impair organ function.

An adequate history includes enquiry about appetite and changes in diet and weight. There may be evidence of muscle wasting as well as features of micronutrient deficiency, such as bruising, rash and glossitis. The recognition of the need for multi-factorial assessment (Detsky *et al.* 1987) has prompted the introduction of simple screening questionnaires for patients who are affected or who are at risk of malnutrition. These patients can then be referred to an appropriate source, most commonly the dietitian, for detailed evaluation. An example of such a screening questionnaire includes questions about the normal weight, unintentional weight loss, impaired appetite, and is complemented by measurement of weight and height (Lennard-Jones *et al.* 1995). Some centres have evaluated screening tools for use by nursing or other staff during the admission process

(Reilly *et al.* 1995). Malnutrition has been measured in terms of changes in body composition and structure, changes in organ and tissue function, and laboratory measurements of biochemical and immunological variables.

Measurement of body composition

The traditional method of measuring body composition from body density determined by underwater weighing, and the use of sophisticated techniques such as dual-energy X-ray absorptiometry are inappropriate or unavailable for routine clinical practice.

Anthropometric measurements

The measurements of weight and height are important. Fluctuation in body weight in the long term may reflect nutritional changes. In the critically-ill patient acute weight change is caused by changes in fluid balance. The measurement of height will determine growth velocity in the child, a sensitive marker of nutrition and disease (Widdowson, 1971). In the adult, knowledge of height and weight allows the calculation of the BMI. The BMI is calculated from the weight (kg) divided by height² (m²). The normal range for BMI is between 19 and 25 kg/m² (Gregory *et al.* 1990).

Fasting in the patient who is not metabolically stressed leads to preferential mobilization of fat stores which are measured by skinfold calipers. In the stressed patient, proteolysis leads to muscle wasting measured by calculating the mid-arm muscle circumference (MAMC). The MAMC (cm) is derived from the mid-arm circumference – triceps skinfold thickness \times 0.314 (Heymsfield *et al.* 1982). These measurements are useful for the identification of malnourished patients, monitoring patients who are at nutritional risk as well as those who are receiving long-term nutritional support. Variation in technique between observers and changes in the patient's hydration status can also influence the results.

Bioelectrical impedance analysis (BIA)

BIA is a non-invasive method of assessment which depends on the difference in electrical conductivity between the fat and fat-free mass (Lukaski *et al.* 1985). The impedance of the body to an electrical current is measured, and is assumed to be proportional to the square of the height of the subject divided by the volume. The resistance between the right wrist and right ankle is measured and used to calculate the conductivity. From the impedance total body fat and body water are calculated. However, the technique assumes a normal hydration state. This may not be the case in many patients, although there have been attempts to produce prediction equations for different disease states including general surgical patients (Fearon *et al.* 1992). Further validation is needed before this technique can be accepted into routine clinical practice.

The measurement of organ function

Malnutrition leads to impaired muscle strength and increased fatiguability (Lopes *et al.* 1982; Jeejeebhoy, 1988). The laboratory methods employed for these measurements using graded electrical stimuli are not suitable for clinical practice. These studies showed that impaired muscle function could be reversed with nutritional support before improvements in nutritional indices were observed. This observation led to the reappraisal of hand-grip

dynamometry (Webb *et al.* 1989). Hand-grip dynamometry, determined by the highest value of three readings recorded with a dynamometer gripped in the non-dominant hand, will give a value that reflects nutritional state when compared with age- and sex-standardized values. However, other influences, notably the willingness of the patient to cooperate, reduce the specificity and, thus, the clinical usefulness of the technique. Tests of respiratory function have also been used for the determination of nutritional status. Unfortunately, the results are influenced by three variables: nutritional state, cooperation, and pulmonary disease.

Malnutrition leads to the loss of cutaneous responses to antigens traditionally determined by the mantoux response (McMurray *et al.* 1981). Many diseases have the same effect. The total lymphocyte count is depressed in malnutrition and has been used to monitor nutritional support. These measurements are little used in this context.

