6.4 Enteral nutrition

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Key points

- The decision to start feeding should consider the ethics of individual patient circumstances, the requirement to do no harm and the potential improvement in quality of life.
- The route of feeding and feeding regimen, including timing and type of feed, should be decided on an individual basis, taking into account clinical indications, treatment plan and nutritional status.
- Effective monitoring will help to ensure that nutritional support is provided safely, complications are detected early and treated effectively, and nutritional objectives are met and/or reviewed.
- Patients going home on enteral feeding should have an individual discharge plan.

Enteral tube feeding (ETF) is a widely used method for ensuring adequate nutrition in patients who have a functioning gastrointestinal tract but are unable to maintain an adequate or safe oral intake. Enteral feeding (EF) in both the hospital and community setting is becoming increasingly common, as a range of access and delivery methods have been successfully established. Prior to initiating ETF, ethics and consent should be considered (British Society of Gastroenterology (BSG), 1999), in addition to practical issues such as discharge planning, training and support in the community. Dietitians are uniquely placed to provide guidance and recommendations regarding nutritional support, and play a key role within the multidisciplinary team (MDT) in the treatment of patients requiring EF (American Dietetic Association, 1997).

Indications for enteral nutrition

EF is indicated when oral intake is insufficient or unsafe (NICE, 2006), and is the preferred option whenever a patient's gastrointestinal tract is accessible and functioning (Stroud *et al.*, 2003). It is most commonly used in patients with the following features or disorders (NICE, 2006):

- Unconscious patients.
- Neuromuscular swallowing disorders, e.g. stroke.
- Physiological anorexia.
- Upper-gastrointestinal obstruction, e.g. head and neck tumours.
- Gastrointestinal dysfunction or malabsorption, e.g. pancreatitis, gastrointestinal dysmotility.
- Increased nutritional requirements.
- Psychological problems.
- Specific treatment, e.g. Crohn's disease.

Several factors need to be considered when deciding to initiate ETF. These include the risks and benefits of ET placement, the most appropriate method of tube placement and selection of the most suitable feeding tube. The decision should be made following a multidisciplinary discussion, and the views and wishes of the patients and/or their families or carers should be considered. A decision to enterally feed a patient may also be influenced by the future treatments required, e.g. surgery or radiotherapy. Nutritional support should be tailored to the clinical state and the perceived best outcome for the patient (see Chapter 2.2, Assessment of nutritional status and Chapter 6.1, Nutritional requirements in clinical practice).

Ethical considerations

Ethical issues should always be considered before initiating ETF, and consent must be obtained if a patient has the mental capacity. Consent and ethics must be considered before nasogastric (NG) tube placement. Even when only short-term nutritional support is thought to be necessary, informed consent should be obtained (if possible), and ethical issues should be considered (RCP & BSG, 2010). Ideally, a multidisciplinary nutrition support team (NST)

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should be available to assess patients. The team is ideally placed to communicate with patients, carers and the referring team regarding appropriate feeding options. A well-functioning NST can reduce the number of inappropriate gastrostomy placements (Abuksis *et al.*, 2004; Sanders *et al.*, 2002). In the absence of a formal NST, e.g. in community settings, an MDT meeting should be held involving the patient, family, relevant care staff, dietitian and any other relevant health professionals to discuss the instigation of EF.

When making a decision regarding EF, it is essential to first establish the indication for nutritional intervention, treatment goal, and the will and consent of each individual patient (Druml *et al.*, 2016). While offering adequate food and water to patients is a basic duty of care, artificial nutritional support (both enteral and parenteral) is regarded as a medical treatment. Any previous relevant opinions of the patient must be taken into account. Under the Mental Capacity Act (2005), the medical team is required to obtain the view of the family and carers. Patients may have conferred a Lasting Power of Attorney (LPA), giving someone else the authority to make decisions about their health and personal welfare. The Royal College of Physicians (RCP) and the British Society of Gastroenterology (BSG) (2010) have provided a comprehensive overview of the legal position regarding the withholding and withdrawing of life-prolonging medical treatment, including nutritional support (see Chapter 1.1, Professional practice and Chapter 7.16, Palliative and end-of-life care). The treating physician is responsible for making the final decision and is ultimately accountable. In cases where the benefits of nutritional support are uncertain, a time-limited trial can be undertaken with clearly agreed objectives. Open communication with family members, carers and the MDT is essential.

The issue of whether to continue feeding severely ill patients who have a poor prognosis is less clear; nutritional care should always be considered on an individual basis. The decision to withdraw artificial nutrition support should be considered on a case-by-case basis. The overall benefit to the patient, including the purpose of nutritional intervention, risks, and the significance of nutrition in the latter stages of life should be considered (Druml *et al.*, 2016).

Routes of enteral feeding

EF is preferable to parenteral nutrition (PN) when the gut is accessible and has adequate absorptive capacity, as it is more physiological and cheaper (Stroud *et al.*, 2003). Only a few patients cannot receive some form of EF. The route of EF is decided on an individual basis according to the clinical indications, treatment plan and nutritional state. It may be delivered:

- Directly into the stomach (gastric feeding) via orogastric, NG, gastrostomy or oesophagostomy tube.
- After the stomach (post-pyloric feeding) via nasoduodenal or nasojejunal tube, gastrojejunostomy or jejunostomy.

Gastric feeding routes

Nasogastric feeding

This is usually used for short-term nutritional support (<6 weeks), or in the longer term when other options such as gastrostomy feeding are contraindicated or inappropriate (Stroud *et al.*, 2003). Each patient should have individual nutritional risk assessment carried out prior to passing an NG tube (NGT), and managing healthcare professionals (HCPs) should ensure that recommendations to reduce the harm caused by misplaced NGTs are followed (National Patient Safety Agency, or NPSA, 2005, 2011).

