

Enteral Feeding Manual for Adults in Health Care Facilities



FOREWORD

The DAA Nutrition Support Interest Group has developed this manual for dietitians and other health care professionals who need a practical resource for managing enteral nutrition support. It should be used in consultation with an appropriately qualified dietitian. The Interest Group would like to acknowledge the valuable contribution of the members responsible for the previous (1996) edition of the manual.

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NUTRICIA

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INTRODUCTION

What is enteral nutrition support?

Enteral nutrition support refers to the introduction of a nutritionally complete liquid formula directly into the stomach or small intestine via a narrow, often specifically designed, tube.

When is enteral nutrition used?

Enteral nutrition should be considered when an individual is not safe for oral intake or when oral intake is not adequate to meet their nutrient requirements. Enteral nutrition has been shown to be safe, cost effective, and compatible with the body's normal processes. Adequate nutrition support is important for the following reasons:

- * malnutrition has been found to affect around 40% of patients in major Australian hospitals^{1,2}
- * patients with chronic or debilitating disease processes are often already malnourished on admission to hospital/health care facilities
- * without appropriate nutrition support, malnourished patients continue to deteriorate in their nutritional status during their hospitalisation, especially if repeatedly placed "nil by mouth" for investigations and surgical interventions.
- * if uncorrected, malnutrition may result in a prolonged and complicated recovery from illness or surgery. This, in turn, leads to a longer hospital stay with an associated increase in cost.^{1,2}

When is enteral nutrition not used?

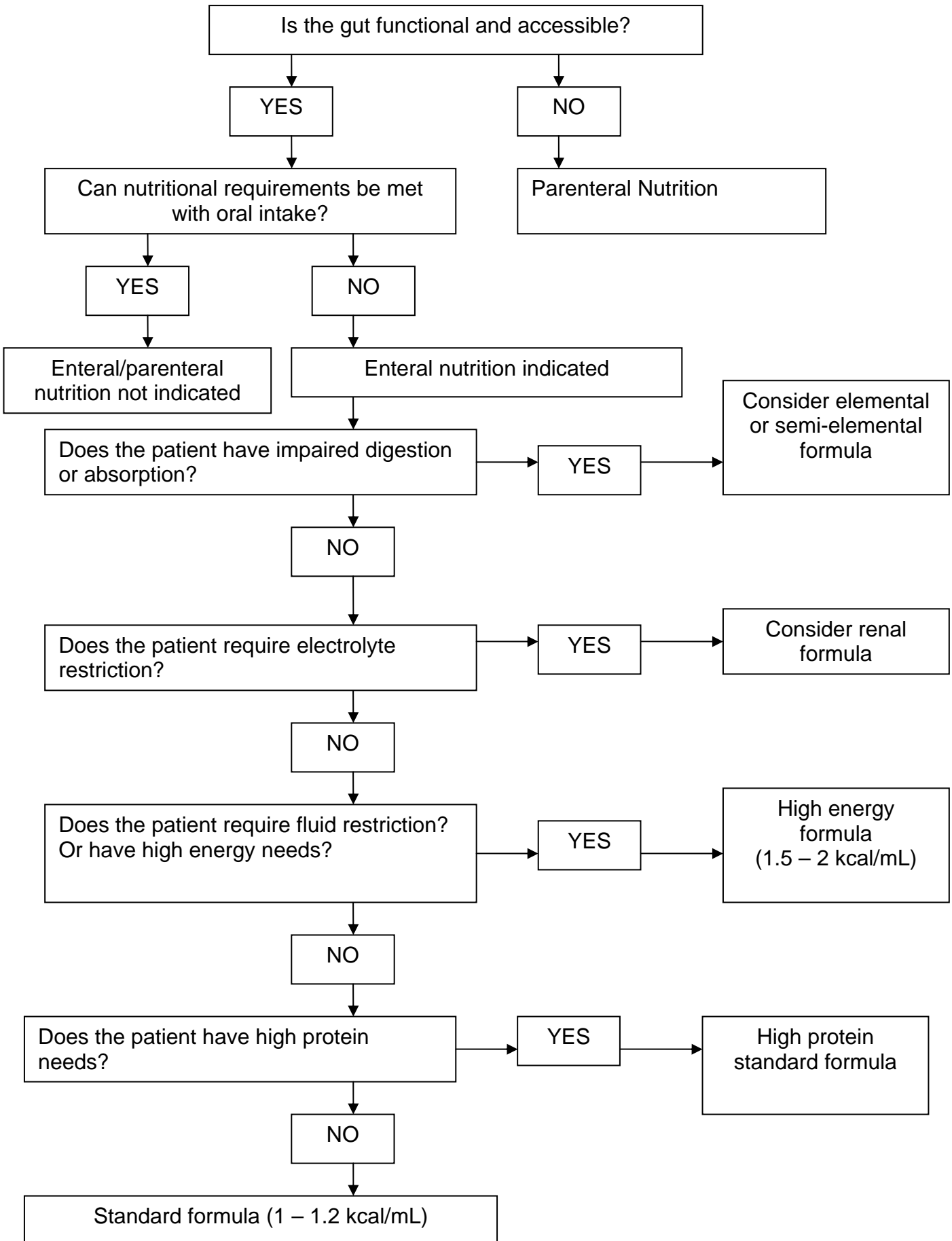
In some clinical conditions, such as gut failure, intestinal obstruction, or an inability to gain enteral access, it may be necessary to bypass the gut and deliver nutrients directly into the bloodstream (parenteral nutrition).

