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The Pennington Lecture

Integrated nutrition

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There is no branch of medicine in which nutritional considerations do not play some part. Overnutrition, undernutrition or unbalanced nutrition are the major causes of ill health in the world. Conversely, illness causes important nutritional and metabolic problems. The spectrum from lack to excess of nutrients is seamless as a clinical and scientific discipline, the two extremes being linked by the Barker effect by which intrauterine malnutrition and low birth weight predispose to obesity, diabetes and CVD in later life. However, the teaching of nutrition in medical and nursing schools remains sparse. Nutritional care cannot be practised satisfactorily in isolation from other aspects of management, since factors such as drugs, surgery and fluid and electrolyte balance affect nutritional status. Nutritional treatment may also have adverse or beneficial effects according to the composition, amount and mode of delivery of the diet and the clinical context in which it is given. Any benefits of nutritional support may also be negated by shortcomings in other aspects of treatment and must therefore be fully integrated into overall care. One example of this approach is the enhanced recovery after a surgery protocol incorporating immediate pre-operative carbohydrate and early post-operative oral intake with strict attention to zero fluid balance, epidural analgesia and early mobilisation. Other examples include the deleterious effect on surgical outcome of salt and water overload or hyperglycaemia, either of which may negate the benefits of nutritional support. There is a need, therefore, to integrate clinical nutrition more closely, not just into medical and surgical practice, but also into the organisation of health services in the hospital and the community, and into the training of doctors and nurses. Societies originally devoted to parenteral and enteral nutrition need to widen their scope to embrace wider aspects of clinical nutrition.

Integrated nutrition: Clinical practice: Training

It is a great honour to be asked to give this lecture to the British Association for Parenteral and Enteral Nutrition (BAPEN) in the name of Chris Pennington, a friend and greatly esteemed colleague, who contributed so much in this field. Paradoxically, he and other colleagues have been so successful in fulfilling many of the original aims of BAPEN that they have presented current members with a challenge to its future identity, role and strategy.

Ancestors of today's clinicians, from Hippocrates to Galen, Hunter, Graves and Florence Nightingale, had access to few effective drugs and only a few basic surgical techniques. Alterations in diet, fluid intake and the patient's environment were their main weapons in the

maintenance of health and in the care of the sick. Good nutrition was recognised to be important in the recovery from illness, and undernutrition to be a contributor to poor outcome. Although gluttony was a recognised problem, it was easily managed by a few days of restriction. Overnutrition on a large scale was rare, salt intake was low and regular physical activity was necessary to existence. During the 20th century, however, energy and salt intake increased in the Western diet and the invention of mechanical aids reduced the need for physical exertion.

During the Second World War rationing was paradoxically responsible for a most remarkable period of healthy eating in the UK, although many of the population in

Abbreviation: BAPEN, British Association for Parenteral and Enteral Nutrition.

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Table 1. Historical aspects of nutrition in health and recovery from illness

Nutritional balance in health	
Leonardo da Vinci (1452–1519):	recognised the necessity of providing the human body with 'the same amount of nourishment it has lost'
Paracelsus (1493–1542):	chemical mechanism for identifying usable foods and converting them into bodily components
Santorino (1561–1636):	experiments on the material balance of the human body
Bartolemeo Beccari (1682–1766):	'body formed from substances introduced into the diet'
Lavoisier (1743–1794):	energy metabolism
Health and dietary frugality	
Hippocrates in 400 BC:	frugal diet of fish, bread, fruit and vegetables
Galen of Pergamon in 170 AD:	'around the diet of slimness.' 'To prevent disease, the best foods to eat are vegetables, including herbs, cereals and pulses: also fish and lean meat of small animals'; the only parts of pigs he allowed were trotters, nose and ears, provided that a lot of exercise is done and overeating is avoided
de Baldach in 1052 AD:	Baghdad; Theatrum Sanitatis
Cornaro (1494–1566):	Speeches on a Sober Life
Nutrition and disease	
Hippocrates:	'In all maladies, those who are well nourished do best'
John Hunter in 1794:	'Response to injury'; 'Tube feeding'
Robert Graves in 1849:	'He fed fevers'
Florence Nightingale in 1859:	'Starvation in the midst of plenty'
Cuthbertson in the 1920s:	Response to injury

Europe were less fortunate and were exposed to privation and famine conditions. Some historical landmarks are shown in Table 1. The availability of increasingly sophisticated treatments in the 20th century pushed nutritional considerations into the background of medical practice and training, although in the second half of that century, the development of artificial feeding by the parenteral and enteral routes, for a small number of patients with gastrointestinal failure, reawakened an interest in clinical nutrition and stimulated research into disease-related malnutrition, its diagnosis, importance and treatment.

