ENTERAL NUTRITION: 'USE THE GUT OR LOSE IT' — PART I

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When in the mid-19th century Robert Graves, Dublin, showed that mortality from typhus fever could be reduced by giving food and drink to his patients, he overturned established dogma and heralded modern interest in nutritional support to aid survival and recovery from illness and injury.[1]

Over the years it has become increasingly clear that the nutritional status of patients is critical for their potential to recover from trauma and disease. The metabolic response to illness is an integrated process that involves multiple organ systems, with profound changes in energy utilisation. This leads to impaired host metabolism and cardiac, pulmonary, hepatic, gastrointestinal, and immunological dysfunction, which can readily culminate in multiple organ failure and death.[2,3]
Many studies published since the 1970s document that a significant number of surgical patients are malnourished, that their nutritional status deteriorates in hospital, and that they remain malnourished for a considerable period thereafter. These reports on malnutrition have led to more aggressive nutritional care, new methods of nutritional assessment, new medical and surgical strategies, new developments in parenteral and enteral feeding, specialised formulations and additives, as well as improved methods of nutrient delivery.[3-6]

The guidelines for nutritional intervention are listed in Table I.

Objective measures normally used in the diagnosis of malnutrition include the assessment of nutritional intake, anthropometry such as weight loss, and biochemical indices, which may be useful in lieu of a gold standard. However, all of these individually are affected by other variables, making it hard to control for factors such as the presence of oedema returning a falsely high body mass index (BMI), especially in children. Therefore a combination of varied measurements is used, increasing the sensitivity and specificity of the results gathered.[7]

A nutrition risk screening tool (NRST) is usually a collection of subjective or objective measures which may be used to determine the extent of malnutrition within a population, but the aims and objectives of each tool may vary depending on the patient population target.[8] It has been argued that in the absence of an appropriate nutrition screening tool malnutrition may go untreated[7] (Appendices 1 and 2).

Appendices 1 and 2 provide examples of a nutrition screening tool and nutritional risk score, respectively. However, there are many others available.

There is general consensus that the early introduction of nutritional support in the form of enteral feeding has become a very beneficial therapeutic modality.[8,9] If a patient is capable of eating and drinking, the provision of enteral nutrition is focused more on the use of nutritional supplementation, dietary counselling and appetite stimulation. However, when this is not possible, an alternative method of feeding is required. Under these circumstances nutritional requirements can be met either parenterally, enterally or utilising both methods concomitantly.[10]

Appendix 1. BAPEN nutrition risk screening tool (NRST)[39]

Nutrition risk score

Patient's name
Hospital name
Date of birth

Ward
Date
Height/ length

Please circle relevant score. Only select one score from each section.
Select the highest score that applies.

COMPLETE ON ADMISSION AND WEEKLY IF PATIENT'S CONDITION HAS CHANGED

1

Paediatrics (0 - 17 years)	**Score**
Present weight	
Expected weight for length	0
90 - 99% of expected weight for length	2
80 - 89% of expected weight for length	4
< 79% of expected weight for length	6

Adults (18 years)	**Score**
Weight loss in last 3 months (unintentional)	
No weight loss	0
0 - 3 kg weight loss	1
> 3 - 6 kg weight loss	2
> 6 kg weight loss	2

2

Omit question 2
for paediatrics

BMI (body mass index)	
20 or more	0
18 or 19	1
15 - 17	2
Less than 15	3

3

Appetite	
• Good appetite, manages most of 3 meals/day (or equivalent)	0
• Poor appetite, poor intake — leaving > half of meals provided (or equivalent)	2
• Appetite nil or virtually nil, unable to eat. NMB (no food for > 4 meals)	3

4

Ability to eat/retain food	
• No difficulties in eating, able to eat independently No diarrhoea or vomiting	0
• Problems handling food, e.g. needs special cutlery Vomiting/frequent regurgitation (or posseting)/mild diarrhoea	1
• Difficulty swallowing, requiring modified consistency Problems with dentures, affecting food intake Problems with chewing, affecting food intake Slow to feed. Moderate vomiting and/or diarrhoea (1 - 2/day children) Needs help with feeding (e.g. physical handicap)	2
• Unable to take food orally. Unable to swallow (complete dysphagia) Severe vomiting and/or diarrhoea (> 2/day for children). Malabsorption	3

