Nutrition in the paediatric surgical patient

Simon Eaton
Helen Carnaghan

Abstract

Nutritional care of surgical infants and children is of major importance. This is for several reasons: (i) body stores are often smaller and more precarious; (ii) infants and children not only require energy for maintenance, but also for growth; and (iii) as in adults, recovery from surgery is faster in those patients who are adequately nourished. Survival of infants with congenital anomalies dramatically improved following the introduction of parenteral nutrition. However, infection and cholestasis remain problematic for parenterally fed infants and children.

Keywords Cholestasis; enteral nutrition; growth; parenteral nutrition

Background

Nutrition is especially important to surgical infants and children, firstly because of smaller body stores and relatively higher energy expenditure, and secondly because of the requirement for growth and adequate neurodevelopment. Energy stores are only adequate for ~2 days at 24–25 weeks gestation, increase to ~20 days at term as glycogen and fat stores increase[1] and are in excess of 50 days in the adult, hence the urgent need for adequate caloric intake in preterm infants after birth. Full-term neonates have higher content of endogenous fat (approximately 600 g) and therefore can tolerate a few days of undernutrition. Nevertheless, adequate nutrition in excess of basic requirements, i.e. enough to support growth, should be instituted as soon as practicable. Although adults following surgery or trauma have increased energy requirements,[2] there is no strong evidence that increased energy should be provided to septic or surgical neonates,[3] or to older children requiring surgery. Target enteral calories are as indicated in Table 1.

The optimum nutritional route is oral enteral feeding, However, artificial enteral feeding or parenteral nutrition (PN) may be required if adequate oral feeds cannot be tolerated. The basic principle underlying choice of feeding routes is that the most physiological route that is safely possible should be used: gastric feeds are preferred over jejunal feeds, enteral feeds are preferred over parenteral feeds etc.

Simon Eaton ***BSc PhD*** *is a Senior Lecturer in Paediatric Surgery at UCL Institute of Child Health and Great Ormond Street Hospital for Children, London, UK. Conflicts of interest: Simon Eaton has received speakers' honoraria from Danone and support to attend conferences from Fresenius Kabi.*

Helen Carnaghan ***BSc MB BChir (Cantab) MRCS*** *is a Paediatric Surgery Trainee and Wellcome Trust Clinical Research Training Fellow at UCL Institute of Child Health and Great Ormond Street Hospital for Children, London, UK. Conflicts of interest: none declared.*

Growth monitoring

Artificial enteral nutrition and PN are both nutritional interventions, and nutritional outcomes should be assessed in order to determine the effectiveness of these interventions. Growth of all paediatric surgical patients, especially those receiving artificial nutritional support, should be monitored longitudinally using appropriate charts. Currently in the UK we use the UK-WHO growth charts 0–18 years which are available from the Royal College of Paediatrics and Child Health.

Artificial enteral feeding

Indications

The simplest artificial route likely to be encountered by paediatric surgeons is the naso- or oro-gastric tube given to premature infants for immaturity of swallowing. Other indications for artificial enteral feeds are: delayed gastric emptying, gastroesophageal reflux, impaired intestinal motility, Crohn's disease, neurological or metabolic co-morbidity, intensive care/ventilation.

Route

The administration route can be via naso- or oro-gastric or jejunal tube, via gastrostomy, or via gastrojejunostomy or surgical jejunostomy tubes. Gastric feeding is preferable to intestinal feeding because it allows for a more natural and complete digestive process, i.e. allows action of salivary and gastric enzymes and the antibacterial action of stomach acid, in addition to the use of the stomach as a reservoir. Gastric feeding is associated with a larger osmotic and volume tolerance and a lower frequency of diarrhoea and dumping syndrome. Thus, transpyloric feeds are usually restricted to infants or children who are either unable to tolerate naso- or oro-gastric feeds, at increased risk of aspiration; or who have anatomical contra-indications to gastric feeds. Neonates are obligatory nose breathers and therefore oro-gastric feeding may be preferable over naso-gastric feeding in preterm infants to avoid upper airway obstruction. However, naso-gastric tubes are easier to secure and may involve a lower risk of displacement. In infants requiring gastric tube feeding for extended periods (e.g. more than 6–8 weeks) it is advisable to insert a gastrostomy, to decrease the negative oral stimulation of repeated insertion of nasal or oral tubes. The tube can be inserted using an open, laparoscopic or percutaneous endoscopic (PEG) approach. In infants with significant gastro-oesophageal reflux, fundoplication with gastrostomy tube or enterostomy tube placement is indicated,[4] although some authors favour a gastrojejunal tube over fundoplication plus gastrostomy.[5] There is no strong evidence to choose any of these therapeutic approaches over any other.

