OVERVIEW

Artificial nutritional support in clinical practice in Britain

ABSTRACT—Malnutrition is common in hospitalised patients. It often develops insidiously and its diagnosis is frequently delayed or missed. A multidisciplinary nutrition support team can improve the quality of nutritional support, reduce inappropriate feeding, reduce the complications associated with enteral and parenteral nutrition, and so improve clinical outcome and reduce hospitalisation. These improvements have obvious financial advantages, yet only a minority of British hospitals (25–30%) has a nutrition team. The increasing use of parenteral and enteral nutrition at home, which represents one of the most important areas of recent developments in artificial nutritional support, also has financial and clinical advantages, but the management of such patients is also less than optimal. Better education and greater awareness of nutritionally related problems, as well as changes in the local and national infrastructure of nutrition support services, are required to improve the quality of care and the clinical outcome for patients being treated by parenteral and enteral nutrition in hospital and at home.

Although the West is distressed by outbreaks of famine in less-developed countries, it also has its own problems of malnutrition. In the Third World, malnutrition often develops entirely through dietary insufficiency in the absence of disease, but in the West malnutrition usually occurs as a result of disease. At any one time, almost 0.5% of the British population resides in hospitals, and during a single year about 15% of the population is admitted to hospitals. The prevalence of malnutrition varies with the specialty and type of hospital [1], and depends also on the criteria used to assess protein-energy malnutrition. By some definitions, more than a third of the patients in medical and surgical wards may be subclinically malnourished, but overt clinical malnutrition is less common. While attempts have been made to eradicate or minimise hospital malnutrition, the problem still remains, especially since medical practice has become increasingly involved with more aggressive treatment of more advanced disease, eg malignancy and transplantation.

Effective methods are now available for preventing or treating malnutrition. To understand the possible benefits resulting from these methods, it is first necessary to consider the causes of malnutrition and its consequences. Furthermore, since one of the most important recent developments in artificial nutritional support is the treatment of patients at home (eg tube feeding), it is also necessary to consider whether home nutritional support is used appropriately.

This article concentrates mainly on the use of artificial nutritional support (ental tube feeding and parenteral nutrition) as a form of clinical support and treatment of patients in hospital and at home.

Malnutrition and its consequences

Causes

Patients may suffer from malnutrition before admission to hospital but others develop it while in hospital. Anorexia is a common cause and may result directly from the disease, or indirectly from pain, drugs, and secondary psychological factors. Intake may also be suppressed because painful mouth conditions make chewing and swallowing difficult, or because of gastrointestinal obstruction and ileus. In unconscious patients, if artificial means of providing nutrients are not used, malnutrition rapidly develops. Malabsorption and increased nutrient requirement associated with disease may also contribute to malnutrition. Finally, food intake is also limited by the multiple clinical investigations which frequently require patients to be fasted prior to the test.

Death from malnutrition

The effects of malnutrition may range from the inconsequential to death. In lean adults, total starvation uncomplicated by disease leads to death within about two months [2]. Obese adults may survive considerably longer, but normal children or babies only as little as one month [3], largely because of the higher energy requirements relative to their energy stores. Survival time in premature infants is even less (a few days) on nutritional grounds alone, because the fetus accretes its energy store (ie fat) mainly in the last trimester of pregnancy. At 26 weeks' gestation the fetus contains only about 1% body fat compared to about 15% at full term [4]. Since many babies born prematurely at 26 weeks of gestation do not have an effective sucking and swallowing reflex, artificial nutritional support becomes an immediate necessity.

Death from total starvation commonly occurs after the loss of about 40% bodyweight, and of about 50% bodyweight during semi-starvation [2]. Patients who starve after severe trauma, injury, or infection lose

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weight more rapidly, and under these situations death in lean adults may occur after only about one month.

Effects of malnutrition in subjects without disease

One of the classic studies of experimental semistarvation in healthy, lean individuals [5] involved a 25% reduction in dietary intake in a group of lean subjects until they had lost a quarter of their initial bodyweight. During the six months of dietary there was a loss of muscle strength and endurance associated with a variety of symptoms, including depression, anxiety, irritability and loss of mental concentration (Table 1). All these symptoms were reversed by refeeding. Even short-term hypocaloric dieting for obesity can impair cognitive performance, including recent memory [6]. Semistarvation in prisoner-of-war camps confirmed the progressive deterioration in physical and mental function [7]. Describing the effects of severe malnutrition in concentration camps, Leyton [8] wrote: ‘The desire to sleep would increase: the number of hours that an adult male would wish to remain in bed, partly doing but for the most part in genuine sleep, rose from the normal eight hours to 16 or more out of the 24.’ This reduction in physical activity and energy expenditure can be regarded as having survival value. In children, poor dietary intake reduces growth and exploratory behaviour, and adversely affects social and emotional behaviour, intellectual function and mother-child relationships [6,9].