A fine-bore NGT, usually made from polyvinyl chloride (PVC), polyurethane (PU) or silicone, is inserted through the nose and into the stomach. PVC tubes are suitable for short-term feeding (<10 days), and are usually rigid and wide-bore (10–18 FG; French gauge). The complications associated with wide-bore tubes are well known (nasal erosion, oesophageal ulceration), but they should be considered in patients at high risk of pulmonary aspiration, with conversion to a fine-bore tube once successful gastric emptying is established. More expensive and durable PU tubes are more suitable for longer-term use. Fine-bore feeding tubes are usually of 6–9 FG. Tubes must be radio-opaque throughout their length and have visible markings to ensure accurate identification and documentation of position (NPSA, 2011).

Other methods of gastric placement are:

- Orogastric – used in head injury patients or in those with facial trauma.
- Cervical pharyngostomy, oesphagostomy and stomagastric tubes – used in head and neck cancer patients.

Confirmation of gastric tube placement

It is vital to establish that the tube tip is positioned in the stomach (and not in the lungs) before each feeding episode, before flushing with water or medication, and if there is any doubt about tube's position. Deaths resulting from the misplacement of NG tubes have been reported (NPSA, 2005, 2011). The following methods for confirming NG tube placement are recommended (NPSA, 2005, 2011):

- *Stomach aspirate pH* – aspirate stomach contents, and check that it is acidic, pH ≤ 5.5, using CE-marked pH indicator strips or paper (pH ≤ 5 on paper that does not have ½ markings). If the patient is on continuous feeding or receiving drugs such as antacids (including proton pump inhibitors), the pH may be >5.5. If feed is present, pH should be rechecked up to 1 hour after feeding. If antacids are used, the timing of their consumption may need to be reviewed.
- *X ray confirmation* – this should only be undertaken if there is doubt about the position of the tube or difficulty in obtaining aspirate. An X ray only confirms the position of the NG tube tip at the time of the X ray, and, as the tip may become dislodged following the X ray, further confirmation of gastric pH will be required.

It is important that nothing be administered via the NGT until gastric placement is confirmed; internal stylets/guidewires should not be lubricated before gastric placement is confirmed (NPSA, 2012).

Alternative methods for placing and confirming nasogastric tube position

Electromagnetic sensing devices permit real- time tracking of feeding tube position during placement, e.g. Cortrak 2 Enteral Access System™ (Corpak Medsystems). This device has been shown to successfully place and confirm the position of gastric tubes (Taylor *et al.*, 2014). However, NHS England (2013) recommends that HCPs perform pH or X ray testing to confirm correct placement of NGTs after initial insertion, even when using placement devices.

Feeding tubes with specialist technology that incorporates an integrated real-time imaging system (IRIS) have been developed (Coviden Commercial Ltd). A 3 mm camera visually aids tube placement by enabling clinicians to identify anatomical markers during the placement. The feeding tube is connected to a small touchscreen console via an interface cable. However, clinical studies evaluating its use and cost-effectiveness are needed.

Gastrostomy feeding

A gastrostomy is the creation of an artificial tract between the stomach and the abdominal surface, and is commonly used for long-term enteral support. A gastrostomy can be placed endoscopically (percutaneous endoscopic gastrostomy, or PEG), surgically or radiologically (radiologically inserted gastrostomy, or RIG). The terms PEG and RIG describe the actual procedure; however, the remaining gastrostomy tube often continues to be referred to as a PEG or RIG, which can lead to confusion, given that some gastrostomy tubes can be inserted endoscopically or radiologically. It is important that dietitians understand the differences between the types of tubes and the correct terminology to describe them.

To provide appropriate and safe management of a gastrostomy tube, information regarding when the tube was inserted and how it is retained is important and helps to reduce the risk of complications. Prior to the placement of a gastrostomy tube, a full nutrition assessment should be conducted and the ability to manage the tube confirmed. Placement of a gastrostomy is a consented procedure; patients should have the full risks and benefits of placing the tube explained prior to consenting (Westaby *et al.*, 2010). Tubes specifically designed for gastrostomy use should be used and have an ENFit connector.

Percutaneous endoscopic placement

A PEG is placed under direct visualisation using an endoscope. Transillumination of the abdominal wall identifies the appropriate site for insertion. An incision is made into the stomach and a loop of thread introduced. The thread is grasped internally and pulled up to the mouth using the endoscope. A gastrostomy tube is attached to the thread, pulled down through the oesophagus, and pulled into the stomach and through the abdominal wall to lie with its internal bumper against the gastric mucosa. A flange and clamp are fitted externally. Endoscopic tubes can also be placed using gastropexy and a direct puncture tube insertion. The tube is inserted directly into the stomach through an external puncture, and the stomach is sutured to the abdominal wall until the stoma tract matures. This negates the need for a tube to be pulled through the mouth and oesophagus if there is an obstruction. The advantages of using a PEG include the following:

- Performed as a day care procedure, reducing costs as compared to other placement methods.
- High success rate.
- Fast, <20 minutes.
- General anaesthetic not required routinely.
- Low incidence of complications.

The contraindications and other considerations with PEG placement include the following:

- Severe obesity.
- Portal hypertension or gastric varices.
- Coagulation abnormalities.
- Active gastric ulceration or malignancy.
- Total or partial gastrectomy.
- Ascites.
- Peritoneal dialysis.
- Oesophageal or gastric tumours that prevent passage of an endoscope.
- Oropharyngeal or oesophageal carcinoma – placement of a PEG tube using the standard pull-through technique is associated with a small risk of tumour implantation at the skin site (Cappell, 2007). To reduce this risk, particularly in patients for whom cancer therapy is of curative intent, gastrostomy placement should be achieved by a direct gastric puncture technique (Foster *et al.*, 2007).
- Chronic progressive neurological and neuromuscular disorders, e.g. motor neurone disease. There may be an increased risk associated due to the use of sedation, as patients have a degree of respiratory compromise. There is some evidence to suggest that radiologically placed tubes may confer a survival benefit in these patients, as it avoids the risk of sedation (Shaw *et al.*, 2006).

Removal and replacement of a percutaneous endoscopic gastrostomy tube

Tubes with compressible or deflatable internal bumpers are traction-removable, and therefore help avoid the need for a further endoscopy. Non-traction-removable tubes will require endoscopic removal following the manufacturer's instructions. Removal is performed by cutting the tube and allowing the internal bumper to pass through the gastrointestinal tract naturally. A risk assessment and appropriate patient follow-up is recommended, given the risk of bowel obstruction, perforation and possible death (MHRA, 2012).