Aggressive nutrition support is not always appropriate in the care of palliative or elderly patients. Careful consideration should be given to patient and family wishes concerning the appropriateness of initiating or continuing enteral feeding. Potential benefits, including quality of life; possible complications and expected outcomes should be considered.

Why is nutritional assessment necessary?

When providing enteral nutrition support to a patient it is important to assess their nutrition status. A formal assessment based on anthropometry, biochemistry, clinical and diet history should be carried out by the dietitian. The nutrition assessment is used to determine priorities of nutritional management, estimate the patient's nutritional requirements, and provide a baseline measure for monitoring the effectiveness of intervention. Based on this assessment, a treatment goal can be set and a nutrition care plan developed.

Flowsheet for nutrition support planning



ENTERAL NUTRITION FORMULATIONS

Many different enteral formulas are available, through several different companies. The dietitian selects an appropriate formula based on an individual nutrition assessment of the patient. Only a typical macronutrient composition is shown below; further information on individual products is available from the manufacturer.

		Description/ indication	ENERGY kcal/mL	PROTEIN %energy	FAT %energy	CARBOHYDRATE %energy	OSMOLALITY mOsm/kg
STANDARD FEEDS May or may not contain fibre: fibre-enriched formulae have fibre content approx. 10-15g/L	Standard feeds	No special requirements	1.0-1.2	15%	30%	55%	300-500
	High-protein standard feeds	Increased protein requirement	1.0-1.2	20%	30%	50%	300-500
	High energy feeds (1.5kcal/mL)	High energy needs, or fluid restriction	1.5	20%	30%	50%	500-650
	High energy feeds (2kcal/mL)	High energy needs, or fluid restriction	2.0	15%	40%	45%	450-800
PRE-DIGESTED FORMULAE Nutrients in their simple form (protein as peptides or free amino acids, carbohydrate as monosaccharides, low in fat, may contain MCT.)	Semi-elemental	Minimal residue, protein as peptides.	1.0	20%	10%	70%	320-520
	Elemental	Minimal residue, protein as free amino acids.	1.0	15-20%	3-15% (varies widely between products)	70-85%	500-730
RENAL FORMULAE Energy dense, reduced fluid and electrolyte content. Modified protein content.	Moderate protein	Restricted fluid and electrolytes	2.0	15%	45%	40%	650-700
	Low protein	End-stage renal failure, not for dialysis	2.0	5%-10%	45-50%	45-50%	450-650

Considerations in choosing a feeding formula

Osmolality

An osmolality value of 300-500mOsm/kg is considered to be iso-osmolar. This means that the formula has the same concentration of solutes as the blood. In theory, this optimises absorption of the formula. In practice, this may be difficult to demonstrate.³

Nutritionally complete formulations

A formula is described as nutritionally complete if it can be used as an individual's sole source of nutrition. This means it must contain all essential nutrients in a defined volume.

RDI Volume

The RDI volume is the amount of formula that provides adequate amounts of all essential micronutrients (i.e. vitamins, minerals and trace elements).