Laboratory investigations

Protein–energy malnutrition causes a decrease in the rate of albumin synthesis (Fleck *et al.* 1985). Traditionally the serum albumin concentration has been advocated as a nutritional marker. Whereas there is evidence to support the use of albumin as a prognostic indicator (patients with low serum albumin values have prolonged hospital stay and increased morbidity and mortality), hypoalbuminaemia correlates poorly with nutritional status (Anderson & Wochers, 1982). In the Minnesota experiment the total circulating albumin was reduced by only 2% after 24 weeks of reduced protein and energy intake. This was associated with a 10% reduction in serum albumin concentrations which may have reflected other influences (Keys *et al.* 1950). Children with marasmus, and adults with anorexia nervosa, maintain serum albumin concentrations until the terminal stages of their illness. Conversely, in well-nourished patients who become septic the albumin concentrations fall rapidly, reflecting changes in vascular permeability, fluid retention and reduction in albumin synthesis caused by the influence of cytokine responses to infection or tissue damage. Furthermore, albumin has a very long half-life of 21 d. Consequently, other proteins have been advocated for diagnosis and nutritional monitoring. They include transferrin, thyroxin-binding pre-albumin, and retinol-binding protein; with respective half-lives of 8 d, 2 d, and 12 h. These are also influenced by other factors, such as the Fe and vitamin A status, and the acute-phase response.

The insulin-like growth factors are a family of low-molecular-weight peptides produced by the liver. Studies have suggested that insulin-like growth factor-1 (IGF-1), which has a half-life of a few hours, may be a useful marker of nutritional status. Reduced serum concentration may reflect a general decrease in protein synthesis with malnutrition; unlike the other factors it is thought not to be influenced by the acute-phase response. In a study of thirty-seven malnourished patients IGF-1 correlated with albumin, transferrin and lymphocyte count; values increased in six patients who were given nutritional support (Unterman & Vazquez, 1985). In a further study IGF-1 correlated with albumin, transferrin, and variables of body composition (total body water, total body K and total body N) in malnourished patients with no acute-phase response (Minuto, 1989). However, poor correlation was observed when it was used as a static marker in patients in whom malnutrition was determined by anthropometric indices (McWhirter *et al.* 1995b).

Clearly there is no single laboratory marker of nutritional status. However, the laboratory has an important role in the identification of single nutrient deficiencies, such as Fe, folate, and some vitamins and trace elements. This is especially important during the monitoring of nutritional support.

THE PREVALENCE OF MALNUTRITION IN HOSPITAL PATIENTS

Many studies of the prevalence of malnutrition in hospital patients, defined by anthropometric criteria, have been published during the last 20 years. Bistrian *et al.* (1974) surveyed all 131 surgical patients in an urban municipal hospital. There was evidence of malnutrition in 48%. A second study was undertaken in general medical patients in which 250 patients were examined in three surveys. The prevalence of malnutrition was 44%. Greater reduction in arm circumference was demonstrated in the surgical patients, whereas the medical patients had lower values for skinfold thickness (Bistrian *et al.* 1976). Hill *et al.* (1977) used weight, arm-muscle circumference and serum albumin to determine nutritional status in 105 surgical patients, and also reported malnutrition in 50% of these patients. These surveys all demonstrated that almost half the patients within surgical and medical wards were affected by some degree of nutritional depletion.

Other studies have assessed nutritional status on admission to hospital. The incidence of malnutrition was 31% in 200 consecutive non-obstetric admissions to a community hospital (Willard *et al.* 1980). A large study of 744 elderly females with a fracture of the neck of the femur reported 255 as thin and 138 as very thin on the basis of anthropometric measurements which were respectively 1–2 SD, and > 2 SD below the mean for that population (Bastow *et al.* 1983a). One report suggested a lower incidence of malnutrition (14%) in patients on admission to a general or vascular surgical unit (Zador & Truswell, 1987). However, emergency admissions were excluded and many admissions were unavailable for examination. In a Swedish study of 205 acute medical admissions without cancer, 20% of patients were classified as malnourished (Cederholm *et al.* 1993). A recent study of 500 admissions (100 consecutive admissions to general surgery, general medicine, respiratory medicine, orthopaedic surgery, and care of the elderly), found that 40% of patients were malnourished and 27% had evidence of moderate or severe malnutrition (McWhirter & Pennington, 1994). Finally, 43% of 129 patients admitted to an intensive care unit were malnourished (Giner *et al.* 1996). Thus, malnutrition is common at the time of admission.