There are two types of bedside replacement gastrostomy tubes:

- *A balloon-retained gastrostomy device* – a balloon is inflated internally with sterile water or saline to hold the tip of the feeding tube against the gastric wall following percutaneous insertion. These tubes usually have a length of tube externally, but low-profile tubes, or buttons, are also available which are flush to the skin and therefore more discreet.
- *A flexible bumper-retained gastrostomy device* – held in place by either a flexible internal cage-like bumper or an internal bolster that is deployed by cutting an external suture.

Radiological placement

Gastrostomy tubes can also be placed radiologically. A nasogastric or orogastric tube is required to dilate the stomach with air, and, under X ray guidance, gastropexy sutures are inserted to anchor the stomach to the anterior abdominal wall. A gastrostomy is inserted and its position confirmed in the stomach. Balloon gastrostomies or 'pig tail' tubes are most commonly used. Disc or bumper-retained gastrostomies can also be placed radiologically using the pull-through technique as described. Tubes inserted using this technique are sometimes referred to as a per-oral image-guided gastrostomy (PIGG), and have the advantage of not requiring gastropexy and allowing the insertion of a lower maintenance tube, i.e. bumper/disc retained. However, they are technically more difficult to insert radiologically than endoscopically.

The advantages of RIG placement include:

- Very low risk of tumour seeding from head and neck tumours with direct puncture method as no endoscope required.
- Sedation not required.
- Clear picture of anatomy allows tube placement in difficult patients where endoscopic placement may have been unsuccessful.

Surgical placement

Surgically inserted gastrostomies are becoming less common with the increasing use of PEGs and RIGs. Surgically placed gastrostomies require a mini laparotomy and general anaesthetic. When a gastrostomy is inserted surgically, it requires a purse string suture around the gastrostomy tube in the stomach wall to keep it in place.

Post-insertion instructions

It is safe to commence feeding 4 hours after PEG insertion (NICE, 2006), although local policy may vary. There is no clear consensus on when it is safe to first use a newly inserted RIG for feeding; some centres feed after 4 hours and others wait 24 hours. Potential complications include peritonitis, infection, bowel perforation, haemorrhage and aspiration pneumonia). Prompt recognition of complications with early action reduces the risk of serious harm or death. The NPSA (2010) recommends that:

- Local protocols specify the observations to be taken in the immediate recovery period.
- Medical notes be marked with a high-visibility sticker, warning of possible complications and necessary action.
- Where patients are discharged within 72 hours, equivalent warnings should be communicated to the GP, community nurses, care home nurses, as well as to the patient and/or carers.

Post-pyloric feeding routes

Nasoduodenal or nasojejunal feeding

A feeding route bypassing the stomach overcomes the problem of gastroparesis and subsequent aspiration risk. In patients with high gastric aspirates, the small bowel may be working normally. Tubes can be placed endoscopically under X ray guidance or at the bedside. The risk of aspiration is reduced most significantly when the feeding tube is inserted beyond the ligament of Treitz, i.e. intrajejunal placement (Heyland *et al.*, 2001). Tubes incorporating a lumen for gastric aspiration are also available.

The techniques for bedside placement of nasojejunal tube using different patient positions and prokinetic agents have varying rates of success. Self-advancing PU tubes, e.g. Tiger 2™ Tube (Cook Medical, USA), have unique alternating cilia-like flaps that allow peristalsis to pull the tube into the small bowel more effectively than standard bedside placements. Endoscopic placement is time-consuming and costly, and may not be easily accessible to intensive care patients. A newer bedside technique using a transnasal endoscope for placing nasojejunal tubes has shown promising results, but requires further evaluation (Zick *et al.*, 2011). As with gastric placement, Cortrak 2® has also been demonstrated to be reliable in ascertaining post-pyloric tube placement (Powers *et al.*, 2011; Rao *et al.*, 2009).

Gastrojejunostomy

Post-pyloric feeding access can be obtained in patients with established gastrostomy access by the insertion of an extension device which threads through the existing gastrostomy lumen into the jejunum. A dedicated gastrojejunostomy combination must be used, as most basic gastrostomies cannot house jejunal extensions. Direct puncture techniques can also be used to place gastrojejunal tubes under X ray guidance. These tubes have a gastric internal retention device that can be either a balloon or disc-like bumper.

Jejunostomy

Jejunostomies create a stoma tract between the jejunum and the abdominal surface, and can be placed surgically or radiologically. A jejunostomy is often inserted when major gastrointestinal or hepatobiliary surgery necessitates post-pyloric feeding. It is not, however, without complications, and the optimal route of feeding after upper gastrointestinal surgery is yet to be determined (Weijs *et al.*, 2015). A feeding jejunostomy should be considered if gastric feeding has failed, and may provide a useful route that avoids PN. There is no internal retention device, so these tubes must be secured externally.

The tubes usually directly puncture the jejunum, although some are designed to be tunnelled under the skin and are held in place using a cuff under the skin surface.

A whole-protein feed should be well tolerated in jejunostomy feeding. However, if there is pancreatic or biliary insufficiency, or if the jejunostomy has been sited in the lower small bowel, a peptide-based or elemental feed may be indicated. Feed usually commences at a low volume and is increased slowly until the optimum feeding rate is achieved. Continuous feeding over 24 hours may prevent tube blockage. Jejunostomy tubes often have a thin diameter, e.g. 9 FR, and regular flushing of the tube with water may therefore be necessary to prevent blockage.

Enteral feed delivery

A feeding regimen should be documented in the patient's care plan for nursing staff, or for patients/carers to refer to if home EF takes place. The regimen should include the feed, feeding times, drip rate and additional fluid requirements. Timings should include feed breaks to encompass the psychosocial aspects of feeding, together with the influence on other clinical interventions, e.g. physiotherapy and drug–nutrient interactions. Patients wishing to pump feed at home overnight when they are alone or unsupervised should have the risks explained to them, and this should be documented in their care plan, as some local policies may advise against this.

