Enteral nutrition

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Enteral nutrition is feeding the gastrointestinal tract either with food, oral supplements or via tube. It is generally safe, easy to administer and free of major complications. The most common problems relate to the tubes themselves, such as blockage and stoma infection.

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Enteral feeding is the administration of nutrients directly into the gastrointestinal (GI) tract via a tube. This term does not generally include the optimization of oral intake with diet and/or nutritional supplements.

INDICATIONS FOR ENTERAL FEEDING

Enteral feeding should be considered in any patient with a functioning GI tract who is unable to meet his/her requirements with ordinary diet, food fortification and/or oral nutritional supplements. Such a decision should usually be made only after discussion with a dietitian.

Enteral feed can either be administered into the stomach (intragastric feeding) or directly into the small intestine (post-pyloric feeding). *Table 1* lists the options for each route. The indications for the two routes of feeding are different, as are the indications for the type of tube used (Kirby et al, 1995; DiSario et al, 2002).

Enteral feeding is contraindicated where there is an obstruction to the GI tract, either mechanical (e.g. tumour) or functional (e.g. ileus). If that obstruction is proximal to the pylorus, post-pyloric feeding should be considered. The presence of a proximal gut fistula is regarded as a contraindication to enteral feeding by some, but not all, authorities on intestinal failure, and in this situation advice may need to be sought.

The appropriateness of feeding and the ethical decisions underlying nutritional support will not be covered in this article, but the interested reader can refer to Lennard-Jones (1999).

TABLE 1.
Routes for enteral feeding

Intragastric feeding	Nasogastric tube
	Percutaneous endoscopic gastrostomy
Post-pyloric feeding	Nasojejunal tube
	Percutaneous endoscopic gastrojejunostomy
	Percutaneous endoscopic jejunostomy
	Surgically placed jejunostomy

INTRAGASTRIC FEEDING

Indications

There are two main categories of patients in whom intragastric feeding is required: patients with a functioning stomach and without vomiting or aspiration, and those who require supplements to an inadequate oral intake. Patients with a functioning stomach and without vomiting or aspiration include:

- Those with impaired swallow, e.g. stroke, motor neurone disease, Parkinson's disease
- Those with altered level of consciousness making oral feeding impossible
- Ventilated patients with tracheostomy
- Those with dysphagia without complete oropharyngeal or oesophageal obstruction, i.e. head and neck or oesophageal cancer.

Those in whom intragastric feeding may be required to supplement inadequate oral intake include patients with:

- Cystic fibrosis
- Hyper-catabolic states, e.g. burn injury, decompensated liver disease
- Facial injury
- Human immunodeficiency virus (HIV)-related wasting
- Psychological or psychiatric reasons, e.g. anorexia nervosa.

For short-term feeding, i.e. <4 weeks, nasogastric (NG) tube is usually the most appropriate. For longer term feeding and when there is facial injury a percutaneous endoscopic gastrostomy (PEG) is preferable (Dormann and Huchzermeyer, 2002; Pearce and Duncan, 2002).

POST-PYLORIC FEEDING

Indications

- Feeding a functioning GI tract when the stomach needs to be bypassed, i.e. where there is a gastric outflow obstruction, either as a result of mechanical causes (e.g. pyloric tumour, stricture) or gastric stasis (as seen in critical illness)
- Severe pancreatitis
- Risk of aspiration with intragastric feeding.

The four different methods of delivering post-pyloric feeding, i.e. nasojejunal (NJ) tube, percutaneous endoscopic gastrojejunostomy (PEGJ), percutaneous endoscopic jejunostomy (PEJ) and surgical jejunostomy all have similar indications (Dormann and Huchzermeyer, 2002; Pearce and Duncan, 2002). For short-term feeding NJ would be the route of choice, for longer term feeding the other three options could all be considered.

ROUTES FOR ENTERAL FEEDING

Nasogastric tube

There are two types of NG tubes: fine-bore tubes designed for administration of feed; and wide-bore tubes (e.g. Ryles) designed for aspiration. The latter can cause oesophageal damage, such as ulceration and stricture, if left in for a prolonged period, and should not be used for feeding. Fine-bore tubes are easy to insert and safe, even in patients with oesophageal varices.

The most commonly encountered problem with NG tubes is inadvertent removal, either at the hand of the patient or by accident, e.g. snagged on clothing or as a result of vomiting. If this is a recurring problem and feeding is still required, either a PEG can be considered or a 'nasal loop' can be placed. The latter is a technique whereby some tape is slung around the nasal septum and attached to the feeding tube, thereby making it very difficult to pull out accidentally – further details can be found in Anderson et al (2004).

Percutaneous endoscopic gastrostomy tubes

There are a number of different types of PEG tube in terms of size (9–24 FG), internal fixator (flange, balloon) and material, including more cosmetically acceptable 'button' gastrostomies (*Figure 1*).