5

Stress factor		
• **No stress factor**	(Includes admission for investigations only)	0
• **Mild**	Minor surgery. Minor infection	1
• **Moderate**	Chronic disease. Major surgery/infections Fractures. Pressure sore/ulcers. CVA Inflammatory bowel disease Other gastrointestinal disease	2
• **Severe**	Multiple injuries. Multiple fractures/burns Multiple deep pressure sores/ulcers Severe sepsis. Carcinoma/malignant disease	3

Total

Appendix 2. Nutrition risk score results

Score		Action
0 - 3	Low risk	No action necessary Check weight weekly
4 - 5	Needs monitoring	Check weight weekly Encourage eating and drinking Replace missed meals with supplements (on advice of dietitian) Repeat scores after 1 week. Refer to dietitian if no improvement
6 – 15	High risk	Refer to dietitian as soon as possible

ALSO REFER TO DIETITIAN IF:

- The patient needs a special diet not available on the normal menu
- The patient needs advice about a special diet

DELIVERY OF NUTRITION (FIG. 1)

Parenteral feeding

Total parenteral nutrition (TPN) should be reserved for patients in whom enteral feeding is contraindicated, e.g. those with bowel obstruction and/or gut failure, and those in whom full nutrition needs cannot be met using standard methods. Parenteral nutrition confers no advantage over enteral feeding if the latter is feasible.

Combined enteral and parenteral feeding

This is advisable if nutritional goals cannot be met with enteral feeding alone. As enteral intake is increased, parenteral volume be reduced or vice versa. Combined enteral and parenteral nutrition may become the major feeding modality of the future, ensuring that all patients receive their full nutritional requirement during their illness.[5,11]

Enteral feeding

Advances in feeding techniques and enteral nutrition formulations make enteral nutrition support possible for most critically ill or traumatised patients.[12,13] Early enteral feeding has been the result of a better understanding of the pathophysiological function of the gut during the early phases of acute illness and trauma.

Gastrointestinal function, especially that of the small bowel, remains mostly intact during periods of acute stress or illness, such as major trauma, a disease not involving the gastrointestinal tract directly, and after open laparotomy. It is therefore crucial that the bowel, if not involved in a disease process, should be used for its primary functions of feeding, digestion and absorption.[12,14-16] Full resuscitation can be provided in keeping with the principles of fluid replacement in dehydrated and shocked children, with rapid restoration of fluid and electrolyte deficiencies and correction of metabolic acidosis.[17-19]

Furthermore, clinical and experimental studies have shown that early and progressive enteral feeding has several additional beneficial effects:[9,20-22] The hypermetabolic response is reduced, nitrogen retention and intestinal blood flow are increased, and normal gut flora integrity and immunity are maintained with reduced bacterial translocation. Secretion of gut trophic hormones is maintained. Enteral feeding has the additional advantage of inducing pancreatic and biliary secretions and reducing the incidence of hepatic steatosis. With active and progressive enteral feeding, calculated energy requirements can be reached within 2 - 3 days.[8,9,15,21,23-26]

Based on these findings, the pendulum has now swung towards utilising the enteral route for feeding as a priority whenever possible. It has the advantage of being physiological, safe, effective, and relatively inexpensive. The success of enteral feeding therefore depends on a small bowel that functions normally and the lack of intestinal obstruction, prolonged ileus or malabsorption.

DELIVERY OF ENTERAL NUTRITION (TABLE II)

A variety of methods are available for successful short- and long-term (> 1 month) enteral feeding and they are referenced by the distal position of the feeding tube. Not only are these techniques successful but they can easily be adapted for home and ambulatory care.[10,27]

Nasogastric/naso-enteric route

Many feeding catheters of small calibre, e.g. French 6 - 8 for transnasal gastric or jejunal insertion, are now available.