Specialty formulations

There are many specialty formulae available in addition to the ones listed above. For example, formulae specifically designed for people with diabetes or respiratory disorders; formulae for wound healing; low sodium formulae; low energy formulae etc. In many cases the evidence for their benefit is limited and should be reviewed critically in order to assess the formula's appropriateness for an individual patient.⁴

Other alternatives

Home-made tube-feeding formulae are not recommended. They are time-consuming to prepare, and it is very difficult to ensure that such a formula is nutritionally adequate. Formulae made from whole foods, with a blender, are more likely to cause tube blockage and tube deterioration, and pose a markedly increased risk of bacterial contamination.⁵ Recipes are available for use when there is no other option available (see Appendix 2), but meticulous attention to food safety is essential and the risks and disadvantages should be noted carefully.

ROUTES OF ENTERAL FEEDING

Enteral feeding tubes may enter the body at a number of different sites (see diagram). The choice of enteral feeding route depends on several factors, such as the intended duration of nutrition support, the patient's condition, and any limitations to access (such as trauma or obstructions).

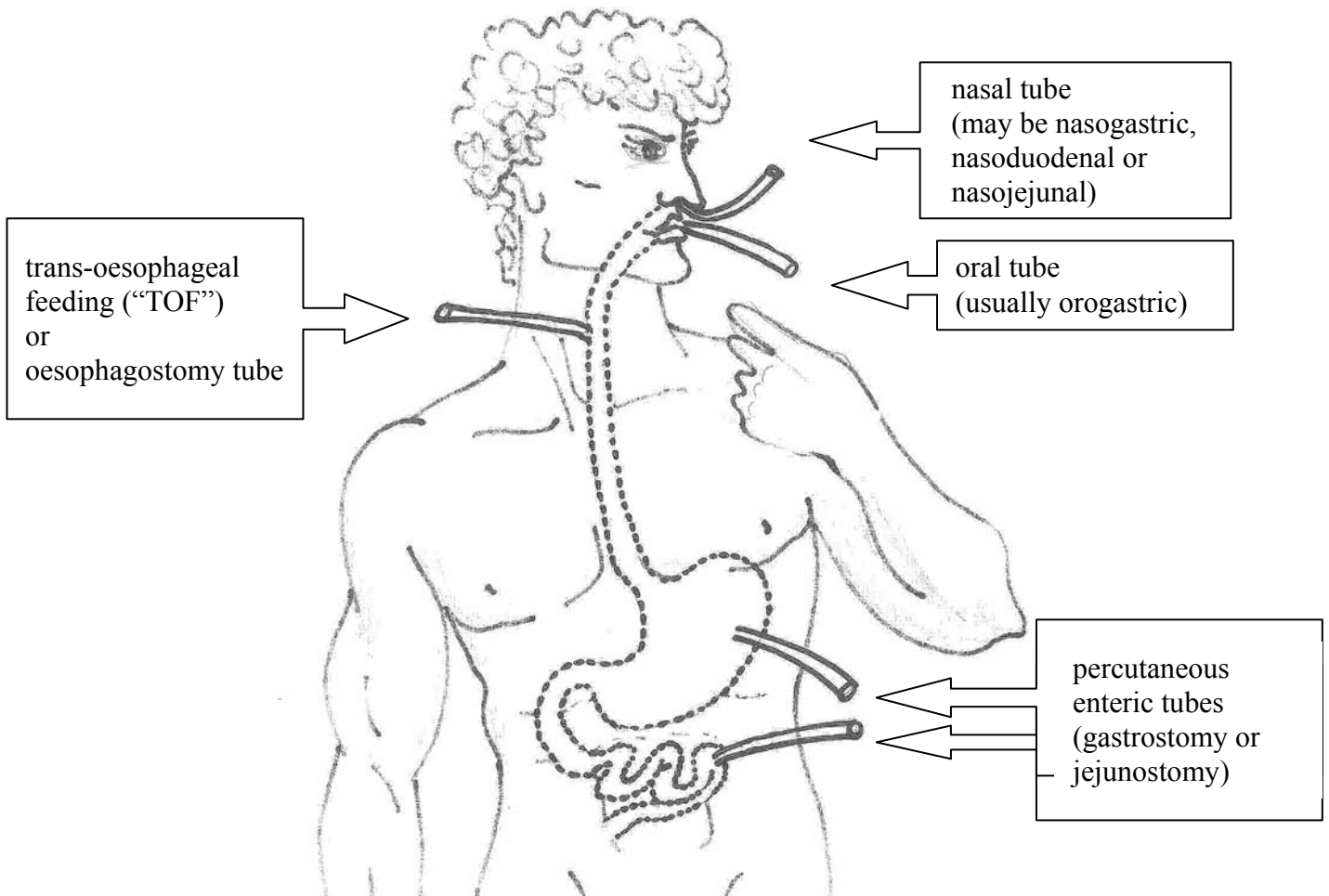


Figure 1: Routes of enteral feeding

SITES OF DELIVERY

Enteral feeds can be delivered, via a variety of different tubes, to the stomach, duodenum or jejunum. There are advantages and disadvantages to each.

