For successful use of enteral feeding it is important to choose the correct formula depending on the condition of the patient, to administer adequate volumes and monitor the response. Complications related to enteral feeding could be dangerous and need to be identified early. In the second part of our article we discuss these issues.

**TYPES OF FEED (TABLE VIII)**

It is important when selecting the type of feed to consider its physiochemical and digestive aspects and the functional status of the gastrointestinal tract. The ideal enteral feed should be nutritionally complete within reasonable volume limitations. The following qualities are desired: It should be easily digestible and absorbed, it should contain fibre and be lactose free and chemically stable. Pre-mixed ready-to-hang feeds containing absorbed emulsified fat that stays in suspension are now widely available. Polymeric formulas will meet most patients’ needs, although other specialised formulas, e.g. semi-elemental feeds, may offer advantages in specific disease states. Vitamin and trace-element supplementation should be added, although the exact requirements have not been determined. Before any additional supplementation it is important to take cognisance of the enteral feeds’ vitamin and mineral contents, as mega-dosing of certain vitamins and minerals may be counterproductive.

**MONITORING OF FEEDING TOLERANCE (TABLE IX)**

Monitoring of feeding tolerance is important, especially at the onset of enteral feeding. Large gastric residues, vomiting, abdominal colic and feeding intolerance in the form of diarrhoea may require reassessment of the technique, volume administered per hour and type of enteral feeding formula used. It is recommended that tube feeding be discontinued for 1 hour if gastric effluent exceeds 13 ml/kg. Unfortunately interruption of feeding schedules due to high gastric volumes, mechanical problems, surgical procedures, administration of medication and nursing procedures may place the patient at risk for not receiving adequate nutritional requirements. The presence of a single, high residual gastric volume should not automatically stop tube feeding, as the next measured volume is often within the normal range. It is important to remember that tubes < 10F diameter have been shown to be unreliable for the determination of residual volumes.

**FEEDING SCHEDULE PRECAUTIONS**

- Use aseptic techniques during enteral preparation, e.g. for powdered infant formula; use ready-to-hang closed enteral feeding systems wherever possible.
- Use closed ready-to-hang delivery systems to decrease the number of contaminants.
- Change the feeding bag every 24 hours.
- Change the administration set every 24 hours.
- Pump-infuse all continuous or intermittent feeds.
- Limit powdered infant formula to a hang-time of 8 hours.
- Use lactose-free fibre-containing formulas where possible.
• Use fibre in the formula as a standard enteral feed.
• Hyperosmolar feeds may be initiated at full strength at a slow continuous rate and gradually increased.
• The enteral tube should be flushed after every feed or every 6 hours.
• Jejunal feeding tubes should not be used to determine residual contents of the bowel and only continuous feeding should be advocated.
• Products such as potassium chloride and theophylline can coagulate tube feeding or obstruct J-tubes.
• Blocked tubes can be opened by flushing with solutions containing alcohol or carbonated mineral water (or Coca-Cola), avoid forcing liquid down the tube as this might result in a tube fracture or rupture.
• Do not use a guidewire to unblock tubes.
• Connections of enteral delivery systems should be incompatible with parenteral delivery systems.
• Oral nystatin should be administered as prophylaxis against Candida infections.

CONTRAINDICATIONS TO ENTERAL FEEDING

Splanchnic perfusion is sensitive to small changes in intravascular volume, and in the haemodynamically unstable patient enteral feeding may render the bowel vulnerable to decreased mesenteric blood flow. This can lead to bowel ischaemia and necrosis, with devastating consequences. Abdominal distension is a non-specific but ominous sign of impending bowel ischaemia; under these circumstances feeding should be promptly discontinued, unless another cause for the abdominal distension can be identified.