It is usual to start feeding at no more than 50% feed requirements to ensure metabolic and gastrointestinal tolerance to the feed (NICE, 2006). Drip rates can then be increased at regular intervals until the maximum desired drip rate is achieved. Guidance for feeding patients at risk of refeeding syndrome is covered under 'Refeeding syndrome' section.

Bolus feeding

Bolus feeding is the delivery of approximately 100–400 mL of feed over 10–30-minutes. Administration is usually by syringe, using the syringe barrel as a funnel to allow the feed to infuse using gravity or using the plunger. Bolus feeding can also be provided via a feeding pump, although it is important to be aware of the maximum drip rate that the feed pump can achieve. The tube should be flushed before and after delivery of the feed bolus. Bolus feeding regimens are advantageous, in that they are more physiologically normal, can allow greater flexibility for the patient as they fit with normal eating patterns, and may be preferable for those who do not wish to be restricted by feeding equipment for several hours a day. Bolus feeding may also be the regimen of choice for patients who interfere with tubing and feeding equipment during continuous feeding. Patient positioning should also be considered; it is advisable for patients to remain in a semi-upright position during and for 1 hour after feeding (Metheny *et al.*, 2006).

Continuous feeding

Continuous feeding usually requires a pump and feeding set for administration, and, if ready-to-hang formulae are not used, a feed reservoir. Continuous feeding usually refers to feeding at rates of 50–200 mL/hour over 16–20 hours, although 24-hour feeding is standard practice in critical care for patients on sliding scale insulin. A rest period of at least 90 minutes is needed as it allows gastric pH to fall sufficiently to promote antibacterial conditions in the stomach (Bonten *et al.*, 1994). A longer planned rest period allows more flexibility, e.g. to catch up if feeding has been interrupted during the day, or to allow sufficient time for therapy. A rest period can provide an overnight break for those without urinary catheterisation and in those who may otherwise experience nocturia and interrupted sleep. Alternatively, a rest period can be given during the day, so that the patient is unencumbered by EF equipment, and to promote intake of oral diet if appropriate.

Continuous feeding is usually the feeding method of choice for patients who are fed via a post-pyloric route; however, bolus feeding is not contraindicated for these patients and can be used if tolerated. In deciding whether continuous and/or bolus feeding would be most appropriate, patient preference, risk of tube dislodgement and mobility of the patient should be considered (NICE, 2006).

In patients at risk of pulmonary aspiration, regular aspiration of the NG tube is routinely undertaken to assess adequacy of gastric emptying. However, there is little evidence to support the conventional use of measuring gastric residual volumes (GRVs). Instead, it is suggested to monitor trends to identify any gradual increase in GRVs; interpretation of these results should be modified so as not to interrupt the delivery of EF (Hurt & McClave, 2010). GRVs up to 500 mL are not associated with adverse outcomes, and this value can be recommended as a normal limit (*Montejo et al.*, 2010) (see Chapter 7.17.1, Critical care).

Enteral feed formulae

EF formulae can be categorised into whole-protein (polymeric) feeds, including disease-specific feeds, and elemental or peptide feeds (see Table 6.4.1). A summary of EF products currently available in the UK can be found in Appendix A6.

Whole-protein (polymeric) feeds

These require an intact gut for their digestion and absorption. The constituents of whole-protein feeds are as follows:

- *Protein* – usually milk or hydrolysed casein, although a soya protein formula is available for those with milk protein intolerance.
- *Carbohydrate* – usually maltodextrin, glucose, sucrose or corn syrup solids.

Table 6.4.1 Condition-specific feeds

Type of feed	Comment
Renal feeds	Suitable for patients on electrolyte and fluid restrictions.
	Similar or lower protein–energy ratio as compared to standard feeds.
	Energy-dense versions for fluid restriction are available, with subtle modification of other nutrients, e.g. higher water-soluble vitamin content to allow for intradialytic losses.
Low-sodium feeds	Standard feeds with a sodium content reduced to 10–15 mmol/L. Clinical hypernatraemia is often secondary to dehydration, so the use of a standard feed (providing 35–40 mmol Na/L) provides less sodium than plasma levels.
	Low-sodium feeds may be beneficial for patients with ascites (liver disease).
Respiratory feeds	Contain a higher percentage of energy content from fat, which reduces the amount of carbon dioxide produced from feed metabolism – may be useful in patients with respiratory failure. However, evidence of the benefit of these feeds is limited, and avoidance of overfeeding is as clinically significant as the choice of feed in respiratory failure (Malone, 1997).
Immune feeds	Contain variable amounts of specific amino acids or fats, together with altered levels of specific micronutrients that have an attributed immune benefit, e.g. glutamine, arginine, dietary nucleotides, fish oils, β-carotene and fructo-oligosaccharides.
	More expensive than standard feeds.
	Evidence that they may benefit some surgical patients (Waitzberg *et al*., 2006).
Elemental/peptide feeds	Provide nitrogen in the form of free amino acids or peptides.
	Indicated in the presence of severe maldigestion or malabsorption.
	With severe gut impairment, a predigested formula may be indicated. Appropriate use of these feeds may reduce the requirement for PN (Hamaoui *et al*., 1990).
	No clinical benefit in using peptide feed rather than whole-protein feed in patients with Crohn's disease (Zachos *et al*., 2006).

- *Dietary fibre* – various feeds are available containing added soluble and insoluble fibres. Insoluble fibre has most effect on gut barrier function, while soluble fibre can increase short-chain fatty acid production (Silk, 1993). Therefore, a mixed fibre source (as is found in most commercially available feeds) is advised. Elia *et al*. (2008) suggest that fibre-supplemented enteral formulae have important physiological effects and clinical benefits, and may help to reduce the incidence of diarrhoea.
- *Fat* – usually a vegetable oil derivative, although many feed companies are now re-blending fats to alter the ratio of n-3 to n-6 polyunsaturated fatty acids (PUFAs) and increase the monounsaturated fat content. n-3 PUFAs may be provided by the use of canola or rapeseed oil, or by fish oils to provide direct sources of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Provision of n-3 PUFAs can downregulate the inflammatory response by reducing arachidonic acid (n-6 PUFA) metabolites, but the mechanism to convert n-3 PUFAs to the active EPA and DHA is impaired in the severely ill.
- *Vitamins, minerals and electrolytes* – in the UK, all EFs provide 100% of the recommended nutrient intake for micronutrients (excluding electrolytes) in a specified volume of feed (usually 1–1.8 L of standard EF). Current levels of micronutrients must comply with the European Union (2013) regulation food intended for infants and young children, food for special medical purposes, and total diet replacement for weight control (Regulation 609/2013).