Loss of muscle bulk is associated with impaired muscle function: reduced strength; reduced capacity for work; reduced endurance, or greater fatiguability; and alteration in the contraction-relaxation characteristics of muscle. Even two weeks of hypocaloric dieting (400 kcal/day) can profoundly decrease maximal relaxation rate after electrical stimulation, and markedly increase fatiguability [10]. These changes are reversed by two weeks of refeeding [10]. Respiratory muscle bulk and strength and endurance are also reduced by malnutrition, and, contrary to popular belief, the diaphragm is also markedly affected by malnutrition both in the presence and absence of respiratory disease [11,12].

During malnutrition the heart also shrinks in size at the same time as there is loss of other lean tissues, and cardiac output decreases approximately in proportion to the reduction in energy expenditure. It is possible that the changes in cardiac size and function predispose to heart failure when demands for cardiac output increase. Malnutrition has been linked to accidental falls and fractures of the hip and neck of femur [13]. Impaired heat production in malnourished elderly people predisposes them to hypothermia [14].

Malnutrition in association with disease

Although low morale, apathy, depression, and reduced incentive to recover from disease may have many caus-
patients with cardiovascular disease who are being weaned off ventilators it is frequently as high as 20–30% [19,20]. As many as 20% of mechanically ventilated patients may be unable to tolerate discontinuation of mechanical ventilation or require reintubation [21]. Although the reasons for this intolerance are not entirely clear, it appears to be due to one of three factors, or more often a combination of them: impaired central respiratory drive; high energy cost of breathing; and respiratory muscle fatigue. Malnutrition contributes to the fatigue as well as to the respiratory muscle wasting, which may also occur from infective and traumatic disease, and from the respiratory muscle inactivity associated with artificial ventilation [22].

Malnutrition has also been causally linked to impaired wound healing and impaired immune status [23], which may lead to infection and further malnutrition. Of particular interest is the observation that malnutrition in animals predisposes to translocation of bacteria from the gut to mesenteric lymph nodes and the systemic circulation [24]. Whether this is an effect on the gastrointestinal mucosal barrier or on the local ‘immune’ system is uncertain.

Malnutrition also delays recovery from illness by reducing mobility and thus predisposing to bed sores and thromboembolism. The overall effects of malnutrition are to increase the frequency and duration of morbidity associated with disease, and to prolong hospital stay. These consequences have obvious economic implications (see below and references 25, 26).

Potential benefits from nutritional support

Malnourished patients admitted to medical, surgical, orthopaedic, and geriatric wards have longer hospital stay and a greater incidence of morbidity and death than well-nourished individuals. The hospital cost associated with the treatment of a malnourished patient who develops a major complication is four times that of a well-nourished patient without complications. However, since malnutrition is usually induced by disease, it is possible that the higher complication rates in malnourished subjects relate more to disease activity than to malnutrition per se. In order to prove that nutrition is causally related it is necessary to demonstrate that nutritional intervention improves clinical outcome. Two such trials involved elderly patients with fractured neck of femur [27,28]. In one of these studies [27], malnourished patients received either 1,000 kcal and 28 g protein nocturnally via nasogastric tube (in addition to the normal ward diet), or the ward diet alone. Mobilisation in the supplemented group took 16 days and 23 days in the unsupplemented group. In the second study [28], supplementary drinks (250 kcal, 20 g protein) were given between meals, with the result that energy and protein intake increased by 23% and 62% respectively. The length of hospital stay was significantly lower in the supplemented group (24 v 40 days; p > 0.02), which also had a lower complication rate (16% v 37%) and a lower mortality (24% v 37%) at 6 months.

In a separate study, 321 geriatric patients, who were initially well-nourished, were randomly allocated to receive either the normal hospital diet or the diet with a supplement of 400 kcal/day [29]. The six-month mortality rate was significantly lower in the group given the supplement (9% v 19%; p < 0.01).