Data have been obtained on the change of nutritional status during hospital stay. Significant reduction in nutritional variables was reported in 401 malnourished patients who did not receive nutritional support during their hospital stay of at least 3 weeks (Pinchcofsky & Kaminski, 1985). In a study of 501 patients admitted to a geriatric ward, those patients who did not receive nutritional supplements exhibited a decline in nutritional status with increased morbidity (Larsson *et al.* 1990). Of 500 hospital admissions to five major acute specialities who were nutritionally assessed, 112 were in hospital for more than 1 week and were examined on discharge. Weight loss occurred in seventy-two (64%) of these patients. Furthermore, in comparison with the normally-nourished and overweight groups, more of the patients who were malnourished on admission lost weight, and their weight loss was proportionately greater (McWhirter & Pennington, 1994). In another study comparing the efficacy of oral supplements with supplemental nasogastric feeding in malnourished patients, the malnourished control group who received normal hospital treatment continued to deteriorate nutritionally (McWhirter & Pennington, 1996). Nutritional assessment of patients who were admitted to an intensive care unit suggested that inadequate nutritional management led to depletion during their hospital stay before admission to the intensive therapy unit (Giner *et al.* 1996).

Thus, many patients are malnourished on admission, there is a tendency for hospital patients to lose weight during their hospital stay, and this particularly applies to those patients who are malnourished on admission.

THE PATHOGENESIS OF MALNUTRITION IN HOSPITAL PATIENTS

Many patients may be expected to suffer from malnutrition on admission to hospital because of the effect of their disease. Depression and chronic illness lead to anorexia. Patients with neurological disorders, oropharyngeal and oesophageal disease may be unable to eat. Intestinal disease, such as gluten enteropathy and Crohn's disease, reduce the efficiency of the intestine and are frequently accompanied by maldigestion and impaired absorption. Sepsis, inflammation and trauma are each associated with the release of inflammatory mediators which influence metabolic function and lead to tissue wasting.

The feeding of patients in hospital has been reviewed (McGlone *et al.* 1995). The selection of 'healthy' high-fibre and low-energy foods from menu cards may not be appropriate for the patient's needs. In many wards food is only available for limited periods during the day. Thus, when meals are missed, because of investigative or therapeutic procedures, there is no opportunity to provide additional meals (Garrow, 1994). Not all patients have access to food brought in from outside the hospital. Assistance with feeding may be needed, particularly in patients with eating difficulties and other disabilities such as severe rheumatoid arthritis. Some patients who were observed for seven consecutive days were consistently unable to reach their food because it was placed beyond their reach. Visits by medical staff or phlebotomists at mealtimes can significantly reduce the consumption of food (Dickerson, 1986). The loss of appetite in some patients as a consequence of disease, or disease treatment, impairs food consumption. The amount of food eaten may not be recorded.

The additional influences of infections, burns and trauma including surgical operations, lead to accelerated nutritional decline. This has been explained by an increased energy requirement in the stressed patient, the humoral response to stress and the release of cytokines. However, energy requirement in critical illness has previously been overestimated; in most patients it is not significantly increased (Elia, 1995). The humoral response does not account for the observed metabolic changes (Frayne, 1986), which may be attributable to the actions of cytokines. These small proteins: interleukins (IL), tumour necrosis factor (TNF) and interferons, are released from immune cells and cancer cells. Increased plasma levels of TNF are observed in septic and cancer patients, elevated serum levels of IL-1, and IL-6 are found in the post-operative period and in burns (Witcher & Evans, 1990). Cytokines share multiple activities (Tracey, 1992). These include anorexia, pyrexia, release of amino acids from muscle tissue, increased glucose transport, the stimulation of hepatic lipid secretion, reduced albumin synthesis, increased vascular permeability, immune cell availability and the promotion of acute-phase-protein synthesis.

CLINICAL CONSEQUENCES OF MALNUTRITION

Death is the ultimate outcome. During the Irish hunger strike ten of the thirty subjects died by day 70, when the group on average had lost 38% of their body weight. The time taken to reach the critical weight when death ensues is prolonged during semi-starvation, but significantly reduced in the stressed patient (Allison, 1995).