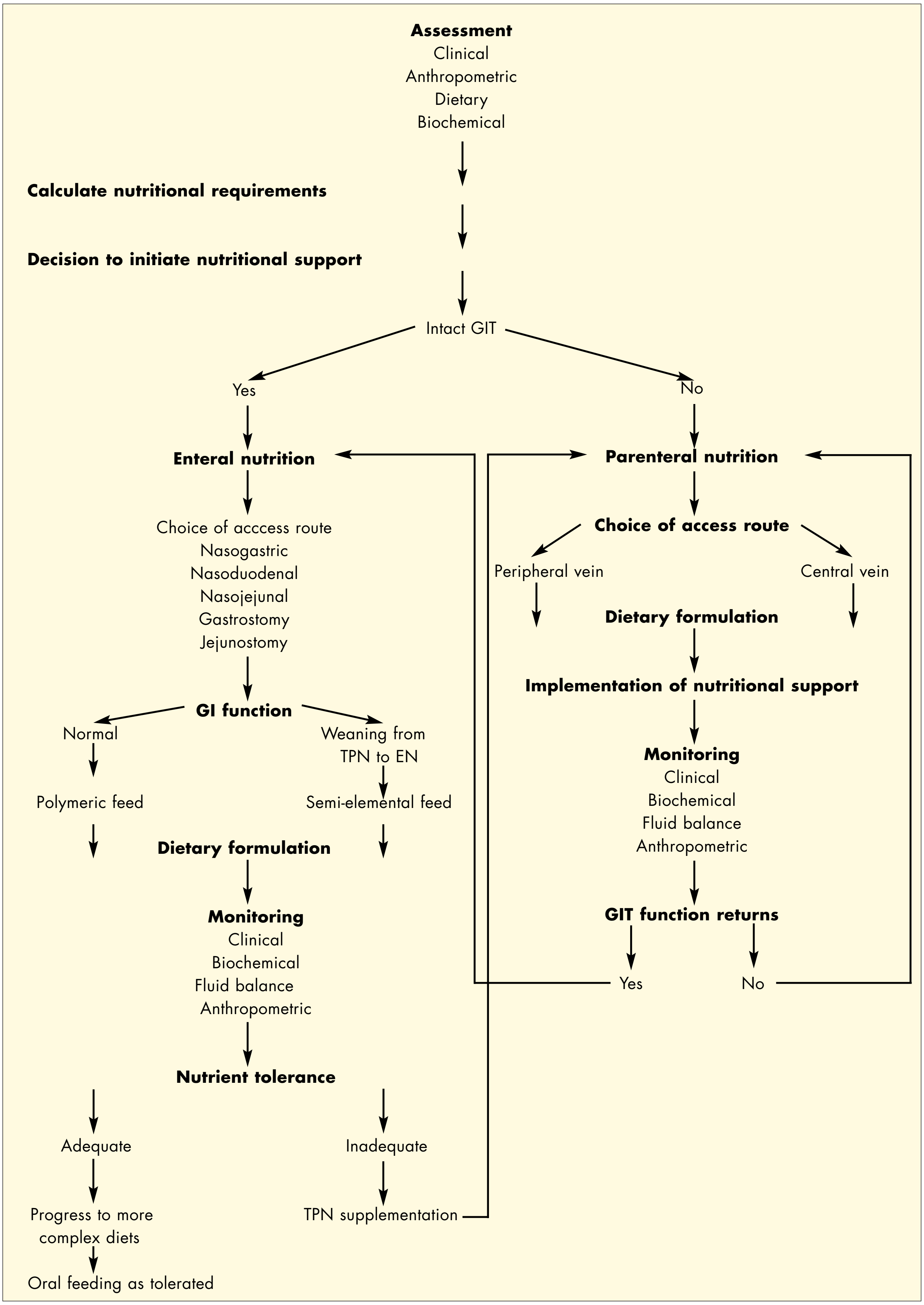

Fig. 1. Nutritional support algorithm 1.

If the stomach is functional and there are no contraindications, intragastric feeding allows greater scope in diet selection and techniques of administration. It also stimulates maximum enteral hormonal responses to feeding. Intragastric feeding should preferably be started within the first 12 - 18 hours. In a small minority of patients in whom nutritional requirements are not met via gastric feeding, e.g. low-birth-weight infants, radiation or chemotherapy enteritis patients, concomitant parenteral nutrition may be required.