PEG insertion is now a standard endoscopic procedure, and details of insertion technique are not included here. Although not a sterile procedure, antibiotic prophylaxis, such as cefotaxime 2 g or co-amoxyclav 2.2 g 30 minutes before the procedure, is recommended (Sharma and Howden, 2000). *Table 2* lists the contraindications to PEG insertion. It should be noted that many of the relative contraindications to endoscopic placement can be overcome if insertion is done under radiological guidance.

PEG can be easily removed, but care is required. If it is removed within 2–3 weeks of insertion a formal tract will not have formed, with consequent risk of spillage of gastric contents into the peritoneal cavity leading to peritonitis. This also means that it will not be possible to re-insert a feeding tube down the same track, as it will not find its way into the gastric lumen. Therefore if the PEG does come out in the first few weeks of insertion, whether at the hand of the patient or some other mishap, the stoma site should be covered, antibiotic cover instituted and, if nutritional support is still required, an alternative access, e.g. NG tube, used until the wound has healed.

After 2–3 weeks removal presents little risk of peritonitis or sepsis. However, closure is rapid, so if replacement is required this must be done within 4–6 hours using a fresh PEG or, temporarily, a balloon gastrostomy or Foley catheter.

Elective removal is usually done endoscopically. Alternatively, the tube can be cut close to the skin allowing the internal fixator to pass spontaneously through the GI tract. There are no reported incidents of obstruction, e.g. at the ileo-caecal junction, and this method is probably safe.

Figure 1. Button gastrostomy.

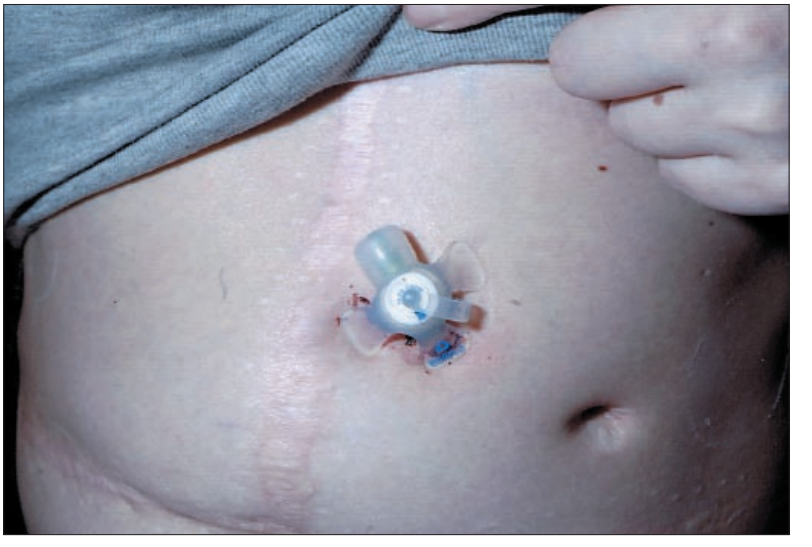

TABLE 2.
Contraindications to percutaneous endoscopic gastrostomy insertion

Absolute	Inability to pass endoscope because of obstructing pathology in oropharynx or oesophagus*
	Obstructing gastric outflow pathology
Relative	Severe obesity (as a result of technical difficulties accessing the stomach)*
	Uncorrected coagulopathy
	Portal hypertension or ascites
	Active gastric ulceration or malignancy
	Gastroparesis
	Gastrectomy (total or partial)*
	Severe kyphoscoliosis (may be difficult to access stomach)*
	Current peritoneal dialysis

* May be achievable if done under radiological guidance to locate stomach

Nasojejunal tube

Specifically designed NJ tubes such as the Bengmark tube (Nutricia, Trowbridge, UK) will spontaneously cross the pylorus in 70–80% of patients with normal gastroduodenal motility, especially with a concurrent intravenous bolus of metoclopramide 10 mg. If the stomach is atonic, NJ tubes usually require endoscopic placement. The distal end must be placed beyond the duodenojejunal flexure (*Figure 2*) or it will almost invariably pass retrogradely back in to the stomach. Weighted tubes have no advantage over unweighted tubes and are seldom indicated. Plain abdominal X-ray is required to verify placement, unless placed under screening.

Percutaneous endoscopic gastrojejunostomy and jejunostomy

PEGJ are 'extensions' that attach to a PEG and can be passed endoscopically beyond the duodenojejunal flexure. PEJ is similar to PEG but requires a direct puncture into the small intestine. Insertion techniques are not straightforward and, on the whole, there is probably no advantage of these over a surgically-placed jejunostomy for post-pyloric feeding, except in a patient who is too unfit to have a general anaesthetic.