Types of whole-protein feeds can be categorised as:

- *Standard adult formulae* – provide 1 kcal/mL (4.18 kJ/mL) and are suitable for the majority of patients; available with and without fibre.
- *High-energy adult formulae* – provide 1.2–2.4 kcal/mL (5.02–10.03 kJ/mL) and are useful for patients on fluid restriction or with increased nutritional requirements, e.g. burns patients. The electrolyte and protein content of these feeds are variable. Fibre-containing, energy-dense feeds are also available, but only up to energy densities of 2 kcal/mL.
- *Low-energy formulae* – provide 1–1.2 kcal/mL (4.18–5.02 kJ/mL) and 1000 mL of these usually meets the nutritional needs of patients with low energy and/or fluid requirements, e.g. elderly bed-bound patients.
- *Disease-specific enteral formulae* – a variety of EFs are provided for a variety of conditions. However, dietitians should consider the use of specific products within the context of the patient's clinical status, and not take the manufacturer's recommended client group as the sole indication for use. A brief overview of some disease-specific feeds is given in Table 6.4.1.

Liquidised food

There has been an increasing trend in patients wishing to administer liquidised food rather than sterile, prescribed feeds via their feeding tubes. This is not currently recommended due to concerns regarding the nutritional adequacy of the food, and the increased risk of tube

blockage and gastric infection, particularly in those who are immunocompromised or jejunally fed. Some patients wish to proceed with this type of feeding, despite being fully aware of the associated risks. In these circumstances, dietitians have a responsibility to ensure that patients have all the necessary information to make a fully informed choice, and to continue to support patients in the decision they have made. Dietitians should ensure that a risk assessment is completed, and may consider seeking additional support from the local risk management team. The outcome of this process, in addition to the patient's reasons for choosing to feed in this way, should be documented. Further information and resources can be found on the Parenteral and Enteral Nutrition Group (PENG) website (www.peng.org.uk).

Drug–nutrient interactions

EF may interfere with the dosage, presentation and action of many drugs. Crushing oral preparations to pass down a tube may compromise their activity, cause tube occlusion and has the potential to cause fatality, particularly if slow-release preparations are used. Some medications are not available in liquid form; therefore, alternative formulations or preparations should be sought. Drugs should not be added to the feed infusion, as this may alter the stability of the medication and introduce a potential route of contamination into the EF. Liaison with a pharmacist will ensure optimal EF and drug administration. A practical guide to the administration of drugs during EF can be found on the BAPEN website (www.BAPEN.org.uk).

Common drugs such as phenytoin, ciprofloxacin, tetracyclines, penicillin, sucralfate and theophylline bind to the feed and/or have altered absorption kinetics, so should be administered during a rest period. Other drugs that can affect/be affected by EFs are digoxin, carbamazepine and antacids. For further reading, see Bradnam and White (2015), and Chapter 5.3 (Medicines management).

Enteral feeding monitoring

The main objectives of monitoring nutritional support are to ensure that it is provided safely, complications are detected early and treated effectively, and nutritional objectives are met and/or reviewed, thereby ensuring the effectiveness of the nutritional intervention. Close liaison with colleagues, patients and carers is vital when initiating and monitoring EF (NICE, 2006), and all have a role to play in the monitoring process. For example, in the community, the patient and/or carer may be responsible for most of the monitoring. In hospital settings, dietitians will not be directly responsible for performing all of the monitoring, but it is their responsibility, in conjunction with the wider MDT and the patients, to agree to an appropriate monitoring plan and to review the results. Table 6.4.2 details the range of parameters that should be considered for monitoring of nutritional support (NICE, 2006).

The frequency and choice of monitoring is dependent on many variables, including the nature and severity of the underlying disease state, whether previous results were abnormal, the type of nutritional support used, the tolerance of nutritional support, the nutritional care setting and the expected duration of the nutritional support (NICE, 2006). Monitoring frequency may need to be more intense at the start of treatment, but should continue throughout the episode of care. Monitoring should be interpreted with caution, as a full understanding of the meaning of a result is needed before any changes are made. There is no one test that will measure nutritional status, and therefore a combination of clinical and laboratory results should be used. Additional guidance on monitoring patients on EF can be found in Micklewright and Todorovic (2011) and NICE (2006).

Complications of enteral feeding

Refeeding syndrome

Refeeding syndrome (RFS) is a group of clinical symptoms and biochemical shifts that can occur in malnourished or starved individuals upon the reintroduction of nutrition. There is no universally accepted definition or diagnostic criteria for RFS. This limits effective research into its management, and therefore it remains poorly understood by clinicians. Nutritional treatment of patients at risk of RFS should be provided by HCPs with adequate training in nutrition support (NICE, 2006).

During starvation, the body conserves energy, including a reduced action of cellular pumps. Electrolytes are able to leak across cell membranes into the plasma and are renally excreted, leading to whole-body deficits. Once glycogen stores have been exhausted, energy metabolism switches to fat and the production of ketone bodies. The reintroduction of nutrition elicits the following metabolic changes:

- Carbohydrate results in increased insulin secretion, leading to cellular re-uptake of glucose, phosphate, magnesium and potassium, with a simultaneous fall in serum levels. These biochemical abnormalities can result in a spectrum of presentations, from fluid retention to cardiac arrhythmias, respiratory insufficiency and, ultimately, death.
- Reactivation of the sodium/potassium membrane pump leads to further movement of K^+ into cells, with a simultaneous movement of sodium and fluid out of the cells into the extracellular space.
- Reduced renal function impairs the ability to excrete this influx of sodium and water; this leads to fluid overload and oedema.
- Thiamine demand and utilisation is increased upon the reintroduction of glucose, owing to its role as a co-factor for carbohydrate metabolism. Deficiency can result in Wernicke–Korsakoff encephalopathy.