In patients with gastroparesis, documented intolerance to intragastric feeding, or episodes of feeding-associated aspiration, or in a comatose patient with a head injury, direct small-bowel feeding techniques are preferred.[28] A radiograph of the lower chest and upper abdomen should be obtained routinely to confirm the position of the catheter tip before initiating feeding as only 43% of tubes are in the preferred position in the duodenum or beyond.[29] With the tube tip beyond the pylorus, retrograde flow into the stomach rarely occurs. The absence of bowel sounds, especially if the patient is ventilated or passage of flatus has been observed, does not preclude enteral feeding, particularly if it is delivered beyond the pylorus.[10] The tubes must be safely secured and carefully nursed to avoid displacement. The average 'life span' of a naso-enteric tube is approximately 10 days.

Percutaneous endoscopic enteral route

Access can also be gained to the upper gastrointestinal tract through a tube gastrostomy or jejunostomy. This is the preferred route for long-term feeding especially in the presence of oesophageal disease. Many of the complications of nasogastric or naso-enteric feeding can be avoided, especially in patients needing prolonged intensive care. This route is particularly valuable in confused or restless patients suffering from head injuries or metabolic encephalopathy, those with major surgery to the head and neck area and with difficult access to the gastrointestinal tract, and in patients with neurological disorders affecting swallowing and coughing. However, a patient's current disease status, co-morbidity, and requirement for

Table I. **Guidelines for nutritional intervention**

- Pre-existing malnutrition < 80% of ideal body weight
- Recent weight loss > 10%
- Nil per mouth > 5 days
- Increased nutrient losses
  - Malabsorption
  - Short-bowel syndrome
  - Enteric fistulae
  - Organ failure
- Increased nutrient requirements
  - Major trauma
  - Major surgery
  - Sepsis

Table II. **Practical consideration for enteral nutrition**

Route	Advantage	Disadvantage
Nasogastric	Physiological Gastric reservoir capacity Bacteriocidal barrier Higher osmolality feeds tolerated	Aspiration TPN supplementation may be required
Nasoduodenal or nasojejunal	Prevention of aspiration Immediate feeding Large volumes can be given Feeding possible in patient with gastroparesis	Overload syndrome Time needed for adaptation Mechanical tube problems
Gastrostomy/ PEG	Long-term use Cosmetically acceptable	Surgical/endoscopic procedure Aspiration/reflux Wound infection, peritonitis
Jejunostomy	Long-term use Aspiration unlikely Immediate feeding Bypasses stomach	Pump infusion required Displacement of tube Malabsorption Bacterial contamination Volume adaptation required

Table III. **Schofield equation for calculating resting metabolic rate (RMR) (kcal per day)**

Age (yrs)	Male subjects	Female subjects
< 3	0.167W + 1 517.4H - 617.6	16.252W + 1 023.2H - 413.5
3 - 10	19.59W + 130.3H + 414.9	16.696W + 161.8H + 371.2
10 - 18	16.25W + 137.2H + 515.5	8.365W + 465H + 200.0
> 18	15.057W + 10.04H + 705.8	13.623W + 283.0H + 98.2

W= weight; H = height

Table IV. **Schofield equation for calculating resting metabolic rate (RMR) (kcal per day) in children**

Age (yrs)	Male	Female
0 - 3	(60.9 x kg) - 54	(61.0 x kg) - 51
3 - 10	(22.7 x kg) - 495	(22.5 x kg) + 499

Table V. **Calculating resting metabolic rate (RMR) using WHO equation from weight**

Age (yrs)	Male	Female
0 - 3	(60.9 x kg) - 54	(61.0 x kg) - 51
3 - 10	(22.7 x kg) + 495	(22.5 x kg) + 499
10 - 18	(17.5 x kg) + 651	(12.2 x kg) + 746
18 - 30	(15.3 x kg) + 679	(14.7 x kg) + 496

medical therapy will determine the appropriate enteral access route and technique. Available techniques include the following:

- surgical gastrostomy or jejunostomy
- percutaneous endoscopic gastrostomy (PEG)
- percutaneous endoscopic gastrojejunostomy (PEG-J)
- percutaneous jejunostomy (endoscopic, radiologic).