Malnutrition adversely affects organ function. Muscle strength is reduced, muscle fatigues more readily and muscle relaxation is delayed. Furthermore, such impairment can be demonstrated during dietary restriction for only 2 weeks, before there are any changes in the conventional indices of nutritional assessment (Jeejeebhoy, 1988). Such changes may delay patient mobilization following surgery, but they may have other important consequences. Respiratory muscle strength and maximum voluntary ventilation were significantly reduced in a study of sixteen malnourished patients without respiratory

disease (Arora & Rochester, 1982). Clearly the need for artificial ventilation, and the ability to wean from ventilation may well be influenced by respiratory muscle impairment in the malnourished subject. Impairment of cardiac function through malnutrition has also been documented (Heymsfield *et al.* 1978).

The immune system is influenced by the ageing process, underlying disease and malnutrition. Protein-energy malnutrition in children is associated with thymic atrophy. Similar changes also occur in other lymphoid tissues. There may also be impaired antibody production and phagocyte function (Animashaun & Heatley, 1994). Malnutrition adversely affects mental function, and thermoregulation (Mansell *et al.* 1990; Hill, 1992).

Specific nutrient deficiencies lead to well-recognized syndromes. Examples include thiamin and Wernicke's encephalopathy, folate and megaloblastic anaemia, ascorbic acid and scurvy. Deficiency syndromes have also occurred during prolonged artificial nutritional support when early nutrient solutions were deficient in certain micronutrients such as Se (Cohen *et al.* 1989; Yagi *et al.* 1996).

There are many studies which attest to the fact that morbidity is increased in the malnourished patient. Studley (1936) reported deaths following surgery for peptic ulcer disease in one of twenty-eight patients who had lost less than 20% of their body weight (mean 12.6% weight loss) compared with six of eighteen patients who had lost more than 20% body weight (mean 26.1% weight loss). In a study of eighty patients who were undergoing surgery, protein depletion, determined by neutron activation analysis, was documented in thirty-nine patients. The depleted patients, who were similar in other respects, had impaired respiratory function, increased propensity to pneumonia, and prolonged hospital stay (Windsor & Hill, 1988). Malnutrition was identified in fifty-five of 129 patients who were admitted to an intensive care unit. The incidence of complications and the number of patients who were not discharged from hospital were both greater in patients who were malnourished on admission, and the impact of malnutrition was greater in the patients who were less ill (Giner *et al.* 1996).

NUTRITIONAL SUPPORT

Artificial nutritional support is available in the form of oral supplements, enteral tube feeding, and parenteral nutrition. It is used to prevent or treat malnutrition. Enteral feeding stimulates the gut-associated immune function. Furthermore, the intestinal mucosa is largely dependent on luminal nutrition and glutamine is an important fuel (Bengmark, 1996). Enteral feeding has physiological and clinical advantages, is less expensive and avoids the complications associated with parenteral nutrition. Studies comparing enteral and parenteral nutrition in surgical patients indicate fewer complications, and a reduced number of infective complications in the patients who received enteral nutrition (Moore *et al.* 1992).

The starving patient

Nutritional support in the starving and malnourished patient will lead to an anabolic response through increased protein synthesis. In the severely-malnourished patient a switch of energy source from endogenous lipid to exogenous carbohydrate may be one explanation for the dramatic reduction in the serum concentrations of phosphate, Mg, and K, which move into the cell under the influence of insulin. Under these circumstances increased provision of these nutrients will be required. This is described as the refeeding

syndrome (Solomon & Kirby, 1990). Hypoenergetic feeding in the initial phase may reduce the incidence of metabolic problems in such patients.

The critically-ill patient

In the stressed patient, who is septic or traumatized, nutritional support may increase protein synthesis but protein degradation remains high, and anabolism cannot be achieved with conventional solutions (Askanazi *et al.* 1980). Maintaining body structure pending resolution of the underlying disease process is the goal. Increasing N and energy intakes above normal requirements in an attempt to induce an anabolic response is ineffective, hazardous and wasteful. Energy requirements have been estimated at 125–146 kJ/kg per d, any increase in metabolic demand is balanced by reduced physical activity in these ill patients (Elia, 1995).

In an attempt to prevent or reverse tissue wasting three approaches are under evaluation: the use of anabolic agents, novel substrates and antioxidants.