The results of studies on the effects of perioperative nutritional support on clinical outcome have not always been clearcut [30], partly because in some studies well-nourished individuals were observed while in others a variable proportion of malnourished individuals were included. The skill of the surgeon, the type of nursing care, and differences in patient characteristics have also not always been adequately controlled. Therefore in studies where no benefit of perioperative feeding has been reported, it is possible that the beneficial effects of feeding have been masked by the many other confounding variables. It is, of course, possible that perioperative feeding is ineffectual in reducing postoperative complications in some patients.

The largest controlled trial, which was conducted in the USA, involved more than 1,000 patients [31]. As expected, morbidity and mortality were greatest in the most severely malnourished patients. For the well-nourished and malnourished patients combined, perioperative feeding was not found to reduce the postoperative complication rate. However, among the 395 malnourished patients who had thoracotomy or laparotomy, the incidence of non-infectious complications was lower in individuals given intravenous nutrition for one to two weeks before surgery and for at least three days afterwards than in subjects who did not receive intravenous nutrition. This study emphasises the importance of selecting for perioperative nutritional support patients who have lost more than 10% bodyweight or whose intake is likely to remain poor or inadequate for at least seven to ten days following surgery.

Studies in intensive care units are particularly difficult to interpret because of the heterogeneity of the patients. Nevertheless, in one small study in which patients were artificially ventilated following surgical complications, it was found that those who received appropriate nutritional support were more readily weaned off mechanical ventilation than those without support (91% v 36%) [32]. Larger studies in different groups of artificially ventilated patients are required to confirm the validity of these results.

Artificial nutrition in hospital and at home: the size of the problem

It is estimated that about one in 50 patients in British hospitals currently receives artificial nutritional support. The proportion of seriously ill patients receiving artificial nutrition is, however, considerably higher. The incidence of artificial feeding is also higher in
emergency hospitals than in non-emergency hospitals, and in teaching hospitals compared with non-teaching hospitals. Enteral tube feeding in British hospitals is probably about two to three times more common than parenteral feeding, although in the USA the rates are nearer equal.

The duration of artificial feeding is variable [1], but in most hospitals the mean period is about 11-23 days both in Britain and in other countries. From this information it is possible to calculate the approximate incidence of artificial nutritional support in Britain. If there are about 350,000 hospital beds in the UK (1990 figures for England, Scotland, Wales, and Northern Ireland) with an occupancy rate of 80%, it is estimated that there are at any one time 5,600 patients fed by tube or intravenously, or about 97,000-145,000 per year (assuming a mean feeding period of two to three weeks).

Although data for home nutritional support in Britain are scanty, it is estimated from a combination of national and regional surveys, and from industrial sources, that about 150-200 patients are currently receiving home intravenous nutrition and about 2,000 are receiving enteral nutrition (Subcommittee of British Association of Parenteral and Enteral Nutrition—unpublished data). This means that in Britain almost 30% of the artificial nutritional support (enteral tube feeding and intravenous feeding) takes place at home. The number of patients fed artificially at home is probably similar to those in France and Germany, but considerably less than in the USA where currently as many as 12-15,000 patients are thought to be receiving home parenteral nutrition and 50-70,000 receiving home enteral tube feeding. Indeed, home enteral nutrition is not only practised much more frequently in the USA than in Britain (allowing for population differences) but it is also practised more frequently in US homes than in US hospitals. In addition, about 2% of patients in US nursing homes receive tube feeding [33]. There has been a remarkable growth rate in home nutritional support in the USA (~25%/year) and an increase in home nutritional support has already begun in Britain and other European countries, and is expected to continue.

One of the most detailed regional studies of artificial nutritional support in Britain was undertaken in the Cambridge health district, which serves a population of about ½-million. The one-year prospective study, carried out between 1988 and 1989, indicated that although the number of neo-natal patients treated at home was only about 5% of those treated in hospital, the prevalence of home nutritional support, measured in patient-days, was 50% of that in hospital (Table 2). This apparent discrepancy exists because patients at home are fed considerably longer than those in hospital. In some cases, they are fed at home for the rest of their lives.

