CHAPTER 6
NUTRITIONAL SUPPORT

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Introduction

Nutritional support is indicated in paediatric surgical patients for a variety of reasons. Invariably, it is indicated for patients who, for one reason or another, are unable to get enough calories to meet the requirements for daily function and to maintain lean body mass. Preoperatively, most of our patients in Ghana are frankly malnourished or very close to this, which has implications for postoperative outcomes, resulting in varying degrees of poor wound healing. A 2006 World Bank report on nutrition suggests that 24% of children in Africa are underweight and 35% are stunted.[1] This situation puts those children who then go on to develop problems requiring surgery at a distinct disadvantage in relation to their peers in developed countries. Surgical site infections of varying degrees or wound dehiscence are common manifestations of this poor nutrition.

Patients undergoing surgery who are at risk for long periods of ileus postoperatively will require careful planning for nutritional support. Patients with high metabolic requirements postoperatively will also require nutritional support. If surgery is elective, it is better to improve on nutritional status preoperatively. This is the best opportunity to maximise postoperative outcomes. If surgery is emergent, then supplemental nutrition should be offered as soon as possible following surgery. Oral and enteral feeding is always preferred, offering fewer complications than parenteral nutrition. In our environment, and for most centres, full parenteral nutrition is not always available, and other options must be explored.

Nutritional Support Needs

Preoperatively, oral and enteral feeding are the best ways to provide needed calories. The advantages of oral and enteral feeding include promoting the natural flora of the intestine, maintaining the integrity of the intestinal mucosa, and preventing the translocation of bacteria from the gut.[2] These feedings can promote immune function. If the intestinal tract is functional, a large amount of calories can be given by the oral or enteral route. Evidence shows that adequate nutrition can be provided, even to patients with short gut who have only 2 feet of viable bowel, in the absence of parenteral nutrition, by overnight tube feeding with a slow infusion, which also serves to correct fluid and electrolyte imbalance.[3,4] In addition to resulting in fewer complications, enteral feeding is also lower in cost than parenteral feeding.[5]

Generally, in the first year of life, caloric requirements are estimated at 90–150 kcal/kg, gradually decreasing to 40–60 kcal/kg by adolescence.

The Institute of Medicine (IOM) recommendations for children in the United States are shown in Table 6.1. There are no comparative figures currently available for African children.

If parenteral nutrition is necessary, the general guidelines for the distribution of calories (although these are fairly broad) are specifically: not more than 50% of the calories as fat (usually 20–40%), 40–60% of the calories as carbohydrate (specifically dextrose), and 10–20% of the calories as protein. Protein requirements vary by age, as seen in Table 6.2.

The daily trace metals requirements for children are given in Table 6.3.[6] In addition, selenium at 2 µg/kg per day and vitamins should be added to the parenteral nutrition. Fluid and electrolyte needs will vary with the patient's underlying condition and losses, and will need to be monitored for adequacy of supplementation. Routine fluid requirements in children are given in Table 6.4.

Table 6.1: Caloric recommendations for children.

Age	Caloric recommendations
2–3 years	1000–1400 calories
4–8 years	1400–1600 calories
9–13 years	girls: 1600–2000 calories boys: 1800–2200 calories
14–18 years	girls: 2000 calories boys: 2200–2400 calories

Table 6.2: Protein requirements.

Age	Protein requirement
Low birth weight neonate	3.5–4 gm/kg per day
Infant	2.5 gm/kg per day
2- to 13-year-old child	1.5–2 gm/kg per day
Adolescents	1–1.5 gm/kg per day

Table 6.3: Trace minerals requirements.

Trace mineral	Recommended requirements
Zinc	100 µg/kg*
Copper	20 µg/kg
Chromium	0.14–0.2 µg/kg
Manganese	2-10 µg/kg

*There may be increased needs with diarrhoea or losses via an ostomy.

Source: Adapted from Skipper A. Dietitian's Handbook of Enteral and Parenteral Nutrition, 2nd ed. Aspen Publishers, 1998, Pp 80–108.

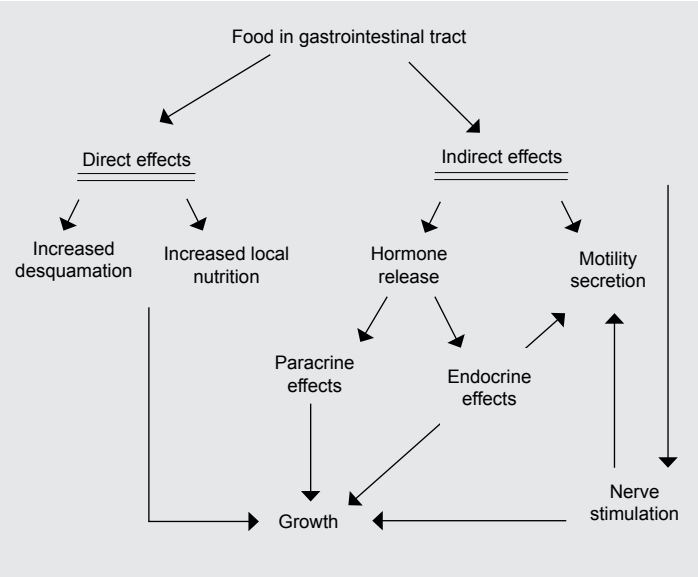
Table 6.4: Fluid guidelines.