SITE	ACCESS	INDICATIONS	ADVANTAGES	DISADVANTAGES
Gastric (stomach)	<ul style="list-style-type: none"> • Nasogastric tube (NGT) • Orogastric tube (OGT) • Trans-Oesophageal feeding tube (TOF) • Percutaneous Endoscopic Gastrostomy (PEG) • Surgical or radiologically placed gastrostomy tube 	Patients with normal emptying of gastric and duodenal contents	<ul style="list-style-type: none"> • Large reservoir capacity of stomach • Most cost effective • Easiest to insert • Can give bolus feeds, without need for a pump 	<ul style="list-style-type: none"> • Increased risk of oesophageal reflux and/or pulmonary aspiration
Duodenum (small bowel)	<ul style="list-style-type: none"> • Nasoduodenal tube (NDT) 	Patients who have impaired gastric emptying or who are at risk of oesophageal reflux	<ul style="list-style-type: none"> • Can be used for early enteral feeding, eg: 4-6 hours after trauma • May reduce risk of oesophageal reflux and/or pulmonary aspiration 	<ul style="list-style-type: none"> • Potential gastrointestinal intolerance (bloating, cramping, diarrhoea) due to lack of reservoir capacity in duodenum; likely to need pump to control feed rate • May require fluoroscopic or fibre-optic endoscopic placement of tube • Risk of displacement/migration back into stomach • Unable to use tube aspirates to indicate feeding tolerance
Jejunum (small bowel)	<ul style="list-style-type: none"> • Nasojejunal tube (NJT) • Surgical jejunostomy (JJ) • Percutaneous Endoscopic Gastrostomy with jejunal extension (PEJ) 	Patients who have impaired gastric emptying or who are at risk of oesophageal reflux	<ul style="list-style-type: none"> • Can be used for early enteral feeding, eg: 4-6 hours after trauma • Reduces risk of oesophageal reflux and/or pulmonary aspiration 	<ul style="list-style-type: none"> • Potential gastrointestinal intolerance (bloating, cramping, diarrhoea) due to lack of reservoir capacity in jejunum; likely to need pump to control feed rate • May require fluoroscopic or fibre-optic endoscopic placement of tube • Risk of displacement/migration back into stomach • Unable to use tube aspirates to indicate feeding tolerance

EQUIPMENT

Equipment involved in enteral feeding may include the following:

- Enteral feeding tube
- Administration reservoir (Feed bag, bottle, etc)
- Giving set
- Syringes
- Enteral pump

Enteral feeding tubes

Nasoenteric / oroenteric feeding tubes

A nasoenteric feeding tube refers to any feeding tube placed through the nose into the stomach or small bowel. Oroenteric feeding tubes are placed through the mouth into the stomach or small bowel, and are most often used in people with facial or base-of-skull trauma.

Fine-bore feeding tubes are widely available and are the tubes of preference for enteral feeding. Wide bore tubes may be used for short term feeding.

Comparison of fine-bore and wide-bore feeding tubes

	FINE BORE TUBE	WIDE-BORE TUBE
SIZE (French gauge*)	6-12 F	14-22 F
	* The external diameter of the tube is designated by French (F) units: 1F ≈ 0.33mm	
MATERIAL	PVC / polyurethane / silicon	PVC
INTENDED PURPOSE	Enteral feeding	Gastric drainage, gastric aspiration and gastric decompression/deflation
PATIENT COMFORT	Relatively comfortable. Soft (polyurethane and silicon tubes) and more flexible.	Can be uncomfortable. Remains hard. Stiffens when exposed to gastric juices. May cause nasal/oesophageal irritation or ulceration if used long term. ⁶
APPROPRIATE DURATION OF USE (refer to manufacturer for information on intended lifespan of product)	4-6 weeks before replacement. Gastrostomy feeding tube should be considered if feeding required long term.	10 days. If feeding required for longer than 10 days, replacement with a softer, fine bore feeding tube or gastrostomy should be considered.
GUIDEWIRE	Available with or without guidewire to assist in tube placement.	No guidewire (tube is stiff).
WEIGHTED TIP	Available with or without weighted tip.	No weighted tip.
EXAMPLES	Many different products are available.	Salem sump tube Ryles tube Levin tube

The length of different feeding tubes can vary significantly. Nasogastric tubes are generally up to 90cm in length, while nasoduodenal or nasojejunal tubes are longer (105cm or longer) to enable the tip to reach the correct position.