### Table 2. Artificial nutrition at home and in hospital: 1 November 1988–31 October 1989.

| Place of artificial nutrition | Patients No. | % Total | Patient days No. | % Total |
|-----------------------------|--------------|---------|-----------------|---------|
| **Enteral nutrition**        |              |         |                 |         |
| Hospital                    | 291          | 93.9    | 6970           | 62.4    |
| Home                        | 19           | 6.1     | 4192           | 37.6    |
| Total                       | 310          | 100.0   | 11162          | 100.0   |
| **Parenteral nutrition**    |              |         |                 |         |
| Hospital                    | 195          | 98.5    | 2668           | 80.0    |
| Home                        | 3            | 1.5     | 637            | 19.2    |
| Total                       | 198          | 100.0   | 3305           | 100.0   |
| **Enteral and parenteral nutrition** | | | | |
| Hospital                    | 486          | 95.7    | 9638          | 66.6    |
| Home                        | 22           | 4.3     | 4829          | 33.4    |
| Total                       | 508          | 100.0   | 14467         | 100.0   |

1 Includes 22 patients (576 patient-days hospital feeding) who subsequently received home enteral tube feeding in either Cambridge health authority or another health authority.

2 Includes 3 patients (130 patient-days hospital feeding) who subsequently received home parenteral nutrition.

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As expected, patients requiring artificial nutritional support in hospital suffer from a wide range of diseases (Table 3). Patients receiving tube feeding can be subdivided into those with anorexia and those with neurological problems which make swallowing difficult or impossible (e.g. unconsciousness, head injury, cerebrovascular accident). Most of the patients who are tube fed return to normal eating (Table 4). The feeding therefore prevents or reduces the rate of development of malnutrition during periods of critical illness. The same can be said for patients receiving parenteral nutrition, who often have intestinal failure (e.g. ileus, gastrointestinal disease, fistula, obstruction or inflammation and damage to the mucous membranes following aggressive chemotherapy or radiotherapy for malignancy).

Patients receiving home parenteral nutrition have intestinal failure, usually Crohn’s disease, radiation enteritis, or the short bowel syndrome caused by mesenteric thrombosis or embolism. Patients with Crohn’s disease, who form the largest category of patients on home parenteral nutrition in Britain, have a better prognosis than the other categories of patients [34,35]. In the US [36], malignancy is a much commoner indication for home parenteral nutrition than
Table 3. Artificial support in Cambridge health district: 1 November 1988–31 October 1989.

| Diagnosis                                      | Enteral tube feeding | Parenteral nutrition |
|-----------------------------------------------|----------------------|----------------------|
|                                               | No. of patients      | Patient days in      | No. of patients | Patient days in      |
|                                               | receiving treatment  | receipt of treatment | receiving       | receipt of treatment |
| Cardiovascular accident                       | 57                   | 1540                 | 3              | 26                   |
| Trauma with head injury                       | 55                   | 1884                 | 3              | 27                   |
| Trauma without head injury                    | 2                    | 27                   | 6              | 41                   |
| Malignancy including GIT diseases             | 47                   | 1005                 | 64             | 828                  |
| GIT diseases excluding malignancy             | 36                   | 577                  | 75             | 1219                 |
| Neurological conditions (non-malignant)       | 32                   | 1004                 | 3              | 23                   |
| Respiratory disease                           | 24                   | 216                  | 3              | 46                   |
| Cardiovascular diseases                       | 5                    | 236                  | 15             | 237                  |
| Infection                                     | 4                    | 74                   | 1              | 13                   |
| Muscular diseases                              | 3                    | 92                   | 1              | 19                   |
| Other                                         | 21                   | 255                  | 10             | 91                   |
| Unknown                                       | 5                    | 60                   |                |                      |
| **Total**                                     | **291**              | **6970**             | **184**        | **2570**             |

in Britain, and AIDS is becoming an increasing indication. Home enteral nutrition is often given to patients with swallowing difficulties (e.g., multiple strokes, motor neurone disease, muscle diseases) or obstruction of the upper gastrointestinal tract. In children it is frequently given because of growth failure (e.g., genetic defects, fibrocystic disease).

The mortality rate of patients on home nutritional support in Britain is about 20% a year [37] (A. Mickewright, personal communication). This high mortality reflects the severity of the conditions in which home enteral nutrition is used. However, there is no doubt that many of these patients, especially those with swallowing difficulties or obstruction of the upper gastrointestinal tract, would have died much earlier had they not received artificial nutritional support.