Weight of patient	Basic amount	Additions
<10 kg	100 ml/kg per 24 hours	
11–20 kg	1,000ml	50 ml/kg for each kg >10 kg per 24 hours
21–40 kg	1,500ml	20 ml for each kg >20 kg per 24 hours
>40 kg	1,500ml/m2 per 24 hours	

Source: Adapted from Kerner JA. Manual of Pediatric Nutrition. John Wiley & Sons, 1983.

Pathophysiology of Malnutrition

Paediatric surgical patients who require nutritional support include those who normally would fall within the 50th centile on their weight charts but who, for one reason or another, have not been able to feed orally for more than 5 days; those who, as a result of their surgical problems, have a poor absorptive capacity; those who have high nutrient losses, such as would occur with small bowel enterostomies and



Source: Courtesy of European Society for Clinical Nutrition and Metabolism (ESPEN), Guidelines on Enteral Nutrition.

Figure 6.1: Normal intestinal function.

fistulas; and those with surgical conditions that result in an increase in nutritional needs from increased catabolism, such as occurs in burns and conditions of prolonged sepsis (e.g., peritonitis due to bowel perforation in complicated enteric fever).[7]

Food in the intestinal tract has both direct and indirect beneficial effects, as indicated in Figure 6.1.

Prolonged chronic illnesses that result in overall reduction in total caloric intake will result in poor nutritional state. In addition, any condition in which there is injury to the intestinal mucosa or reduction in total absorptive surface area of the bowel, either from local or systemic disease or any condition in which there is a reduction in overall length of bowel, may result in quantitative nutritional deficiencies and a need for nutritional support. These conditions include, but are not limited to, the following:

- the neonate with an ileostomy;
- antenatal rupture of exomphalos or gastroschisis;
- extensive intestinal resection with short gut and decreased transit time;
- necrotising enterocolitis;
- intestinal atresia ;
- midgut volvulus where there is extensive mucosal damage;
- massive injury, especially to the gastrointestinal tract, in conflict and various situations of violence, where enteral feeding is not feasible;
- inflammatory bowel disease;
- paediatric burns;
- complicated bowel perforations in enteric fever;
- oesophageal strictures from ingestion of corrosives; and
- achalasia of the cardia.

Clinical Evaluation

History

Generally, most communities in Africa place more value on boys than girls. After birth and until babies are weaned, there is usually no difference in nutritional status between girls and boys if the mother is generally well nourished herself. On weaning, however, gender differences in nutritional status in most communities in Africa are more likely to develop, with the boys being favoured.

A history of nutritional intake will be essential. A detail of the composition of the diet for a typical day will give a good indication of the type of nutritional deficiency that may exist. A history of the source of water may help to identify potential micronutrient deficiencies. If these are found to be present, they should then be added to the diet. Teenage and unmarried mothers are more likely to have undernourished or malnourished children because they generally belong to the lower socioeconomic classes and thus may not be able to obtain adequate food. The specific disease conditions listed in the previous section may be indications for additional nutritional support.

Physical Examination of the Child

Physical examination of the child will help to determine the degree of nutritional deprivation. The traditional parameters to measure include the weight and height, which can be compared with standard age, weight, and height charts, and the triceps skinfold thickness or midarm circumference determination. Among the various indices that help in determining nutritional status in children are anthropometric indicators, specifically weight-for-age, height-for-age, weight-for-height, weight/height index, upper arm anthropometry, and head circumference.[8] For preterm infants, crown-heel length and weight gain are the most sensitive indices of the adequacy of intake of nutrients.[6,8,9]

Investigations

Basic investigations required to confirm the proposed clinical diagnosis will be covered in the relevant chapters of this book. The discussion in this chapter is confined to the diagnosis of nutritional deficiency. The most helpful diagnostic indices of nutritional status are the physical examination findings noted in the preceding section. Laboratory investigations should include serum albumin and protein determination, although there are some limitations to their utility, as they may be normal even with significant malnutrition. They can be low in circumstances of excess losses or decreased synthesis. Before parenteral nutrition is given, it is important to check baseline levels of liver function tests, as well as levels of serum urea, electrolytes, and minerals (specifically, calcium, phosphorus, and magnesium). A chest x-ray will be needed to confirm the adequate placement of the total parenteral nutrition (TPN) catheter tip.