A gastrostomy is a well-described method of providing enteral nutrition in children. Two methods are currently being utilised. A Stamm gastrostomy is considered the standard method and can be placed either as part of a laparotomy or solely for feeding purposes under general or local anaesthesia.[30]

The other method, namely a PEG, has proved to be a satisfactory alternative and feeding can be administered within 24 hours of insertion. Placement of the PEG may be either by the Sacks-Vine (push) or by the Gaurderer (pull) techniques.[31] This is associated with only a few procedure-related complications.[32] Skin level gastrostomy tubes, e.g. the button type, are used as PEG replacement devices either at the outset or after 3 weeks when the tract has matured. Specific recommendations have been developed for PEG care, i.e. only liquid diets should be used, the tube should be flushed with water to prevent clogging, liquidised food should not be used through tubes < 10F in size, and tablets, capsules or bulk-forming agents should not be given.[33]

Concomitant anti-reflux surgery should be done only in patients with proven gastro-oesophageal reflux, in the presence of oesophagitis and with laryngopharyngeal inco-ordination with recurrent aspiration. Immunosuppressed patients are at high risk of developing abdominal wall infections after gastrostomy or jejunostomy and it is advisable to give a preprocedural prophylactic antibiotic to all these patients.[34]

METHOD OF ADMINISTRATION (TABLE II)

The initiation of a specific enteral regimen in a patient will vary with regard to the desired flow rates of the selected formulation and the use of either intermittent or continuous feeding protocols with the aim of obtaining weight gain and a positive nitrogen balance. Continuous or intermittent enteral feeding should be administered by pump-controlled techniques. Physiological gravity bolus feeding is adequate in the majority of ambulatory patients who have a nasogastric tube or have undergone a gastrostomy, while pump-controlled feeding is preferred in critically ill patients and in those in whom continuous feeding is indicated. Continuous feeding via an enteral feeding pump is preferred when the tip of the tube is beyond the pylorus, as the small bowel cannot accommodate boluses of feed. Post-pyloric feeding reduces energy expenditure by 4 - 17% by reducing diet-induced thermogenesis,[35] lessens the risk of pulmonary aspiration (although this is questioned by some),[36] avoids the deposition of large volumes of hyperosmolar feeds directly into the upper jejunum and is associated with a reduced incidence of gastrointestinal haemorrhage. Bolus techniques detach patients from mechanical devices and are especially beneficial for alert, awake and mobile patients.

VOLUME OF ENTERAL FEEDING

'Slow start — gradual increase.' The normal bowel is remarkably tolerant of the deposition of an isotonic enteral

Table VI. **Physical activity factors**

Activity	**Activity factor**
Sleeping (ICU, sedation and muscle relaxation)	1.0
Hospitalised	
Not ambulant	1.2
Ambulant	1.3
At home	
Relatively inactive	1.4
Very active	1.9

Table VII. **Stress factors**

Disease	**Stress factor**
Trauma	
Little (e.g. long bone fracture)	1.2
Central nervous system	1.3
Moderate to severe (multiple)	1.5
Sepsis	
Moderate	1.3
Severe	1.6

feed.[37] Feeding protocols should take into account flow rates and advancement, feeding composition and osmolality and method of administration, i.e. continuous or intermittent schedules. It has been shown experimentally in human volunteers that the deposition of more than 6 - 18 ml/kg/h of intraluminal jejunal feeds leads to diarrhoea — the body's means of disposal of excess load.[37,38] Volume advancement is done at 1 ml/kg/h increments in children and at 60 ml/h in adults. Jejunal adaptation usually occurs over time, allowing greater latitude with regard to concentration and composition of jejunal feeds. Energy intake (EI) in calories or kilojoules should meet estimated energy expenditure (EEE) in addition to an activity factor of 1.2 (EI = EEE x 1.2). This formulation will provide adequate nutrition for the majority of patients. A practical alternative to this method is the use of predictive equations developed by Schofield *et al.*[40] and the Food Agriculture/World Health Organization/United Nations University.

There are two methods for the equations, which use weight only (Tables IV and V) and weight and height (Table III), both of which yield similar results when combined with activity and stress factors (Tables VI and VII, respectively).

References available on request.