Anabolic agents reverse the defect in amino acid transport in these patients. Growth hormone, which increases protein synthesis, and IGF-1, which reduces protein degradation, have a complementary effect. Their opposing influences on blood glucose concentrations circumvent hyperglycaemia and hypoglycaemia which respectively occur when each agent is used alone (Kupfer *et al.* 1993).

Lipid solutions provide a useful energy source which reduces the glucose load and associated respiratory and hepatic complications, and correct essential fatty acid deficiency. Concern has been expressed about the potential immunosuppressive properties of conventional lipid solutions (Hill, 1992). However, there has been no convincing evidence of increased susceptibility to infection in patients who are receiving lipid-containing parenteral nutrition solutions. Another concern about conventional long-chain triacylglycerol lipid solutions is the effect on pulmonary haemodynamics and gas exchange in the septic patient. This has been attributed to the increased formation of prostanoids. There is no evidence that when conventional solutions are used in the recommended doses, and infused as part of a mixed solution, this effect is observed. Nevertheless mixed lipid solutions containing medium-chain triacylglycerols (MCT) have been introduced and structured lipids are being developed. The substitution of MCT for some long-chain triacylglycerols (LCT) has been shown to reduce the production of some pro-inflammatory cytokines (Gogos *et al.* 1994). An increase in the *n*-3 fatty acids : *n*-6 fatty acids ratio leads to the synthesis of eicosanoids with less inflammatory potency (Wernerman & Tucker, 1994; Meydani, 1996). This may also be useful in the management of the cancer patient.

The suggestion that intestinal permeability with translocation contributes to the cytokine response in critically-ill subjects has led to the appraisal of glutamine in parenteral nutrition solutions (Van der Hulst *et al.* 1993). Many animal experiments suggest that the provision of glutamine may preserve intestinal integrity and protect against intestinal translocation of micro-organisms, in addition to an effect on immune function. Because of considerations of stability this is difficult to achieve, although peptide solutions are undergoing evaluation (Furst *et al.* 1990; Tremel *et al.* 1994). In spite of these theoretical considerations there are relatively few studies at present which support the role of parenterally-administered glutamine in the clinical situation. Nevertheless in a study of critically-ill patients the administration of glutamine dipeptide in the parenteral nutrition solution appeared to improve the absorptive capacity compared with the control group (Tremel *et al.* 1994). The use of glutamine was associated with improved outcome with reduced infection and fluid retention in bone-marrow transplant recipients (Zeigler *et al.*

1992). However, the role of IgA in preventing bacterial adherence and cytokine generation may also be important. The production of secretory IgA has been linked to cholecystokinin which is released in response to enteral stimulation by whole protein and LCT, not by elemental diets and parenteral nutrition. This may be one reason why early enteral feeding, compared with parenteral feeding, is associated with fewer post-operative septic complications. Ornithine α -ketoglutarate, which may facilitate the release of growth hormone and insulin and the synthesis of glutamine and arginine, is being evaluated as a nutritional substrate.

Free radicals are generated by the inflammatory response. They may have a role in the killing of micro-organisms, cell signalling and the reduction in cell volume by the opening of K channels which may be the signal for the catabolic response. Nevertheless, free radicals also cause tissue damage which is minimized by antioxidants. The requirement for antioxidants, Se and vitamins A, E and C, is increased in catabolic patients, although the amounts that should be supplied are uncertain (Conner & Grisham, 1996).

Oral supplements

Swedish studies have demonstrated that nutritional goals can be achieved in some patients by the adequate provision of conventional food (Olin *et al.* 1996). Within the UK there has been concern about inadequate hospital food, and the fact that it is not readily available outside limited periods (Garrow, 1994). Oral supplements are convenient complete nutrient solutions with various flavours. They are used between meals to increase oral nutrient intake. The perception that they suppress the appetite and are taken in preference to the hospital diet is false; a significant increase in nutrient consumption with improved nutritional status can be achieved in many patients (McWhirter & Pennington, 1996).