At-risk patients are those who have had very little or no food intake for >5 days, especially if already undernourished (BMI <20 kg/m^2); or those who have unintentional

Table 6.4.2 Monitoring of patients receiving enteral feeding

Monitoring parameter	Examples of monitoring	Rationale
Nutritional intake	Food charts, fluid charts, patient reporting	Compare prescribed with actual volume of feed delivered.
		Facilitate transition between different forms of nutritional support.
		Prevent over-hydration and under-hydration.
		Take account of energy and electrolyte content of IV/enteral fluid.
		Infusions.
Anthropometry	Weight, BMI, mid-upper-arm circumference, triceps skinfold thickness, hand grip dynamometry	Monitor nutritional status changes.
		Ensure nutritional objectives are met.
Clinical chemistry	Biochemistry, haematology	Aids interpretation of hydration status, metabolic stress, specific nutrient deficiencies and metabolic abnormalities.
Clinical condition	Consciousness, swallow status, temperature	Observe changes which may affect nutritional requirements and most appropriate route of access.
		Ensure that the type of nutritional support provided remains appropriate.
		Monitor for infection.
Medications prescribed	Drug charts	To be aware of side effects that may affect tolerance of ETF, e.g. nausea/altered bowel habit.
		To be aware of possible drug–nutrient interactions.
		To be aware of drugs that may affect timing of ETF.
		Ensure that drugs are in appropriate form for administration via feeding tube.
		Reduce incidence of tube blockage.
		To be aware of the importance of adequate flushing of tubes before and after administration of medication.
		To be aware of medication that may contribute to energy intake, e.g. propofol.
Gastrointestinal tolerance	Stool charts, gastric residual volumes	Monitor bowel function and feed tolerance.
		Assess gastric emptying, and therefore determine the appropriateness of gastric feeding.
Feeding device	Observe position and condition of feeding tube and the site of tube insertion	Ensure appropriate position of feeding tube.
		Monitor for signs of infection and/or irritation.
		Check for leaks and cracks in tube.
Nutritional goals and dutcomes	Dependent on specific goals set, but likely to include a measure of nutritional intake and nutritional status	Ensure progress towards agreed objectives.
		Ensure clinical effectiveness of dietetic intervention.
		Ensure objectives remain realistic and achievable.
		Ensure that nutritional interventions remain appropriate to the overall care of patients.

weight loss of >5% within the last 3–6 months NICE (2006). High-risk patients are those with any one of the following:

- BMI <16 kg/m^2.
- Unintentional weight loss of >15% within the last 3–6 months.
- Very little or no nutrition for >10 days.
- Low levels of potassium, magnesium or phosphate prior to feeding.

Patients with two or more of the following are also considered to be at high risk:

- BMI <18.5 kg/m^2.
- Unintentional weight loss of >10% within the last 3–6 months.
- Very little or no nutrition for >5 days.
- Some drugs, including insulin, chemotherapy, antacids or diuretics, or alcohol abuse.

It is important to note that patients with normal levels of potassium, magnesium and phosphate prior to the commencement of feed can still be at risk of RFS (Marinella, 2004; NICE, 2006). RFS can occur in patients fed orally, enterally or parenterally; it is less likely to occur in those fed orally (Fung & Rimmer, 2005), since starvation is usually accompanied by a reduction in appetite. However, care should be taken when prescribing oral nutritional supplements.

There are several guidelines available for the management of RFS (Khan *et al.*, 2011; NICE, 2006; Royal College of Psychiatrists, 2014; Stanga *et al.*, 2008). Current evidence indicates that the most effective management of refeeding syndrome may differ across different clinical

conditions (Doig *et al.*, 2015; Garber *et al.*, 2016). The most widely reported guidelines are those from NICE (2006), which make the following recommendations:

- *At-risk patients:*
  - Introduce feeding at a maximum of 50% of total energy requirements for the first 2 days, increasing to full requirements if no biochemical abnormalities are detected.
  - Meet full requirements for fluid, electrolytes, vitamins and minerals from day 1 of feeding.
- *High-risk patients:*
  - Consider starting nutrition at a maximum 10 kcal/kg and increase slowly to meet full requirements by 4–7 days. Any increase in feed should be dependent on trends in biochemistry.
  - Potassium, magnesium and phosphate supplementation should be given from the outset (unless blood levels are already high).
  - Give thiamine and a multivitamin.
  - Restore circulatory volume and monitor fluid balance closely.
  - Monitor appropriate biochemistry, including potassium, phosphate and magnesium.
  - In extreme cases (e.g. BMI <14 kg/m², very little or no nutrition for >15 days, or prefeeding hypokalaemia, hypophosphataemia or hypomagnesaemia), consider starting feed at 5 kcal/kg (21 kJ/mL).

A UK survey regarding attitudes towards the NICE guidelines found that approximately one-third of clinicians found them excessively cautious (De Silva *et al.*, 2008), with another survey of practice finding that starting at 20 kcal/kg was common, increasing to full requirements over 3–4 days (Wagstaff, 2011).

Some guidelines recommend higher feeding thresholds than NICE, and suggest that limiting carbohydrate provision to less than 50% of energy intake may limit refeeding syndrome (Culkin & White, 2017). Close communication with the medical team is crucial to prevent and recognise RFS. A clear plan should be formulated to ensure that all team members are aware of their roles and responsibilities in close monitoring and treatment.