Confirming correct placement of feeding tubes

Ensuring the correct position of the feeding tube is essential prior to commencing feeding. If the tube is incorrectly positioned, aspiration of feed may occur with potentially fatal results. Xray confirmation is considered the most reliable way to confirm tube position.^{7,8} Other common methods for checking the position of gastric feeding tubes include air insufflation with auscultation of the stomach, and aspiration of gastric contents with pH testing. It is not possible to aspirate gastric contents with some fine bore feeding tubes. The tube should not be used if there is any doubt about its position.

Placement of tubes into the small bowel for nasoduodenal/nasojunal feeding can be difficult, sometimes requiring endoscopic or radiologically-guided placement. Various modified tubes have been developed to facilitate placement. These generally have alterations to the distal end of the tube, such as an altered shape or barbed/textured surface, that allows peristalsis to grip the tube more effectively and move it spontaneously down the gut.

Gastrostomy

A gastrostomy feeding tube is one which has been inserted directly through the abdominal wall into the stomach and is commonly used for long term enteral support (more than 4 – 6 weeks).

Most gastrostomies are inserted by the percutaneous endoscopic technique (PEG), but they may also be placed surgically or radiologically.

Gastrostomy tubes vary in size from 9-28F, and normally last for 18 months to 2 years.

Replacement gastrostomy tubes include the following:

- * ‘balloon’ gastrostomy, which has an end balloon that is inflated with water to hold the internal tip against the gastric wall.
- * obturated gastrostomy, which has a mushroom-shaped internal flange that is stretched into a suitable shape for insertion, using a special introducer.
- * low-profile gastrostomy devices or ‘buttons’. These sit flush at skin level and have a detachable extension tubing for feeding. They are more commonly used for young, more ambulant patients or those who have a tendency to pull out their tube.

The external fixation plate or flange on a gastrostomy tube keeps the tube from rubbing around the PEG site, protecting the skin from damage, and also prevents the tube from being drawn further into the gut by peristalsis. It should not be removed, and if faulty should be replaced.

It is important that a patient's tube is correctly identified (type of tube, size, and manufacturer) by staff caring for the patient, and that these details are documented in the patient's notes. This allows appropriate care, and replacement parts to be provided when required. For example, a balloon gastrostomy should be checked fortnightly to ensure that the balloon is inflated with the correct amount of water.

Urinary catheters (eg Foley's catheters) are designed for urinary drainage and are not recommended for use as feeding tubes. As they do not have an external flange, there is a much greater risk of tube migration and duodenal obstruction; also they are not designed to withstand gastric acid. In an emergency, they may be useful as a short term replacement when

a PEG tube falls out, but a replacement gastrostomy tube should be inserted as soon as practical.

Care of the PEG tube

Taking care of the PEG site is important to reduce the risk of skin breakdown and infection. The PEG site should be washed daily with warm soapy water, rinsed and dried thoroughly. The external flange will need to be lifted to clean around the tube. Unless the tube has been stitched into place, it should be gently pulled in and out (1-2 mm only) and rotated through one full turn daily. The PEG site should not be covered with a dressing, as this can cause dampness, skin damage and infection.

Jejunostomy

A jejunostomy feeding tube is a specialised tube designed for jejunal feeding. It is inserted into the proximal jejunum, creating a tract between the jejunum and abdominal surface. The jejunostomy tube may be placed surgically, radiologically or endoscopically (when it would be called a PEJ). Needle catheter jejunostomy is the most commonly used type of surgical jejunostomy. A combined gastrojejunostomy tube, with a double lumen, can be used to facilitate gastric decompression and jejunal feeding simultaneously. Jejunal Extension Tubes (JETs) are also available, which can be used to extend a PEG into the jejunum.

Cervical pharyngostomy or oesophagostomy

An oesophagostomy or pharyngostomy refers to the surgical procedure whereby a feeding tube is placed into the oesophagus or pharynx and down into the stomach. This procedure is occasionally used after head and neck surgery, however it is not widely used for long term feeding because of the ease and relative safety of inserting a PEG instead.