Feeding is contraindicated in patients with bowel obstruction distal to the site of delivery and in patients with pre-existing bowel disease. Persistent vomiting despite regular gastric aspiration, dysmotility, enteric fistula or diarrhoea may provide special challenges to enteral feeding but are not necessarily contraindications. A limiting factor may be glucose intolerance (glucose or reducing substances in the stool) accompanied by a large increase in stool output. Maintaining a positive fluid balance may be problematical under these circumstances.

Contraindications to surgically invasive techniques (gastrostomy, percutaneous endoscopic gastrostomy, jejunostomy) include local sepsis, massive ascites, peritoneal dialysis and uncorrected coagulation disorders.

COMPPLICATIONS ASSOCIATED WITH ENTERAL FEEDING

The increasing popularity of invasive methods for enteral feeding has been accompanied by a rise in serious complications of which the following are important:

Pulmonary aspiration

This is one of the most dangerous complications, with a reported incidence of up to 95%. The diagnosis of aspiration is based on the occurrence being witnessed and clinical signs of fever, dyspnoea and coughing suggestive of aspiration, with other causes being excluded. Aspiration of enteral formula from tracheal secretions and the presence of glucose or fat-laden macrophages provides supportive evidence. With careful nursing supervision, raising the head of the bed by 15 - 30° during and for 1 hour post prandially, frequent assessment of gastric residue, avoidance of large bolus feeding and good airway management, pulmonary aspiration is uncommon and generally benign. Enteral feeding can also increase the risk of ventilatory-associated pneumonia secondary to an increase in gastric pH, which will promote gastric bacterial colonisation. Research clearly favours transpyloric jejunal feeding over gastric feeding to prevent aspiration pneumonia, although the latter may still occur after pyloric feeding.

Factors impeding adequate delivery

These include surgical procedures requiring endoscopy, general anaesthesia, accidental feeding-tube removal and attempts to replace a malpositioned or malfunctioning tube, diagnostic studies, routine nursing care procedures and treatment procedures. In addition the following tube-related complications are not uncommon and include excessive tube length with knotting, wrong position, retrograde movement of tubes (especially during coughing or vomiting episodes), clogging of the tube with feeds and tube displacement or fracture. Placement of a naso-enteric tube is particularly hazardous in patients with a depressed level of consciousness, and a cuffed endotracheal tube is not always protective against pulmonary intubation. Both methods of gastrostomy placement (open, PEG) are not without complications. Although the PEG method is very successful it has a reported mortality of 1% and minor and major complications of 13% and 3%, respectively. The gastrojejunostomy (PEG-J) method has a high complication rate with failure (84%), frequent tube separation (59%), clogging (32%), kinking and knotting (9%). Specific complications are also encountered with jejunostomy tubes, i.e. obstruction of the tube, dislodgement, wound infection, peritoneal leak, enterocutaneous fistula or volvulus. Jejunostomy tube feeding is therefore not commonly used in children.

Diarrhoea

This is a common complication associated with an ill child (incidence of up to 70%). Diarrhoea is defined as a stool output of > 10 ml/kg/h or > 3 liquid stools per day. Its genesis is multifactorial and includes the use of antibiotics, rate and composition of infusion, feed contamination, altered bacterial flora, bowel wall oedema, use of osmotically active agents and overuse of prokinetic agents.
Gastrointestinal intolerance to enteral feeding is often observed by some groups in patients with low (< 15 - 20 g/dl) albumin levels. However, other groups report that physiological hypoalbuminaemia (1.0 - 2.5 g/dl) is well tolerated in acute malnutrition.

**Re-feeding syndrome**

This refers to the combination of depletion of total body stores during catabolic starvation and increased cellular influx of electrolytes during anabolic re-feeding, which leads to severe extracellular hypophosphataemia. Over-zealous feeding in the malnourished or traumatised patient can lead to this potentially fatal syndrome. Compartmental shifts and interrelationships of especially phosphate, magnesium, potassium, glucose and fluid occur. In the starved individual the catabolism of fat and muscle leads to the loss of lean body mass, water and minerals. With the conversion to carbohydrates as the major source of energy during the re-feeding syndrome, enhanced cellular uptake of glucose, phosphorus, magnesium, potassium and water is observed. Hypomagnesaemia and hypocalcaemia may also develop. These biochemical imbalances lead to alterations in cardiac, neuromuscular, haematological and respiratory function.