Selection of enteral feeds

Breast milk is the ideal feed for infants because it has specific anti-infectious activities, aids gastrointestinal maturation and neurological development. When breast milk is not available chemically defined formulae can be used, which are designed either for preterm infants, term infants, or older children. If malabsorption is present and persists, an appropriate specific formula should be introduced, such as soy-based disaccharide-free feed for disaccharide intolerance, medium chain triglyceride

Target caloric intake in infants and children

Age of child	Target caloric intake (kcal/kg/d)	
	Males	Females
Premature	110–120	110–120
0–1 month	113	107
1–3 months	100	97
3 months–1 year	80	80
1–4 years	82	78
5–8 years	73	70
9–13 years	64	58
14–18 years	53	47

Table 1

(MCT) formula for fat malabsorption, elemental (free amino acids) or semi-elemental (protein hydrolysate containing di- and tri-peptides) formula for severe malabsorption due to short bowel syndrome or severe mucosal damage as in NEC. For persistent severe malabsorption, a modular diet may be necessary, in which glucose, amino acid and MCT preparations are provided separately.

Administration of enteral feeds

Enteral feeds can be administered as boluses, continuous feeds or a combination of the two. Bolus feeds are more physiological and stimulate intestinal motility, enterohepatic circulation of bile acids, and gallbladder contraction. Bolus feeds mimic or supplement meals and are easier to administer than continuous feeds since a feeding pump is not required. Where bolus feeds are not tolerated, for example in the presence of gastro-oesophageal reflux, continuous feeds should be administered via an infusion pump over 24 hours. Infants and children with jejunal tubes should receive continuous feeds and not bolus feeds as the stomach is no longer providing a reservoir.

Complications of enteral tube feeding

Complications can be mechanical including leakage, tube blockage, tube displacement or migration, and intestinal perforation. Although infection is less of a risk than with PN, the risk of infected enteral feeds should not be ignored, and the gastrostomy/jejunostomy site can become infected. Other complications involve the gastrointestinal tract. These include: gastro-oesophageal reflux with aspiration pneumonia, dumping syndrome, and diarrhoea. Jejunostomy tubes inserted at laparotomy can be also associated with intestinal obstruction.

In surgical infants and children, enteral feeding often results in vomiting, interruption of feeding, and inadequate calorie intake. In infants with congenital gastrointestinal anomalies, exclusive enteral feeding is commonly precluded for some time after surgery due to large gastric aspirates and intestinal dysmotility, so calorie intake is established initially by PN (see below). Enteral feeding is introduced when intestinal motility and absorption improves. The percentage of calories given enterally is gradually increased at the expense of intravenous calorie intake. This transition time from total PN to total enteral feeding could be quite long. The presence of gastric aspirate often induces clinicians and surgeons not to use the gut for nutrition. However, minimal enteral feeding (trophic feeding) can be implemented early in these patients. These minimal feeds may prevent gut mucosal atrophy, increase intestinal blood flow, improve activity of digestive enzymes and thus 'prime' the gut for subsequent higher volume, nutritive feeds. Although enteral nutritional adequacy ('full enteral feeds') is usually assessed as enteral volume/calorie tolerance, it should be borne in mind that tolerance is not the same as absorption, as infants and children may require a significant period of time for intestinal adaptation to allow complete absorption of administered feeds. Growth monitoring following full enteral nutritional tolerance therefore remains necessary. In infants and children with stomas, frequent urinary electrolyte measurements are particularly important. Low urinary sodium with normal serum sodium suggests active sodium conservation. As sodium is important for growth, sodium supplementation may be appropriate in this scenario.[6]

Parenteral nutrition

Indications

PN should be utilized when enteral feeding is impossible, inadequate, or hazardous, but should be given for the shortest period of time possible and the proportion of nutrition given enterally increased as tolerated. Energy reserves are such that stable term infants can tolerate 3–4 days without enteral feeds, and older children 7–10 days, before starting PN, if it is anticipated that enteral nutrition may be resumed within this time. Premature neonates have smaller energy reserves and the time before introducing PN is much shorter.

The most frequent indications in paediatric surgery are intestinal obstruction due to congenital anomalies, although acquired conditions may require PN for variable lengths of time. Although infants with some neonatal surgical conditions, such as gastroschisis, are all likely to receive PN, there are some other congenital anomalies where the use of PN is more controversial, for example duodenal atresia, in which many surgeons would routinely initiate PN, whereas some surgeons preferentially manage patients without PN by the use of trans-anastomotic tubes.[7] In addition to congenital bowel obstruction, PN may also be used in cases of postoperative ileus, necrotizing enterocolitis, short-bowel syndrome, gastroenterological indications, and respiratory co-morbidity.

Route

PN must be administered via centrally placed catheters (including peripherally inserted central catheters (i.e. PICC lines), surgically placed central catheters or centrally placed umbilical catheters), as peripheral administration gives significant risk of complications from hyperosmolar glucose, which can cause vascular irritation or damage and thrombosis. Central catheter choice depends on catheters already in place, and the length of time over which PN is anticipated.[3]

Components of parenteral nutrition

The caloric requirements for PN are provided by carbohydrate and lipid. Protein is required for growth and is not used as a source of calories, since the catabolism of protein to produce energy is an uneconomic metabolic process compared to the oxidation of carbohydrate and fat which produces more energy at a lower