Administration reservoir, giving sets and syringes

Administration reservoirs are available as either bags or bottles, in a range of sizes. 'Closed system' or 'ready-to-hang' formulae are available, where the formula is presented in a container that can be used as a reservoir and connects aseptically to the giving set by a recessed spike. Closed feeding systems have been found to have a lower risk of bacterial contamination compared to an open system, where the formula is decanted into the administration reservoir.⁹ Closed system formulae can hang safely at room temperature for 24 hours, whereas decanted formula should not be allowed to hang for longer than 8 hours (shorter times may be appropriate if the environmental temperature is warm). While manufacturers may claim a longer hang time is possible for closed system formula, this is limited by the fact that the feeds can hang only until the giving set needs to be changed, after 24 hours.¹⁰

The giving set is plastic tubing, attached from the administration reservoir to the enteral tube, with a roller clamp to regulate or stop the flow rate. They may have an optional side port for the administration of drugs or water flushes. In some systems the giving set and reservoir come as an all-in-one combined system. The reservoir should have volume levels indicated, and a hook or other facility to allow it to hang, as well as a secure connection to the giving set. The giving set should be an appropriate length to enhance patient mobility. It should be incompatible with IV equipment to avoid confusion. Syringes are useful for flushing enteral tubes with water and for the delivery of bolus feeding. A 60 ml catheter tip syringe is recommended for this, as smaller syringes produce greater pressure and may split the tube.

Giving sets and syringes are ‘single use items’ and should be discarded after use. Re-using equipment is not recommended – refer to manufacturer’s guidelines. The Australian Therapeutic Goods Administration (TGA) does not permit the re-use of single-use items.¹¹

Enteral feeding pumps

Use of a pump for feeding allows precise delivery of formula, at an even rate, which should maximise feeding tolerance and reduce the likelihood that the tube will block. High-fibre and energy-dense formulae may be easier to deliver with a pump, as the viscosity of these feeds can make gravity feeding problematic. Pumps can be used to deliver bolus and intermittent feeds, as well as for continuous feeding.

Pump feeding is the preferred method of feeding directly into the small bowel, as the small bowel may not tolerate large changes in volume infusion. Rapid administration of formula into the jejunum may result in dumping syndrome, or signs of feeding intolerance such as abdominal distension, cramps and diarrhoea.

A power source is required for regular use of enteral pumps. Useful features of the pump include battery back-up, portability, simplicity of use and ease of cleaning, alarm sound, quiet operation, excess pressure cut-out, a hold facility for administration of medications and a method of attaching the pump to the bed/IV pole/other location.

Pumps should be kept clean by wiping daily with a cloth moistened in mild detergent and water. Spillage of formula onto the pump should be wiped clean immediately.

Many different types of enteral pumps are available, including lightweight, compact pumps for ambulatory patients and pumps with the capacity for programming automated water flushes. Check that the supplier provides maintenance service. Some companies provide pumps for hire or loan in addition to selling them.

Gravity drip feeding

If an enteral pump is unavailable, gravity feeding can be used. By adjusting the roller clamp of the giving set to deliver a specified number of drops of formula per minute, a consistent feeding rate can be achieved (see table below). This method is not precise and the drip rate should be checked regularly to ensure the desired rate of formula is being given.

Approximate drip counts to achieve a desired feed rate

mls/hr	No. of drops/minute
25	7
50	13
75	20
100	27
125	33
150	40
175	47
200	53

REGIMENS FOR ENTERAL FEEDING

The choice of enteral feeding regimen is based on assessment of the individual needs of the patient. The goal is to provide safe enteral nutrition and hydration appropriate to the clinical status of the patient, taking quality of life issues into consideration.

Choice of feeding regimen

Enteral feeds can be administered by continuous, intermittent or bolus methods.

Continuous feeding

Defined as feeding for 24 hours continuously either by gravity drip or feeding pump. (See *Equipment* section for information on gravity feeding).

Continuous feeding at low volume is often used as the first step to commencing a patient on an enteral feeding regimen. It is the preferred method of use if the patient has rapid intestinal transit and may be suitable for critically ill patients. Continuous feeding is often tolerated better than intermittent when it is administered post pylorically.

The formula needs to be replenished every 4-24 hours depending upon whether the system used is decanted feed or closed system.