Patients often feel more comfortable at home than in hospital, and their quality of life is often improved. In a survey of 70 children receiving home tube feeding mainly for failure to thrive (cardiac disease, liver disease, fibrocystic disease, chronic renal failure), the parents reported that their children were happier and more active than before tube feeding [38]. The parents also enjoyed more freedom because they did not have to spend long periods of time trying to get their children to eat. On the other hand, in some cases sleep was disturbed because parents frequently got up during the night to ensure that the infusions were continuing satisfactorily. During the day, children who are not severely handicapped or homebound by illness can either remove the nasogastric tubes or spigot the gastronomy tube before going to school. Only a small proportion of adult patients on home parenteral nutrition in Britain are housebound and require major assistance (<10%). About 40% are able to have a full-time job and look after their family [34,35].

Current lack of well-structured nutrition support services

Although recent technological advances have made possible effective means of nutritional support even in critically ill patients, the techniques are often not used appropriately. A national survey in Britain in 1988 revealed that only about a quarter of the hospitals had a multidisciplinary nutrition team to organise and advise on issues related to nutritional support [39]. Only 38% of nutrition teams had a specialist nurse. A more recent national survey in 1991 showed little change.

Multidisciplinary hospital nutrition teams offer a number of advantages. Since patients receiving artificial nutritional support are widely dispersed in different hospital wards (see Table 4 for diagnosis), the team can ensure more uniform and acceptable standards of care than those provided independently by individual wards. The team may also ensure ‘best buys’ through bulk ordering of feeds and accessories, and reduce the incidence of unnecessary nutritional support [40] as well as wastage of feed [41]. Furthermore,
the team can ensure that trace element, vitamin, and mineral deficiencies are avoided, especially during parenteral nutrition, and that incompatibilities do not occur. Examples of incompatibilities include: precipitation of calcium phosphate when the concentration of calcium and phosphate exceed certain limits; coalescence of fat globules (leading to fat embolism) in ‘all-in-one’ intravenous solutions containing high concentrations of divalent cations; drug incompatibilities and interactions with enteral [42, 43] and parenteral feeds.

Nutrition teams have been reported to reduce the mechanical and metabolic complications in patients receiving enteral tube feeding [44] and parenteral nutrition (Table 5). Furthermore, the incidence of catheter-related sepsis during parenteral feeding has repeatedly been reported to decrease from about 25% before the introduction of a nutrition team to between 0 and 5% after its introduction (Table 5). Catheter-related sepsis prolongs hospital stay and increases the estimated cost by £1,650–£5,000 per episode [29]. In a health district which provides intravenous feeding to 300 patients per year [1], the nutrition team can save as much as £110,000–£330,000 a year by simply reducing the incidence of catheter-related sepsis. Overall, it has been estimated [30] that if the hospital stay of 10% of the UK hospital patients is reduced in medical and surgical wards by five days as a result of nutritional intervention, the cost saving in the UK is £266-million per year. It could be argued this is not a ‘real’ saving for the health service since the hospital beds will be used for the treatment of other patients. Nevertheless, it helps to reduce waiting lists and increases the cost-effectiveness of the health service.

The financial implications for home nutritional support are also large. The use of parenteral and enteral nutrition at home instead of in hospital involves an estimated cost saving of 50% and 75% respectively, or approximately £120/patient/day. In the country as a whole, this saving corresponds to about £90-million per year (assuming that there are 2,000 patients receiving home nutritional support at any one time).

There is also room for improving the organisation and care of patients receiving home nutritional support [30]. For example, in hospital the training of patients receiving home enteral tube feeding is often not undertaken by the health professionals who subsequently look after the patients at home. In one survey, patients requested closer contact with hospital health professionals [1], especially during the early period of their home care. When problems arose they sometimes did not know who was the most appropriate person to contact. Written instructions and telephone contacts should routinely be made available to patients on home nutritional support, and appropriate monitoring and follow-up arranged. In some districts, controversies about who should pay for home nutritional support (eg hospital, individual wards, community ser-
sives) and problems relating to the care of patients between districts has resulted in some patients either not receiving home nutritional support, or receiving it only after considerable delay. Some anomalies in the current system also do not help. For example, at present the general practitioner is able to prescribe the feeds for home nutritional support but not the accessories (e.g. giving sets, swabs, etc), which have to be prescribed and obtained from an alternative source (e.g. community services).