Management of Undernutrition and Malnutrition

Methods of Feeding

Oral feeding

Indirect methods of improving the caloric content of the food being given orally include cup and spoon feeding. Oral supplements may also need to be given. Antiemetics may be given for nausea and vomiting, or agents to help improve gastric emptying can be tried. If all these fail to improve the patient's nutritional status, the next step will be to give enteral feeding. Normally available local foodstuffs can be used if their caloric value can be determined. These can be blended and fed to the patient as needed.

Enteral feeding

Tube feedings can be delivered either as bolus or by slow infusion, depending on the patient's nutritional requirements, the composition of the feed being given in terms of solute load, and the capacity of the child's stomach to accommodate the quantities being fed. Various available commercial preparations can be used. In resource-poor settings, a dietitian can be engaged who will be able to use locally available foodstuffs to prepare high-energy blends to which additional nutrients can be added based on any identified deficiencies. It is important when enteral feedings are being given to ensure that the required amount of energy is actually being delivered.[6,9,10]

Parenteral feeding

Parenteral feeding can be given as an adjunct to other nutrition or as total parenteral nutrition if the period of starvation is prolonged or if enteral feeding is going to be impossible. Administration can be by a peripheral line for those requiring immediate support but whose conditions are expected to improve within 1–2 weeks.[11] Lower dextrose concentrations of no more than 12.5% dextrose should be given through a peripheral vein. A peripheral vein can be used only for short-term infusion and must be checked on a frequent basis and discontinued immediately if there are any signs of thrombophlebitis. A catheter can also be placed through a peripheral vein and then advanced until it is in a central position. The pressure from these catheters correlates well with centrally inserted catheters.[12]

Administration can also be through a centrally placed venous line. It is important to ensure that the tip of the central catheter is adequately placed before the solutions are infused. With centrally placed catheters, it is possible to give higher concentrations of dextrose and thus deliver more calories.

In all cases, nutritional support must include lipid, an energy source (usually dextrose), and amino acids. In environments where not all of these preparations are available, anecdotal experiences suggest some benefit in the use of alternative sources, including aliquots of fresh frozen plasma in the short term for small babies or intravenous preparations of amino acids, which can be administered with dextrose preparations in the short term.

Parameters for Monitoring Nutritional Outcomes

Nutritional outcomes are monitored, including a daily assessment of the overall clinical status of the patient, the state of hydration, and weight change. Ideally, it is also necessary on a daily basis to estimate electrolyte, creatinine, and urea levels; serum glucose levels; and magnesium, phosphorus, and calcium. Once the patient has stabilised, these parameters can be assessed much less frequently.

Postoperative Complications

Complications of Enteral Feeding

Complications with enteral feeding are less common than with parenteral nutrition. Such complications are summarised here. If the feeding contains an excess of electrolytes, these can be absorbed into the circulation, resulting in electrolyte imbalance. The concentration of the feeding or the rate of feeding may not be tolerated, with resultant nausea, abdominal cramps, vomiting, diarrhoea, or—less often—constipation. These are usually managed symptomatically, and often just a dilution of the solution given by introducing water into the mixture or slowing the rate of delivery will resolve the problem over a period of time. Rarely will the feeding have to be discontinued. Pulmonary aspiration may occur if amounts fed are not controlled.[9] This is particularly true if the patient has swallowing problems and therefore cannot protect the airway.

If there is any question about satisfactory placement of the tip of the enteral tube, a simple plain radiograph of the abdomen will be able to confirm the placement of the catheter if it is radio-opaque. If the tube is not radio-opaque, a small amount (5 ml) of contrast can be placed in the catheter prior to the x-ray.

Complications of Parenteral Feeding

Complications of parenteral feeding are numerous and include bacteraemia and septicaemia, air embolus, pneumothorax, hypo- or hyperglycaemia, thrombosis, hyperosmolality, metabolic acidosis, and hyperammonaemia. Other complications include cholestasis, migration of the catheter, and catheter blockage. Each complication has to be managed on its own merits. The metabolic complications, such as hypo- or hyperglycaemia and metabolic acidosis, can be managed by adjusting the parenteral nutrition solution. The most serious complication is sepsis, for which antibiotics are given first and then adjusted based on the organisms identified by blood culture. If the patient continues to have fevers or is clinically deteriorating, the parenteral catheter will need to be removed and the sepsis controlled before consideration is given to placing a new catheter, depending on the condition of the patient.

Poor nutrition in the surgical patient affects the clinical course of the disease and the clinical outcome of the patient.