Advantages:

- Allows the lowest possible hourly feed rate to meet nutrient requirements
- Better gastrointestinal tolerance due to the lower feed rate
- Better control of blood glucose levels due to continuous carbohydrate input

Disadvantages:

- Physical attachment to the feeding apparatus (may affect quality of life)
- Expense of equipment (pump and giving sets)

Cyclic / intermittent feeding

Enteral nutrition is stopped for a 4-16 hour period either during the day or at night. The shorter the period of feeding, the higher the rate may need to be in order to meet the patient's requirements. Suitable for pump and gravity drip.

Advantages:

- Allows greater patient mobility (may improve quality of life)
- Allows breaks for physical activity, for administration of medications that are incompatible with feeds, and to encourage oral intake if applicable.
- Useful in the transition from continuous to bolus feeding, or from tube feeding to oral intake.
- Daytime feeds may reduce aspiration risk if it is difficult to maintain a 30° elevation overnight
- Feeding during daytime only is more physiological and may therefore have benefits such as helping to re-establish the diurnal cycle;¹² promoting normal gastrointestinal motility¹³ and promoting re-acidification of the stomach (which protects against bacteria).^{14,15}

Disadvantages:

- Compared with continuous feeding, a higher infusion rate is required to provide the same volume of feed. This may be less well-tolerated, with a higher risk of problems such as reflux, aspiration, abdominal distension, diarrhoea and nausea.

Bolus feeding

Defined as rapid administration of a bolus feed /water by syringe (usually by gravity, without the plunger). Bolus feeding is usually into the stomach, which has the reservoir capacity to tolerate a large volume of feed. A prescribed volume of feed is given (such as 100-400ml) over 15-60 minutes at regular intervals. The patient must have a competent oesophageal sphincter and an adequate cough reflex.

Advantages:

- Physiologically similar to a typical eating pattern
- Allows greater patient mobility
- Suitable for gastrostomies
- Can be used to supplement oral intake
- Can be flexible to suit the patient's lifestyle and improve quality of life
- May facilitate transition to oral intake
- Avoids the use of expensive equipment

Disadvantages:

- Large boluses may be poorly tolerated, especially in small bowel feeding
- Requires more nursing time compared with pump-controlled feeding
- Highest risk of aspiration, reflux, abdominal distension, diarrhoea and nausea

Tube feeding rate

All patients require individual assessment for determining the rate of delivery of nutritional support.

Determination of the starting rate involves consideration of the patient's medical condition, formula type, site of delivery, and degree of inadequate nutrition prior to starting feeds. The decision to advance the feeding rate is based on assessment of feeding tolerance. See *Monitoring* section for criteria that may be helpful in identifying and managing intolerance symptoms such as vomiting, abdominal distension, diarrhoea, large gastric aspirates, and decreased bowel motility.

Where there is no obvious risk of intolerance or refeeding syndrome, there is little evidence to support the practice of gradually initiating tube feeding,^{16,17} however many institutions still prefer to do this. There is wide variation of recommendations in the literature for feeding rate commencement and advancement, with suggestions varying from 15-50ml/hr for starting rates and 10-50ml/h for the amount to increase the rate each 4-24 hours.

Individual needs of the patient should always be considered. A slow initiation regimen may significantly delay the patient receiving his or her full nutritional requirements, but may be necessary for patients who are at risk of refeeding syndrome, bowel ischaemia or feeding intolerance.¹⁸ These may include patients who have been nil-by-mouth for a prolonged period, critically ill patients, patients being fed jejunally or those who have had major

surgery, particularly abdominal surgery. Patients receiving feeds via the stomach rather than postpylorically may have a better tolerance for hypertonic feeds, higher feeding rates and bolus feeding. Patients with normal gastrointestinal function and who have had a normal nutritional intake in the week preceding enteral feeding may safely be commenced at higher initial volumes than recommended below.

The following table provides a guide to common practice in starting and advancing feed rates.