Nutritional support

Initial optimism saw parenteral nutrition used as a panacea to treat even modest periods of fasting peri-operatively, following trauma or during treatments such as chemotherapy. The very term hyperalimentation conveys the intention to push catabolic patients into positive nutritional balance, on the assumption that this approach would prove beneficial. During the 1980s the iconoclasts were already busy pointing out the risks and failures of parenteral nutrition and the lack of controlled evidence for its benefit in the many grey areas to which it was applied (Allison, 1992). Although much of the criticism was justified, it obscured the vital role of parenteral nutrition in the treatment of prolonged gastrointestinal failure, in the same sense that dialysis is the treatment of renal failure and

ventilation is the treatment of respiratory failure. It would be absurd to suggest that dialysis and ventilation should be submitted to controlled trial under such dire life-threatening circumstances and the same consideration applies to total parenteral nutrition. Data concerning patients with non-malignant disease causing an average period of 50 d gastrointestinal failure (normally fatal) show the life-saving nature of this treatment, since the 10-year survival rate after receiving parenteral nutrition during that 2–3 months of gastrointestinal failure was found to be 75% (Shields *et al.* 1996). Nonetheless, criticism was healthy, in so far as it stimulated large numbers of trials into the benefits or otherwise of oral, enteral and parenteral nutritional support under different circumstances. Much of this evidence has been summarised recently in the remarkable book by Stratton *et al.* (2003).

One of the most important studies, interpreted as showing the negative aspects of parenteral nutrition, is the Veterans' Administration peri-operative study (The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991). In a multicentre trial patients were randomly assigned to receive peri-operative parenteral nutrition or to a control group receiving routine peri-operative fluids. The trial shows that outcome is worse, particularly in relation to infectious complications, among those receiving parenteral nutrition. Only in a subgroup of those patients with previous malnutrition is there any benefit of parenteral nutrition, mainly in terms of reduced non-infectious complications. From a trial design and statistical point of view this evidence appears to be category 1. Unfortunately, however, the metabolic and clinical foundation of the study has since been shown to be shaky. Dileep Lobo (Lobo *et al.* 2002, 2004) has described work carried out in Nottingham, UK, and that of other researchers (Brandstrup *et al.* 2003), showing that a peri-operative positive salt and water balance of as little as 3 kg not only delays return of gastrointestinal function post-operatively, but also increases post-operative complications, including infections. Bistran (Pomposelli *et al.* 1998) has also suggested that hyperglycaemia, even in non-diabetics, could increase the risk of infections. The proof of this outcome comes from the landmark study by Van den Berghe and colleagues (Van den Berghe *et al.* 2001, 2003), showing a dramatic reduction in infections and other complications post-operatively when blood glucose is tightly controlled by insulin infusion. If the Veterans' Administration paper (The Veterans Affairs Total Parenteral Nutrition Cooperative Study Group, 1991) is examined carefully, it can be seen that the parenterally-fed group were more hyperglycaemic, with blood glucose >16.7 mmol in thirty-eight of the treated group compared with three of the controls. Since the feed was given in a volume of 2–3 litres, in addition to oral and other intake, it may be surmised (although fluid balance data are not given) that the treatment group would have been in more positive salt and water balance than the control group. The outcome of that study, therefore, in terms of complications, could be explained, in large part, by hyperglycaemia and fluid overload, and may well have had less to do with parenteral nutrition *per se* than with the way it was applied. This situation occurs when nutritional

Table 2. Enhanced Recovery after Surgery programme; measures in colo-rectal surgery to improve outcome, integrating nutrition into overall management (adapted from Nygren, 2002)