Aspiration

Aspiration risk for gastrostomy feeding is the same as for NG feeding, and can occur without any obvious signs of vomiting or regurgitation. Gastroparesis may be a result of disease management, starvation, or nerve damage, e.g. diabetic neuropathy (see Chapter 7.4.4, Gastroparesis). Regurgitation of stomach contents and aspiration into the lungs can cause asphyxia; even small amounts increase the risk of pneumonia. The aspiration risk has traditionally been assumed to increase with residual volumes of 200 mL or above (McClave *et al.*, 1992); however, more recent evidence suggests that a value of 500 mL can be recommended as a normal limit for GRVs (Montejo *et al.*, 2010) (see Chapter 7.17.1, Critical care). Failure to establish gastric emptying is not a reason for immediate PN support, and post-pyloric feeding should be considered before this option. Prokinetic agents such as metoclopramide and domperidone are not recommended for the long-term treatment of gastro-oesophageal reflux disease, owing to the risks of these medications outweighing the benefits (EMA, 2013, 2014).

If aspiration is a risk, the following actions may be taken:

- Elevate the head and upper body to at least 30°, and maintain this position during and for 1 hour after feeding.
- Consider a post-pyloric feeding route – jejunostomy feeding with aspiration of gastric contents by an NG tube is the only safe way to prevent feed aspiration (Elpern, 1997).

Other risk factors associated with the development of aspiration pneumonia include advancing age, poor oral hygiene, impaired consciousness and sedative medications (Loeb *et al.*, 2003).

Diarrhoea

Diarrhoea is common in enterally fed patients, but is rarely attributable to the EF (Bowling & Silk, 1998), although it may be attributed to the feeding mechanism. Prolonged use of antibiotics results in *Clostridium difficile* overgrowth, and subsequent diarrhoea (Bliss *et al.*, 1998). Enteral administration of magnesium or electrolytes can cause osmotic diarrhoea. Osmolality of the feed is rarely a concern, and feed dilution exacerbates the problem. Management of diarrhoea in enterally fed patients should include the following steps:

- Obtain a stool sample to exclude pathogenic bacteria overgrowth.
- Review the need for, and choice of, antibiotic.
- Ensure adequate hydration – additional fluid may be required as a result of increased losses.
- Reduction in infusion rate of post-pyloric feed.
- Use of a peptide feed if malabsorption is suspected.
- Bile acid sequestrants, e.g. cholestyramine, if bile salt diarrhoea is suspected.
- Review medications (drugs in a sorbitol syrup containing ≥15 g of sorbitol can have a laxative effect).
- Consider a fibre-containing feed; fibre helps minimise diarrhoea in enterally fed patients, particularly in those who are not critically ill (Kamarul Zaman *et al.*, 2015).
- Current evidence to support probiotic use in the management of diarrhoea in critically ill enterally fed patients remains unclear (Jack *et al.*, 2010).

Tube blockage

The small internal diameter of fine-bore tubes increases the risk of occlusion. The most common cause is coagulation of feed by drug syrups and suspensions, combined with inadequate tube flushing, or obstruction by particles of crushed oral medications. Tube occlusion risk can be minimised by:

- Flushing the tube regularly with water.
- Flushing the tube with water during and following drug administration.

- Giving medicines individually, rather than together, to avoid precipitation from drug interactions.
- Using drugs in syrup or dispersible form, rather than as crushed tablets.

Consideration should be given to the type of water used to flush EF tubes. For gastric tubes, the choice is tap, cooled, boiled, or sterile water, but a risk assessment should be undertaken as the choice may be different in the hospital and the patient's home. For post-pyloric feeding, sterile water should be used; it is important to take into consideration that, once the container has been opened, it is no longer sterile. Flushing with warm water should be tried initially to unblock a tube, along with manipulation of the tube. Soda water and sodium bicarbonate can also be effective in clearing a blockage. Cola, pineapple juice and lemonade should not be used, as the acidity may contribute to occlusion by denaturing the proteins in the EF (Beckwith *et al.*, 2004). Pancreatic enzymes are effective, and can unblock a feeding tube blocked with feed within 10–20 minutes (Marcaud & Stegall, 1990); other agents are commercially available. Although gastrostomy tubes are larger in size, blockages can still occur, and therefore measures to minimise risk should still be taken.

Microbiological contamination of feed

EFs provide an ideal growth medium for microbial contamination, but low counts of non-pathogenic bacteria are clinically unimportant. Bacterial growth within the feed can be minimised through the following steps:

- Using commercially prepackaged, sterile, ready-to-hang feeds (Beattie & Anderton, 1999, 2001). Modular feeds carry a greater risk of microbiological contamination.
- Limiting the hanging time of the feed to a maximum of 24 hours, or 4 hours for non-sterile feeds (Payne-James *et al.*, 1992).
- Replacement of reservoir and giving set daily.
- Filling the feeding reservoir with feed for up to 24 hours, rather than 4 hours (Patchell *et al.*, 1998).
- Hygienic handling of systems and adequate hand hygiene (Lee & Hodgkiss, 1999).
- Ensuring that systems marked as 'single use' are used only once.
- Ensuring that reusable equipment for single-patient use (e.g. syringes, NG tubes and guide wires) are cleaned, labelled and stored appropriately in accordance with local policy.

Additional care should be taken with jejunal feeds in patients with achlorhydria and immunosuppressed patients as their lack of gastric acidity and impaired immune function, respectively, may increase infection risk.

Accidental tube removal

Feeding tubes can become dislodged or may be removed accidentally. NG tubes should be removed completely and repassed (with the same tube and original guide wire if single-patient use), and position reconfirmed. If a gastrostomy tube is accidentally removed, prompt replacement is required to preserve the stoma tract, which can start to heal immediately. Balloon replacement tubes can be used, and a spare tube should be routinely supplied to the patient in case of such circumstances. Where there is no spare tube available, a Foley catheter can be used to maintain the tract until an appropriate feeding tube is reinserted. This is generally discouraged; however, if a Foley catheter is used to preserve the tract, it must not be used for feeding, and end users should be made aware of the potential risks of its use in this way (MHRA, 2010). Stoma plugs are now commercially available, designed solely to preserve the stoma tract in cases of accidental tube removal. It is essential that patients and carers be aware of what to do if the feeding tube becomes dislodged or is removed. Adequate training and education should be provided for patients, carers and professionals.