Enteral-tube feeding

Tube feeding may be necessary in patients with profound anorexia, and nocturnal tube feeding is a useful method of fully exploiting residual bowel function in patients with intestinal failure and cystic fibrosis. It is an essential method of nutrient delivery in patients who are unable to eat or swallow. Many of these patients suffer from chronic neurological disease, such as cerebrovascular disease and motor neurone disease; others have chronic oropharyngeal disease. The recognition that following abdominal surgery small-intestinal function returns rapidly led to the use of naso-enteral feeding with simultaneous gastric aspiration. Not only does this technique avoid the expense and complications of parenteral nutrition in these ill patients, it may protect the intestinal integrity and reduce enteric-associated sepsis (Gardiner *et al.* 1995). This led to the concept of minimal enteral feeding, emphasizing the potential value of some nutrient delivery to the intestine, even though intestinal function was inadequate, requiring supplemental parenteral nutrition. Similarly there is evidence to suggest that patients with burns have a better outcome with early enteral feeding than with total parenteral nutrition (Kaudsk, 1994).

When enteral-tube feeding is required for more than 2–4 weeks the use of a percutaneous gastrostomy (PG) should be considered (Gauderer *et al.* 1980; Payne-James, 1995). These devices are commonly inserted endoscopically, but for patients in whom endoscopy is not possible or advisable, for example with carcinoma of the upper-alimentary tract, or severe respiratory impairment in patients with neuromuscular

disorders, radiological placement under screening should be considered. PG represents a useful development and leads to improved nutritional care by ensuring the more effective delivery of nutrient solutions when compared with nasogastric tubes (Park *et al.* 1992). A significant improvement in the nutritional status of a group of mentally-handicapped patients was observed following the adoption of PG feeding, all had previously received nasogastric feeding for at least 3 months (Wicks *et al.* 1992). Although the procedure is occasionally associated with complications such as stomal infection and peritonitis, complications of nutrient delivery are reduced and nutritional management simplified.

Parenteral nutrition

Parenteral nutrition is required when the intestine is unavailable or intestinal function is inadequate.

The realization that nutrient needs are less than previously estimated, and the development of the all-in-one lipid-containing nutrient solution, has facilitated the administration of parenteral nutrition by the peripheral vein. Many studies have demonstrated that adequate nutritional support can be provided for at least 2 weeks by peripheral parenteral nutrition (Maddan *et al.* 1992; Payne-James & Khawaja, 1993). This avoids potentially serious complications associated with the insertion and use of central feeding catheters. The addition of low-dose heparin and hydrocortisone in the nutrient bag, and nitrate patches over the vein, may delay the onset of thrombophlebitis (Khawaja *et al.* 1988; Maddan *et al.* 1991; Tighe *et al.* 1995). However, not all authorities accept the need for these measures.

Management of nutritional support

There is convincing evidence that artificial nutritional support is suboptimal in many, probably the majority, of our hospitals. Many studies attest to the high complication rate of nutrient delivery. There is evidence that some of these complications, such as catheter-related sepsis, can be avoided when nutritional management is undertaken by nutrition support teams (Burnham, 1995). The majority of hospitals in the UK still do not have access to such multidisciplinary teams (Payne-James *et al.* 1995). Whereas it is possible to minimize complications of treatment by the application of standard protocols, data suggest that even with established nutritional advisory groups standards of treatment are unsatisfactory. A 6-month study of artificial nutritional support in a teaching hospital in which a nutritional advisory group had introduced nutritional management protocols illustrates this point. The estimated nutrient requirements were received by only 42 % of enterally-fed patients, and 36 % of parenterally-fed patients. The deficit arose because of inappropriate prescription and failure to deliver the prescribed nutrients. Complications occurred in 47 % of patients who were fed enterally, and 36 % of patients who received parenteral feeding. The latter included catheter-related infection in five of forty-nine patients who were receiving central parenteral nutrition (McWhirter *et al.* 1995a).

BENEFITS OF NUTRITIONAL SUPPORT

Studies demonstrate that nutritional status can be improved by nutritional management. There are also data to show that this translates into improved outcome.

Nutritional status

A study of nutritional status in malnourished patients revealed that 70 % of those who received nutritional management improved, whereas nutritional decline continued in the 75 % who were not referred for nutritional support (McWhirter & Pennington, 1994). A prospective study of patients who were malnourished on admission to hospital demonstrated nutritional improvement in those patients randomized to the nutritional-support groups (63 % with oral supplements and 68 % with supplemental nasogastric feeding), and deterioration in 73 % of the control patients who received conventional nutritional management. Food consumption was the same in all three groups (McWhirter & Pennington, 1996). Nutritional status was improved in elderly patients by increasing the energy density of hospital food (Olin *et al.* 1996). This may well be the most cost-effective approach for the majority of patients. However, nutritional recovery with oral supplements may be slow and incomplete, especially in the elderly with an acute-phase response (Cederholm & Hellstrom, 1995). Clearly in the surgical patient the intestinal tract may not always be available. In a study of patients who had lost weight on account of malignant disease, post-operative parenteral nutrition prevented a further decline in muscle protein in association with the surgery (Petersson *et al.* 1995).