Pre-operative assessment and counselling
Avoidance of bowel preparation
Avoidance of 12 h pre-operative starvation by giving carbohydrate drinks 12 and 2–4 h pre-operatively
Avoidance of fluid overload
Minimal use of naso-gastric tubes
Early oral intake (within 24 h post-operatively)
Post-operative epidural analgesia
Avoidance of opiate suppression of gastrointestinal function
Early mobilisation and graduated exercise programme
Early discharge

support is used as a blunt instrument, irrespective of other aspects of treatment, rather than being integrated into the overall management and requirements of each patient. Any benefits of nutritional support may be negated by shortcomings in other aspects of treatment, be it surgery, anaesthesia, drugs, fluid balance or control of glycaemia. The integrated approach is the basis for the Enhanced Recovery after Surgery programmes developed by Ljungqvist, Nygren, Hesson and others (for example, see Nygren, 2002), which attempt to optimise and integrate all aspects of care, as shown in Table 2. It can be seen that, although nutrition forms an integral part of the whole, it is not expected to work wonders on its own. It is also remarkable that, although some elements of this programme have been submitted to prospective controlled trials, it has never been submitted as a whole. Nonetheless, its application to colo-rectal surgery has resulted in substantial improvements in outcome and halving of hospital stay compared with historical controls (Nygren, 2002). Although this evidence may not be category 1, the evidence for the benefit of Enhanced Recovery after Surgery programmes is overwhelming persuasive (Nygren, 2002).

Thus, emergence from a period of rather naïve expectations of nutritional support into a period in which its important role within a balanced and integrated programme of care, tailored carefully to the needs of particular clinical situations or patient groups, can be perceived. This principle not only applies to therapeutic protocols, but also to the design of research projects, that must take account of all these possible confounding factors. Although much useful data have emerged that shows, in particular, the benefits of oral supplements and of enteral nutrition peri-operatively, it is hoped that future trial designs will control more carefully for such aspects as drug use, fluid balance, glycaemia, previous nutritional status etc., so that the benefits or otherwise of nutrition when other important factors are equal can be seen more clearly.

Clinical examples

Some further clinical examples illustrate the integrated approach and the close interdependence between nutritional and other care.

Case 1

A 45-year-old woman with a 20-year history of type 1 diabetes was fond of food and entertaining, and became overweight with poor diabetic control. As a consequence, she developed diabetic complications, including renal failure. This outcome reduced her appetite and her daily energy intake fell from >12.5 MJ (3000 kcal) to <6.3 MJ (1500 kcal). All the hazards of overnutrition changed to those of renal failure and weight loss, necessitating the re-integration of nutritional care into a new set of clinical problems.

Case 2

Two elderly ladies, identical twins, developed thyrotoxicosis causing weight loss despite increased energy intake. With treatment thyroid function was normalised, but one of the twins became depressed and anorexic resulting in a BMI of 11.0 kg/m², while the other became overweight and needed to diet. The first twin was treated not only with tricyclic antidepressants but also with overnight enteral tube feeding, which can disinhibit the appetite. After 2 weeks her oral intake had risen to the point where it met her requirements and enteral feeding was discontinued. In both cases nutritional care was necessary but needed to be appropriate to the changing situation as well as being integrated into overall medical management.

Case 3

A 48-year-old man with osteomyelitis and a soft tissue abscess of the femur lost 20% of his body weight during this catabolic illness. He became nauseated and anorexic with an oral intake of >1.7 MJ (400 kcal)/d, so that parenteral nutrition was considered. A search of his drug chart revealed the cause of his symptoms as the antibiotic Metronidazole. As soon as this treatment was stopped his oral intake rose to >10.4 MJ (2500 kcal)/d. Drainage of the abscess reduced fever and catabolism, allowing regain of weight and rapid recovery.

Case 4

A 20-year-old man was admitted with a chest infection and cardio-respiratory failure. Initial notes failed to mention his obesity and BMI of 70 kg/m², the main cause of his ventilatory failure and cor pulmonale (a complication of disorders that slow or block blood flow in the lungs, resulting from raised blood pressure in the lungs). Subsequent dietary treatment, however, resulted in the loss of 30 kg in weight with complete resolution of his obesity-induced cardio-respiratory failure.

These brief case summaries illustrate some of the many ways in which clinical nutrition, in its different aspects, permeates medical and surgical practice. They also emphasise the need for a broader approach that integrates all aspects of nutritional care.

Organisation

A strong case has been made for expert nutrition teams to manage artificial nutritional support (Allison, 1992;

Lennard-Jones, 1992). Originally, such teams acted as missionary groups, travelling the wards and advising on or carrying out parenteral, and in some cases enteral, feeding. The problem with this model is that the team has little or no control over other aspects of treatment, unless there is very close cooperation with the clinicians and nurses caring for the patient. In some centres nutrition units were then established, to which the most difficult cases could be admitted. This approach has the advantage of allowing coordination and integration of all aspects of care under a single high-dependency umbrella; it has the disadvantage, however, that the unit has too few beds to manage the demand. Then, like intensive care unit teams, the Nottingham nutrition unit, in cooperation with dietetics, developed an outreach service, combining the best aspects of the missionary and centralised unit models. This approach has been taken a stage further in Amsterdam, The Netherlands, where the expert team and the Dietetic Department involve themselves in all aspects of nutritional policy, care and training throughout the hospital, in cooperation with other disciplines, i.e. a fully-integrated system. Their team has, therefore, grown from a small group focused on a highly-specialised area of artificial nutrition, to one with an influence that permeates the whole institution, its policies and practice.