Stoma site problems

Stoma site complications include leakage, exit-site infections, pneumoperitoneum, intra-abdominal abscesses, necrotising fasciitis, problems with self-care secondary to poor placement, and infection, which can be potentially fatal (Hanlon, 1998). Overgranulation is also a common stoma site problem, but this can generally be reduced by correctly positioning the external fixation device (Best, 2004). Minor complications can usually be managed without admission to hospital; a swab of the site may be useful to rule out infection. Thorough hand hygiene and avoiding unnecessary dressings around the stoma site can help minimise the risk of such problems, as can good training for patients and carers regarding tube care. Regular assessment of the stoma site should be integrated into the monitoring protocols. A specialist EF nurse can advise regarding treatment for minor gastrostomy-related complications, and this service is often supplied as part of the EF contract for hospitals and community settings.

Buried bumper syndrome

Buried bumper syndrome (BBS) occurs when the gastric mucosa grows over the internal bumper of the gastrostomy tube, resulting in migration through, or into, the abdominal wall. This can result in mechanical feed delivery failure, pain, peritonitis and even death. BBS can be prevented by ensuring that the tube is measured and fitted correctly, and regularly introduced into the stomach and rotated. Should BBS occur, the tube must be removed endoscopically or surgically.

Enteral feeding equipment

The equipment required for ETF depends on the method used. Bolus feeding requires syringes for fluid and feed delivery. Continuous feeding requires a pump, giving sets, syringes and possibly feeding reservoirs if a modular feed or extra water is being administered via

the pump. Pumps can be used for ambulatory feeding with the addition of a backpack or carry case, which can usually be obtained through the EF supplier. Large syringes are used for water flushes and administration of feed; the smaller syringes are used for more accurate measurement and administration of medicines. The International Organisation for Standardisation (ISO) has developed a new global standard for all EF connectors called ENFit, which was phased in from 2015 to reduce the risk of misconnections and improve patient safety.

Weaning

Although many patients will rely on EF as their sole source of nutrition for life, some may be able to resume oral feeding. Once oral feeding has been deemed safe to recommence, EF can be continued in conjunction with an oral diet during the transitional period. The feeding rate or bolus size can be increased to allow a longer rest period, and a higher-energy feed can be used or the feed can be reduced to provide <100% of estimated requirements. Bolus feeding or overnight feeding can be useful in ensuring that nutritional requirements are met while encouraging daytime oral intake during the transitional period. Care should be taken to ensure that patients do not become dehydrated during the weaning process; additional fluid boluses can help to minimise this risk.

Home enteral feeding

Home enteral feeding (HEF) is an expanding area of nutritional support (BAPEN, 2010). The majority of HEF patients have had a stroke, head and neck cancer, or a degenerative disorder, e.g. motor neurone disease (BAPEN, 2011). In recent years, there has been a slight decrease in the number of patients reportedly commencing HEF due to swallowing problems, and a slight increase in those commencing HEF to improve nutritional status (BAPEN, 2011). The dietitian's role in the discharge into the community of patients on nutritional support is integral to the process. Local policies and procedures should be in place for training, discharge planning and monitoring of the patient (Elia, 1994). Pressure on hospital beds often leads to early discharge, and it is therefore important that patients be reviewed regularly during the initial period to ensure that optimal nutritional support is achieved, and that plans for discharge be made in an appropriate and timely manner.

EFs prescribed in the community are available on prescription, but the feeding equipment is usually financed by primary care, depending on contractual agreements. Determination of who pays for the equipment must be confirmed before the patient is discharged. Most UK feed companies provide training, delivery of feeds and equipment, and servicing of pumps to community patients.

Timely and effective communication is necessary to ensure that a patient is discharged safely on HEF. The discharge planning process should take into account the knowledge, skills and support network of those who will be responsible for caring for the tube and setting up the feed once the patient is home. The patient and family are usually encouraged to manage these themselves, with adequate training and support provided pre- and post-discharge. However, if this is not possible, the responsibility may fall to district nursing teams. Many patients are discharged to nursing homes; therefore, adequate and regular training for care staff should be arranged. The feeding regimen may be altered for discharge to best fit with usual home routines and patient/carer preferences. Table 6.4.3 outlines the steps in discharge planning and the dietitian's roles and responsibilities.

The role of the HEF dietitian involves the physical, biochemical and anthropometrical monitoring of patients, and addressing the impact of this potentially life-changing intervention. Quality-of-life issues should

Table 6.4.3 Discharge planning for patients receiving HEF

Stage of discharge planning	Dietitian's role and responsibility
Decision made to insert feeding tube	Part of the MDT; can offer advice regarding what EF will entail to ensure patients/carers make an informed decision.
Decision made to discharge home	Inform HEF dietitian.
	Ensure patient and carers are appropriately trained to use the feeding pump and to care for the tube.
	Provide written information and contact details.
	Involve other services if required, e.g. district nurse.
	Ensure feeding regimen is suitable for home.
On discharge	Ensure patient is discharged with sufficient supply of feed and equipment until repeat prescription and delivery have been confirmed.
	Order supplies, request feed prescription from GP and arrange ongoing delivery of feed and equipment.
	Handover to HEF dietitian.
Post-discharge	Ensure patient and carers are familiar with management of tube and administration of feed.
	Ensure patient has all necessary equipment.
	Monitor nutritional support intervention and provide a follow-up plan.

be examined to ensure that the feeding regimen is acceptable and suitable for the individual. Patient support groups, such as Patients on Intravenous and Nasogastric Therapy (PINNT), may be useful. Some HEF dietitians also take on the extended role of replacing balloon replacement gastrostomies and NG tubes, and this can help prevent unnecessary hospital admissions, reduce the burden on the acute setting and enable feeding to continue with minimum disruption.

Further reading

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Internet resources

American Society for Parenteral and Enteral Nutrition (ASPEN), www.nutritioncare.org

British Association for Parenteral and Enteral Nutrition (BAPEN), www.bapen.org.uk

European Society for Clinical Nutrition and Metabolism (ESPEN), www.espen.org

Parenteral and Enteral Nutrition Group of the British Dietetic Association (PENG), www.peng.org.uk

Patients on Intravenous and Nasogastric Nutrition Therapy (PINNT), www.pinnt.com

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