**Metabolic complications**

Other metabolic complications include hyperglycaemia, hypernatraemia, pre-renal azotaemia, vitamin and trace element deficiencies and abnormal liver functions.

**Table VIII. Enteral nutrition products**

<table>
<thead>
<tr>
<th>Type of feed</th>
<th>Indications</th>
<th>Characteristics</th>
<th>Examples</th>
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<tbody>
<tr>
<td>Supplement</td>
<td>Normal gastrointestinal function</td>
<td>Nutritionally complete – a supplement to food</td>
<td>Ready to use tetra packs: Pediasure, Frebini, Nutrini</td>
</tr>
</tbody>
</table>
| Polymeric          | Normal gastrointestinal function | Nutritionally complete | 0 - 12 mo: Nan, Pelargon  
|                    |                              |                          | 1 - 10 yrs: Ready-to-hang: Pediasure, Frebini, Nutrini, Tentrini  
|                    |                              |                          | > 10 yrs: Ready-to-hang: Fresubin Fibre, Nutrison Multi Fibre, Jevity |
| Polymeric, + fibre | Prevention or treatment of diarrhoea or constipation | Nutritionally complete | Fresubin Fibre, Nutrison Multi Fibre, Jevity |
| Semi-elemental     | Severe impaired gut function | Nutritionally complete Peptides | 0 - 12 mo: Pregestimil, Alfare, Nutramigen, Pepti & Pepti Jnr  
|                    |                              |                          | 1 - 4 yrs: Peptamen Jnr  
|                    |                              |                          | 10 yrs: Survimed, Peptisorb |
| Elemental          | Severe impaired gut function | Nutritionally complete Amino acids | 0 - 12 mo: Neocate  
| Immune-enhancing   | Critically ill patients, oncology | Specialised components | 1 - 4 yrs: Neocate Advanced  
| formula            |                              |                          | + 10 yrs: Perative, Prosure, Supportan |

**CONCLUSION**

Successful enteral feeding regimens can be implemented but they require careful planning and monitoring. Optimal nutritional support decreases the effects of starvation during trauma or illness. Attainment of a positive nitrogen balance prevents specific nutritional deficiencies and supports the acute phase of recovery until the hypermetabolic response has resolved.

The enteral route of administration provides a greater variety of nutrients, and combined enteral and parenteral nutrition may become the major feeding modality of the future. Probiotics may also play an important role in the future, especially in the light of antibiotic-resistant microorganisms.
Table IX. Clinical monitoring protocol

**Initial assessment**

- Assess nutritional support and obtain baseline parameters
- Determine energy, protein, fluid and micronutrient needs
- Recommend vitamin/mineral supplementation
- Select feeding modality(ies)/oral, enteral, parenteral or combination
- Initiate method and feeding regime

**Evaluation of tolerance and effects of nutritional therapy**

- Regular monitoring of weight, biochemical and haematological parameters
- Daily abdominal examination and 6-hourly urine glucose levels
- Daily input and output assessment
- Determine feeding compliance and tolerance with established goals
- Monitor patient’s ability to tolerate advances in nutritional regimen
- Conduct nutrient analysis and record daily and accumulated intake for calories and protein until condition stabilises or feeding is stopped
- Episodes of gastrointestinal and pulmonary dysfunction should be evaluated and treated accordingly
- Monitor for sepsis
- Adjust feeding regimen to surgical procedures and other treatment modalities

(Table adapted from Gottschlich MM et al. Diarrhoea in tube-fed burn patients: incidence, etiology, nutritional impact, and prevention. JPEN 1988, 12:338-345.)

**ICD-10**

*International Statistical Classification of Diseases and Related Health Problems Volume 1, 2 and 3*

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