Removal of PEGJ/PEJ is similar to PEG.

Surgical jejunostomy

Needle jejunostomies inserted using a large needle tunnelled subserosally to reduce the risk of leakage are the most commonly used, but tend to be fine bore and prone to block if poorly managed. Other tubes such as Foley catheters can be used but are not ideal because of leakage and difficulties in connecting with feeding equipment.

Increasingly, jejunostomies are inserted peroperatively to allow for early postoperative feeding. Although complications can occur, the advantages of improved postoperative nutrition usually outweigh the risks (Sarr, 1999).

Figure 2. Nasojejunal tube in situ, with distal end beyond the duodenojejunal flexure.

ENTERAL FEEDS

There are many different enteral feeds available. Broadly speaking they can be divided into the following groups:

Polymeric feeds

These contain whole protein, carbohydrate and fat and they can be used as a sole source of nutrition for those without any special nutrient requirements. The standard concentration is 1 kcal/ml, but they can be more or less energy dense (0.8–2.0 kcal/ml) and can also contain fibre, which can improve bowel function if this is problematic.

Elemental feeds

These contain protein in amino acid form and carbohydrate as glucose or maltodextrins. Fat content is very low. They are used primarily in situations of malabsorption or (by some) as a primary treatment for Crohn's disease. Because of their high osmolality they should not be used in patients with short bowel syndrome.

Disease-specific feeds

Certain clinical situations require alterations in diets. For example there are high energy and low electrolyte feeds designed for patients on dialysis, and low carbohydrate and high fat diets for patients with carbon dioxide (CO_2) retention, such as those on ventilators (carbohydrate has a higher respiratory quotient than fat or protein and leads to more CO_2 production, which can delay weaning from ventilation).

Immune-modulating feeds

These feeds contain extra substrates, which may alter the immune and inflammatory responses. The commonly used substrates are glutamine, arginine, RNA, omega-3 fatty acids and antioxidants. Evidence is gathering for the use of these products in certain surgical, trauma, critically ill and cancer patients but their exact place and indications for use have yet to be fully agreed (McCowen and Bistrian, 2003).

ADMINISTRATION OF TUBE FEEDS

Feeds are ideally given with the patient at 30–45°, although this is often not possible in some clinical situations, such as ventilated or multiple trauma patients.

For intragastric feeding, diet can be delivered either by a continuous pump infusion over 16–18 hours a day (allowing some freedom away from the pump); or by intermittent administration of 50–250 ml boluses over 10–30 minutes by syringe. Concerns that this method results in greater complications including aspiration has not been adequately tested in clinical trials, and very often the method of delivery depends on local resource and practice.

Post-pyloric feeding is generally by continuous infusion, as this is more physiological than bolus feeding.

COMPLICATIONS OF ENTERAL FEEDING

On the whole enteral feeding is safe and complications are not usually serious. They can be divided into those caused by the tubes and routes of feeding (*Table 3* and *4*), and those caused by the feeding itself. Complications caused by the tubes are common, and most patients on long-term feeding can usually expect to have some of the more common problems listed in *Table 4*. Complications caused by the feeding itself include:

Diarrhoea

This is the commonest complication, with quoted rates between 5% and 60% (Bowling, 1995). It is most commonly associated with antibiotics, laxative use, contaminated feeds and hypoalbuminaemia. Management is first to exclude other explanations, e.g. *Clostridium difficile*, colitis and malabsorption. Concomitant medications should be rationalized if possible, especially antibiotics. Antidiarrhoeal medication (loperamide and/or codeine phosphate) is often successful, and fibre can help although evidence for this is lacking. If sufficiently troublesome and resistant to treatment, post-pyloric feeding can sometimes help, but very occasionally parenteral feeding is required.

Constipation

This is usually the result of a combination of inadequate fluid, dehydration, poor mobility and drugs (e.g. opiates). If colonic pathology is excluded or unlikely, management is by laxatives, suppositories and fibre feeds.

Vomiting, aspiration or reflux

Both NG and PEG feeding can increase the risk of aspiration. Both can interfere with gastro-oesophageal sphincter function, and wide-bore NG tubes do so more than fine-bore tubes. Where possible patients should be fed at 30–45°. Standard antiemetics and prokinetic agents are usually effective. Alternative or additional management options include alteration of feed delivery (change from bolus to continuous feeding), or changing diet to a more energy dense one, with smaller volumes delivering