Nutrition and education; the wider picture

Before discussing education and the possible future role of BAPEN, it is pertinent to remember the wider importance of nutrition in health and its implications for the future. The problem of childhood malnutrition is common throughout the world, with rates of low birth weight reaching 30–50% in some Asian countries (James *et al.* 2004). Millions of the world population continue to suffer malnutrition through childhood, leading to a high prevalence of stunting, impaired physical and mental development, and susceptibility to infection. Infection itself exacerbates malnutrition, thereby creating a vicious cycle. In countries such as India there continue to be high rates of adult protein–energy malnutrition, as well as Fe, folate and micronutrient deficiencies. Of Indian women 50% have BMI below 18.5 kg/m², leading to fetal malnutrition during pregnancy. This situation is of concern in relation to the fetal origins of adult disease hypothesis (Barker & Fall, 1993), whereby low birth weight and poor nutrition during infancy predispose to obesity, heart disease and diabetes in later life. In some Asian countries, such as Thailand, as the rural undernourished population moves to the cities and is exposed to increased food intake and diminished need for exercise, it is making the leap from diseases of undernutrition to those of overnutrition in one generation. Since animal studies suggest that the metabolic syndrome can be inherited non-genetically through as many as seven generations, the consequences of this phenomenon for health can be imagined. A scenario in which 50% of a country's population suffer type 2 diabetes is not only possible but probable. In Western countries, while a high proportion of those with disease suffer undernutrition, the pandemic of obesity marches on to

reach a prevalence of 30% in the USA and 20% in the UK. If the special nutritional and metabolic problems related to ageing, childhood, specific disease states and therapeutic interventions are added to these problems of nutrition as a cause of obesity, diabetes, heart disease and cancer, it is possible to see a nutritional panorama, which, taken as a whole, is the single most important cause of ill health in the world today. Despite this fact, there has been a failure to integrate nutrition fully into the undergraduate medical and nursing curriculum of the UK. The present Nottingham University undergraduate curriculum, for example, does not even mention the word 'obesity'. Nutrition is beginning to be taught in postgraduate education, and to be recognised by the Royal Colleges. It is the universities that need persuading to integrate it into the undergraduate course.

Role of Parenteral and Enteral Nutrition Societies

BAPEN, like the American Society for Parenteral and Enteral Nutrition, the European Society for Parenteral and Enteral Nutrition and other Parenteral and Enteral Nutrition societies, has gained from its connection with a technology that was new in the 1970s, but which is now part of routine practice. On the other hand, has the BAPEN become a prisoner of its original narrow remit? As has already been suggested, it has successfully completed many of the tasks it set itself in 1992 (Lennard-Jones, 1992). The importance of nutritional screening is now being accepted nationally. Standards have been set for the conduct of parenteral and enteral nutrition in hospital and at home. The government has accepted the importance of better hospital food and its role in patient care. Ethical and legal issues have also been addressed. What is the next step? The American Society for Parenteral and Enteral Nutrition seems to have lost the allegiance of many of its clinicians, possibly by over-concentration on education and neglect of clinical and basic science. BAPEN, under the umbrella of the Nutrition Society, has an opportunity to widen its scope to embrace nutritional scientists, clinicians and other disciplines, in public health, epidemiology, basic science and metabolism, the clinical sciences, paediatrics and geriatrics, medicine and surgery. Since undernutrition and overnutrition are indivisible as subjects, and indeed the former may lead to the latter, should BAPEN not embrace both? Should BAPEN not open itself to the wider aspects of nutrition and health that have been described? Does BAPEN need to reinvent itself with new aims beyond the confines of artificial nutrition, and perhaps with a new name, for example, the British Association for Clinical Nutrition and Metabolism, while keeping the BAPEN logo? The European Society for Parenteral and Enteral Nutrition has managed this change successfully. The solution to these problems is for the next generation in BAPEN, and not for the old-stagers. BAPEN should, therefore, consider bringing all aspects of clinical nutrition under the BAPEN umbrella, as well as integrating nutrition into its proper place in research, clinical practice and education.

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