Why is the current organisation and standard of nutritional care in hospital and at home suboptimal? Nutritional support is provided for a wide range of patients distributed throughout the hospitals, as well as in the community. This diffuses the specialty and possibly prevents a focussed approach to the problem. Indeed, clinical nutrition is not recognised as a specialty by the Royal Colleges of medicine or surgery. Few practising clinicians have had tuition in clinical nutrition, and surveys on nutrition education in England and Scotland have found both medical students and doctors to perform badly [56–59]. The financial provisions for nutritional support have also not been well structured on a national level, and individual hospitals have therefore attempted to develop their own systems of nutritional support. In some places, especially in those without ‘nutrition teams’, the service is frequently inadequate. The general lack of attention to nutrition is also emphasised by the small budget allocated for food for hospitalised patients (£1.50–£2.00 per day per patient).

Recent developments in Britain

The existing problems associated with the care of patients requiring nutritional support led to the formation of a multidisciplinary committee which aimed to make recommendations to health managers and those involved in nutrition policies for providing standards of care for patients receiving nutritional support in hospital and at home. The committee, comprising practising clinicians, (physicians, surgeons, paediatricians, etc), nurses, dieticians, health managers, and members of various organisations interested in nutritional support, published its report in 1992 under the auspices of the King’s Fund [30]. It drew attention to the need to improve the care of patients requiring nutritional support through education, the use of simple routine methods for assessing nutritional status, institution of appropriate care plans, and better organisation of support services in hospital and in the community. The need for improving organisation at local and national level was also emphasised. General guidelines and standards of care for patients receiving artificial nutrition in hospital and at home have been produced, and are the counterpart of those which have been in existence in the USA for several years. Several of the conclusions of the King’s Fund report have also been emphasised in this paper.

A new organisation called BAPEN (British Association of Parenteral and Enteral Nutrition) was formed in 1992, shortly after the King’s Fund report was launched, to meet some of the recommendations of the report and to encourage research. Members of various professional bodies involved with clinical nutrition (the Clinical Metabolism and Nutrition Support Group of the Nutrition Society; National Nurses Nutrition Group; Parenteral and Enteral Nutrition Group of the British Dietetic Association; the Pharmacists National Total Parenteral Nutrition Group) as well as members of patients’ organisations (the Patients’ Association of Intravenous and Nasogastric Nutrition Therapy—PINNT) and representatives of industry, make up the committee of BAPEN.

Sub-committees of BAPEN have already been formed with the remit to produce detailed authoritative reports and guidelines on topics such as education in clinical nutrition, communication, and nutritional support in hospital and at home. At the same time, the recent growth of home nutritional support has been recognised by industry. The first home-care company involved with delivery of feeds and other equipment necessary for home nutritional support in Britain (Unicare, a division of Baxter Health Care) began operations in 1989. Other companies (e.g. Fresenius Ltd) have also taken on the general role of home delivery, and Abbott are beginning to do this for their own feeds. In the USA such companies have been in operation for many years and their role is much more extensive than in Britain. As well as delivering feeds, they take total responsibility for patient care, including training, education, and follow-up. Such companies employ their own specialist clinicians, nurses, dieticians, and pharmacists, and provide a 24-hour emergency service. Whether such developments will eventually occur in Britain or other European countries remains to be seen.

References

1 Wilcock H, Armstrong J, Cottee S, et al. Artificial nutrition in the Cambridge health district with particular reference to tube feeding. Health Trends 1991; 23:93–100.
2 Elia M. Effects of starvation and very low calorie diets on protein-energy interrelationships in lean and obese subjects. In: Protein Energy Interactions, ed N Scrimshaw. Lausanne, Switzerland: International Dietary Energy Consultancy Group (IDCCG) (in press).
3 Heird WC, Driscoll JM, Schullinger JN, et al. Intravenous alimentation in paediatric patients. J Paediatrics 1972; 80:351–72.
4 Lentner C. Composition of the body. In: Geigy Scientific Tables, vol I, Giba Geigy Ltd, Basle 1981: 217–25.
5 Keys A, Brozek J, Henschel A, et al. The biology of human starvation. Minneapolis, Minnesota: University of Minnesota Press; 1950, vol I: 705–48; vol II, 819–918.
6 Green MW, Rogers PJ. Poorer cognitive performance associated with dieting and high levels of dietary restraint. Proc Nutr Soc 1992 (in press).
7 Brozek J. Effects of generalised malnutrition on personality. Nutrition 1990; 6:389–95.
8 Leyton GB. Effects of slow starvation. Lancet 1946;i:73–9.
9 Grantham-McGregor S, Cumper G. Jamaican studies in nutri-
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Stokes MA, Almond DJ, Petit SH, et al. Home parenteral nutrition: A review of 100 patient years of treatment in 76 consecutive cases. Br J Surg 1988;75:481–3.