TABLE 3.
Complications of nasogastric and nasojejunal tubes

Removal by patient*	Purposeful	Consider patient withdrawal of consent
	Confused	May need re-siting or if repeated removal consider either means of restraint, e.g. nasal loop, or alternative means of nutritional support, e.g. PEG
Oesophageal ulceration or strictures	Now uncommon if fine-bore tubes are used for the short-term	
Malpositioning	If occurs into lungs can lead to infection, effusion and empyema. Occasionally tube can be malpositioned intracranially	
Blockage*	All types of enteral feeding tubes may become blocked and the fine bore tubes are particularly at risk from this. Tubes should be flushed with water before starting and after completion of a feed, 4–6-hourly throughout feeding and before and after medication, as residue can quickly build up. If blocked soda water or pancreatic enzymes, which can break down the coagulated protein, can be used. Acidic fizzy drinks, such as cola, can coagulate protein in the tube and exacerbate the problem – these should therefore not be used	

*Common complications. PEG = percutaneous endoscopic gastrostomy

TABLE 4.
Complications of PEG, PEGJ and PEJ

Early	Pain common within first 24 hours. If severe exclude peritonitis and tube displacement into anterior abdominal wall*
	Haemorrhage unusual if clotting screen within normal limits. As malnutrition can lead to vitamin K deficiency, the prothrombin time and/or INR should always be checked before procedure
	Peritonitis
	Pneumoperitoneum. There will always be some free air after PEG insertion
	Gastrocolic fistula as a result of interposition of colon between anterior abdominal wall and stomach
Late	Stoma infection usually resolves with appropriate antibiotics, e.g. flucloxacillin and proper stoma care. Not usually necessary to remove PEG or stop feeding unless severe ulceration or wound breakdown*
	Tube blockage. Minimized if flushed with water before and after each feed or dose of medication*
	Aspiration. Minimized by feeding for no more than 20 hours per day at an elevation of at least 30°*
	Buried bumper. Migration of internal fixator migrates into gastric or anterior abdominal wall leading to tube blockage. This usually requires surgery to remove
	Tumour tract seeding. A few case reports of PEGs inserted in oesophageal or oropharyngeal tumours developing neoplastic seeding in stoma tracks. Where the PEG is inserted as part of palliative care, this is unlikely to be of relevance in the patient's life-time
	Overgranulation can occur at stoma site and bleed or become painful. Treated with steroid cream or silver nitrate

*Common complications. INR = international normalized ratio; PEG = percutaneous endoscopic gastrostomy; PEGJ = percutaneous endoscopic gastrojejunostomy; PEJ = percutaneous endoscopic jejunostomy

equivalent calories. Occasionally post-pyloric feeding will be required.

Metabolic complications

Both under- and over-hydration can be avoided by rigorous fluid balance control (1000 ml enteral feed delivers approximately 900 ml of free fluid).

Overfeeding: Giving calories in excess of requirements can cause serious or even fatal metabolic complications, especially in critically ill patients. It is usually caused by a combination of inaccurate nutritional assessments and not taking into consideration energy from non-feed sources, e.g. propofol and glucose-containing dialysate solutions.

Hyperglycaemia: This is especially important in critically ill patients where it has been found that controlling blood glucose levels within 4–6 mmol/litre reduces mortality (Klein et al, 1998; Van Den Berghe et al, 2001).

Hypercapnoea: Nutrient metabolism requires oxygen and produces CO_2. Overfeeding should be avoided as greater amounts of CO_2 are produced, and this can delay weaning from a ventilator or cause problems for patients with significant respiratory disease.

Hypertonic dehydration: This can be caused by excessive protein intake combined with inability to excrete nitrogenous waste effectively. This occurs with patients who are dehydrated.

Refeeding syndrome: This can be defined as severe fluid and electrolyte shifts and related metabolic implications in malnourished patients undergoing refeeding (Cook et al, 2001). Excess carbohydrate stimulates insulin release leading to substantial cellular uptake of phosphate, magnesium and potassium and a consequent fall in their serum levels. This may lead to dangerous cardiac arrhythmias and neurological events, and can be fatal. Emaciated patients must never be fed beyond appropriate requirements. In such patients initial feeding should be 20 kcal/kg, for example only 600 kcal/day for a 30 kg patient. Phosphate, magnesium and potassium should be monitored daily, and supplemented if necessary.

Vitamin/trace element deficiencies: These are rare, as most commercially available feeds are now nutritionally complete. Patients being fed over a prolonged period of time may be at risk. Appropriate monitoring should avoid problems. **HM**

Conflict of interest: none.

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KEY POINTS

- Enteral feeding is required for patients with a functioning gastrointestinal tract who are unable to meet their nutritional requirements orally.
- Enteral feeding can be either intragastric or post-pyloric.
- Nasogastric and nasojejunal tubes are preferred for short-term feeding (<4 weeks).
- Endoscopically placed tubes are better for long-term feeding (>4 weeks).
- Enteral feeding itself is generally safe, although long-term feeding requires careful biochemical monitoring.
- Enteral feeding tubes themselves, especially percutaneously placed tubes, lead to complications quite frequently. In the main these are minor and easily managed.