Prevention of Poor Nutrition

Nutrition starts in utero. Attention must be given to appropriate educational programmes to ensure that pregnant women are well nourished and eating suitably balanced diets. This can involve addressing nutritional taboos, such as the belief that if the mother eats eggs in pregnancy, the delivery will be difficult.

Nutrition for children younger than five years of age must ensure adequate intake of calories, minerals, and vitamins that will maximise their growth. Specific known dietary deficiencies peculiar to some areas (e.g., iodine deficiency, which causes specific surgical problems) need to be addressed.

Preoperative assessment of surgical patients must include their nutritional status, and any deficiencies identified must be corrected wherever possible before surgical intervention is undertaken. Where this is not possible, postoperative management must include special attention to nutritional correction.

Ethical Issues

Traditionally and culturally, food and water are considered basic to the needs of each individual person. The modern practice of delivering nutrition and fluids via enteral and parenteral routes now challenges these values, adding on religious and moral dimensions as well as playing out issues of human rights. This is particularly the case when children have complex congenital abnormalities with poor prognosis. Decisions on starting or stopping feeding by oral, enteral, or parenteral means in most countries in Africa requires physicians to adhere to strict institutional policies, which should be developed for this purpose, as the increasing possibility of legal challenges cannot be ruled out.[13] More complex discussions of specific issues is beyond the scope of this book. Additionally, resource constraints in the region would affect the range of options available to the surgeon and the available modes of administration in terms of equipment availability.

Evidence-Based Research

Tables 6.5 and 6.6 present, respectively, a guideline for nasojejunal tube placement and a review of various feeding issues in preterm babies.

Table 6.5: Evidence-based research.

Title	Naso-jejunal tube placement in paediatric intensive care
Authors	McDermott A, Tomkins N, Lazonby G
Institution	The General Infirmary at Leeds, UK
Reference	Paediatr Nurs 2007; 19(2):26–28
Problem	In critically ill children, intragastric feeding is often poorly tolerated.
Intervention	A guideline for bedside nasojejunal tube (NJT) placement has been developed by a multidisciplinary group.
Comparison/ control (quality of evidence)	Audit of the practice was carried out after the implementation of the guidelines. Fifty-eight percent of the children would have definitely or probably started on parenteral nutrition.
Outcome/ effect	Reduction in requests for NJT placement under x-ray screening and reduction in the use of medication for the placement.
Historical significance/ comments	Improved tolerance of enteral feeding for better nutritional outcomes in intensive care units.

Table 6.6: Evidence-based research.

Title	Feeding issues in preterm infants
Authors	Cooke RJ, Embleton ND
Institution	Ward 35, Leazes Wing, Royal Victoria Infirmary, Newcastle upon Tyne, United Kingdom
Reference	Arch Dis Child Fetal Neonatal Ed 2000; 83:F215–F218
Problem	Ensuring that the nutritional intake of sick preterm infants meets requirements for sustained growth.
Intervention	Review of various practices to ascertain whether there are any differences in outcomes among the different practices.
Comparison/ control (quality of evidence)	The relation between measurements of knee-heel and crown-heel length is not consistent, as shown in some studies. These were thought to be the most sensitive indices of the adequacy of nutrient intake. There is no benefit in feeding formula with a protein/energy ration of 2.8 g per 100 kcal until term. Same results are obtained with a similar P/E ration if the infants are fed until between 3 to 9 corrected months.
Outcome/ effect	Feeding practices in preterm infants vary quite widely among special care baby units. Practices must be audited as a basis for their continuance.
Historical significance/ comments	Different studies over a period of time have arrived at different conclusions.

Key Summary Points

1. Preoperatively, most patients in most countries in Africa are frankly malnourished or borderline malnourished, which has implications for postoperative outcomes, including various degrees of poor wound healing.
2. If surgery is elective, it is better to improve on nutritional status preoperatively. This is the best opportunity to maximise postoperative outcomes.
3. If surgery is emergent, supplemental nutrition should be offered as soon as possible.
4. Patients undergoing surgery who will suffer long periods of ileus postoperatively require careful planning for nutritional support.
5. Patients with high metabolic requirements postoperatively also require nutritional support.
6. Enteral feeding is always preferred, offering fewer complications.
7. Necessary baseline tests include serum electrolyte estimation, serum protein levels, and liver function.
8. Attention to nutrition has to start in utero, with education dispelling any nutritional myths for pregnant women.
9. Nutrition in children younger than 5 years of age must ensure adequate intake of calories, which will allow maximum growth of the individual as well as the required intake of minerals and vitamins to maximise their growth. Locally available foodstuffs can be used for this.
10. Institutional policies must be developed to address ethical issues in order to protect physicians.

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