Howard L, Heapley L, Fleming CR, et al. Four years of North American Registry Home Parenteral Nutrition outcome data and their implications for patient management. J Parent Ent Nutr 1991;15:384–93.

Weekes E, Cottee S, Elia M. Home artificial nutritional support in the Cambridge health district—1988–1990. J Hum Nutr Diet 1992;5:41–8.

Holden CE, Puntis JWL, Charlton CPl, Booth JW. Nasogastric feeding at home: acceptability and safety. Arch Dis Child 1991;66:148–51.

Payne-James J, de Gara C, Grimble G, et al. Nutritional support in hospitals in the United Kingdom: national survey 1988. Health Trends 1990;22:9–13.

Hays DP, Kiver KF, Maini BS. Impact of a nutritional support service on the quality of nutritional care of hospitalised patients. An audit, ASPEN 7th Clinical Congress, Washington DC, 1983 (Abs), 106.

Freidman MH, Higa AM, Davies AJ. A unique team approach to optimal nutritional support with minimal cost. Nutr Supp Serv 1991;3:27–38.

Cutie AJ, Altman E, Lenkel L. Compatibility of enteral products with commonly employed drug additives. J Parent Ent Nutr 1983;7:186–91.

Bauer LA. Interference of oral phenytoin absorption by continuous nasogastric feeding. Neurology 1982;32:570–2.

Brown RO, Carlson SD, Cowan GSM, et al. Enteral nutritional support management in a university teaching hospital: Team vs non-team. J Parent Ent Nutr 1987;11:52–6.

Hampson E, Assessing the nutrition support team. J Parent Ent Nutr 1987;11:412–21.

Allen JR. The incidence of nosocomial infection in patients receiving total parenteral nutrition. In: Advances in Parenteral Nutrition, ed Ida Johnston. Lancaster UK, MTP Press Ltd, 1978:339–77.

Freeman JB, Lemire A, MacLean LD. Intravenous alimentation and septicemia. Surg Gynec Obstet 1972;135:708–12.

Sanders RA, Sheldon GF. Septic complications of total parenteral nutrition. Am J Surg 1976;132:214–20.

Ryan JA, Abl BM, Abbott WM, et al. Catherer complications in total parenteral nutrition. N Engl J Med 1980;303:575–60.

Nehme AE. Nutritional support of the hospitalised patient: the team concept. J Am Med Ass 1980;243:1906–8.

Koehane PP, Atrill H, Northover J, et al. Effect of catheter tunnelling and a nutrition nurse on catheter sepsis during parental nutrition. Lancet 1983;ii:1388–90.

Jacobs DO, Melnik G, Forlaw L, et al. Impact of a nutritional support service on VA surgical patients. J Amer Coll Nutr 1984;3:311–5.

Faubion WC, Wesley JR, Khalidi N, Silva J. Total parenteral nutrition catheter sepsis: impact of the team approach. J Parent Ent Nutr 1986;10:642–5.

Hickey MM, Munyer TO, Salem RB, Youl RL. Parenteral nutrition utilisation: Evaluation of an educational protocol and consultant service. J Parent Ent Nutr 1979;3:453–7.

Dalton MJ, Schepers G, Gee JP, et al. Consultative total parenteral nutrition teams: the effect on the incidence of total parenteral nutrition-related complications. J Parent Ent Nutr 1988;4:146–52.

Nutrition in Medical Education. Report of the British Nutrition task force on human nutrition, British Nutrition Foundation, 1983.

Judd PA. Teaching nutrition to medical and dental students. J Hum Nutr Diet 1988;1:45–50.

Brett A, Gooden DJ, Keenan R. Nutritional knowledge of medical staff and students: is present education adequate? J Hum Nutr 1986;40:217–24.

Heywood P, Wootton SA. Nutritional knowledge and attitudes towards nutrition education in medical students at Southampton University Medical School. Proc Nutr Soc 1992;51:67A.