Clinical outcome

Clearly the most important end-point in relation to the value of the prevention or correction of nutritional depletion is the recovery from disease. There have been many studies which established the role of nutritional support in different patient populations. There is no benefit from the routine use of nutritional support in patients who are not malnourished or at risk of malnutrition (Veterans Affairs Total Parenteral Nutrition Co-operative Study Group, 1991; Von Meyenfeldt *et al.* 1992).

Pre-operative parenteral nutrition in patients with gastrointestinal carcinoma was associated with a significant reduction in major complications and mortality. This was attributed to the prevention of nutritional decline during the pre-operative hospital stay (Muller *et al.* 1982). The value of pre-operative nutritional support was assessed by giving depleted patients 10 d of enteral or parenteral feeding. There were depleted and non-depleted control groups. The depleted controls had more septic complications than the non-depleted controls. Artificial nutritional support, by enteral nutrition or parenteral nutrition, led to a significant reduction in major complications in patients who had lost more than 10 % of their body weight (Von Meyenfeldt *et al.* 1992). The use of immediate post-operative nutritional support, as opposed to introducing parenteral nutrition after 1 week if patients were unable to take oral diet by this time, was assessed in a study of thirty-five patients who were undergoing radical cystectomy. Early parenteral nutrition was associated with a reduction in hospital stay of 7 d (Askanazi *et al.* 1986). The use of prophylactic parenteral nutrition in patients who received bone-marrow transplantation reduced nutritional depletion and was associated with improved survival and time to relapse in the treated group (Weisdorf *et al.* 1987).

Early oral feeding with oral supplements reduced the incidence of complications following major gastrointestinal surgery (Keele *et al.* 1997). Supplemental nasogastric feeding led to reduced mortality and a reduction in hospital stay in malnourished orthopaedic patients with a fractured neck of the femur (Bastow *et al.* 1983b). Oral supplements (1.06 MJ/d) led to reduced complication rate, including bed sores and cardiac failure, and reduced mortality in elderly patients with a fracture of the neck of the femur, an

effect which was sustained 6 months after the fracture (Delmi *et al.* 1990). A large study of 501 elderly patients demonstrated that the use of a 1.67 MJ oral supplement greatly reduced mortality at 6 months from 18.6 to 8.6% compared with the control group (Larsson *et al.* 1990). A study of patients who attended a nutrition support clinic indicated that restitution of body weight and lean body mass is associated with significant improvement of quality-of-life indices in chronic illness (Jamieson *et al.* 1996).

Thus, artificial nutritional support in prevention and management of nutritional depletion benefits nutritional status and recovery from disease.

CONCLUSIONS

Malnutrition remains common in patients who are admitted to hospital. More careful monitoring in primary care and in the out-patient department may reduce the number of patients with significant nutritional depletion on admission.

Malnutrition escapes recognition in many affected patients and consequently they do not receive nutritional treatment. The implementation of nutritional screening tools will identify patients who are at risk and who need more formal assessment.

Nutritional status declines in hospital patients. This is most marked in patients who are already depleted on admission. Attention to nutrition during the hospital period, improved availability of food and the earlier use of methods of nutritional support are required.

Techniques for artificial nutritional support are now readily available and when used properly they are relatively safe. However, there is evidence that implementation of nutritional support is inadequate, and patients continue to be put at unnecessary risk from avoidable complications. The development of multidisciplinary nutritional support teams can improve patient care.

Nutritional support techniques can prevent the decline in nutritional status, and correct malnutrition in many patients. This leads to improved patient outcome, measured by reduced mortality, morbidity, and duration of hospitalization.

Novel substrates offer interesting opportunities for future management to improve organ function and modify the inflammatory response. At present, clinical information is inadequate to recommend routine use of these products. More immediate patient benefit will be derived from the adequate implementation of proper policies for conventional nutritional management within each hospital.

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