MODE OF DELIVERY	START RATE	INCREASE BY	COMMENTS
Nasogastric	40-50mL/h	10-50mL/h every 4 hours	Stomach can usually tolerate high rates of feeding (as in bolus or intermittent feeding). This varies between individual patients.
Nasoduodenal or nasojejunal	20-30mL/h	10-30mL/h every 4-8 hours	Continuous feeding at a controlled rate is usually needed due to lack of reservoir capacity in small bowel. Feeds may be tolerated at rates as high as 100-120mL/h. Some patients may tolerate higher rates; others may experience abdominal distension or discomfort. Sterile water should be used for tube flushing (see below).
Gastrostomy / PEG	As for nasogastric	As for nasogastric	After the insertion of a gastrostomy or jejunostomy feeding tube, a water trial is sometimes used to check for leaks before feed is given. Feeds are usually commenced 12-24 hours after insertion of the tube, but there is no evidence to support delaying feeds for more than 3-4 hours after PEG placement. ^{19,20}
Jejunostomy	As for nasojejunal	As for nasojejunal	As for nasojejunal. Surgeon will usually advise when feeds can commence (usually within 24-48 hours of insertion); this depends on the surgical procedure.

Water flushes

Flushing an enteral tube regularly is essential to ensure tube patency and minimise the risk of tube blockage, as well as to meet the patient's fluid requirements. Water is considered the accepted flushing fluid and there is no evidence presented that tap water flushes in reasonable volumes pose any risk to humans. However sterile water for irrigation, commercially filtered or cooled boiled tap water have been suggested for use in particular patients who may be at increased risk. This would include immunocompromised patients and those being fed

postpylorically.²¹ Post pyloric feeding bypasses the acidic environment of the stomach, which normally provides protection against bacteria.

Where possible any drugs administered via an enteral feeding tube should be liquid and given separately from the feed, with flushing of the tube before and after each separate medication.

Recommendations:

- Flush tubes regularly with at least 30mls of water before, between and after medication administration, before and after bolus feedings and before and after checking gastric residuals and when feeds are stopped. See *Troubleshooting* section on delayed gastric emptying
- Smaller bore tubes such as jejunal tubes and fine bore tubes are more prone to clogging and may need to be flushed more frequently
- When several drugs are to be given, each should be given separately with a 5-10ml water flush given between each drug
- Use a 60ml syringe for flushes as smaller syringes may exert a force great enough to damage the tube
- Additional water flushes or increased volumes may be required, to meet the patient's hydration needs – see *Monitoring* section for details on assessing fluid status.
- Avoid flushing with cola and carbonated beverages or cranberry juice, which can make the chance of blockages more likely – refer to the *Troubleshooting* section for advice on unblocking tubes.

Warning about dilution of feeds

Diluting an enteral feed, or mixing anything into the feed, is not recommended as it increases the risk of bacterial contamination of the feed.²² If a closed system of feeding is used, opening the reservoir to add water (or medications, or supplemental protein, fibre, salt etc) will invalidate the stated hang time and can lead to increased wastage. No evidence exists to suggest that diluting feeds is helpful in tolerating tube feeding; absorption of the formula may be less effective if it is hypo-osmolar. Diluting the formula may simply delay achieving nutritional targets.

MONITORING OF NUTRITION SUPPORT

Once an enteral feed regimen has been initiated, ongoing monitoring is essential to ensure adequate nutrition delivery, and identification and management of potential complications.

Anthropometry

MEASURE	APPLICATION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
Weight	Unstable fluid balance (including large stoma output)	-whether fluid input is meeting needs -whether it should be restricted or increased	Baseline then daily
	Patients in first 1-2 weeks of tube feeding	-whether fluid input is meeting needs	Baseline and then second-daily
	Patients in first 3-6 weeks of tube feeding	-whether energy input is meeting needs -interpret in the light of fluid changes	Baseline and then weekly
	Continuation of long term tube feeding	-whether energy input is appropriate	Baseline and then monthly
Mid-arm circumference (at midpoint on back of arm, halfway between acromial surface of scapula and olecranon process of elbow) Calf circumference (at widest point)	Long term tube feeding	-whether energy and protein input are appropriate -interpret in the light of changes in patient's activity level -acute changes in fluid balance may confound this measure in trauma and critical illness	Baseline and then monthly. (Serial measures are more informative than comparing single measures to percentile charts.)

Biochemistry / haematology

Check with your laboratory for the normal range for each parameter as some of these will vary between sites. Only a basic survey of each test is given here. For more details of each test and its interpretation, refer to a clinical chemistry text or your laboratory's handbook, and discuss with medical team.^{23,24}

"EUC" tests

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
Sodium	<ul style="list-style-type: none"> * major extracellular electrolyte * plays an important role in fluid balance * also involved in nerve conduction and membrane transport 	<p>INCREASED in dehydration, refeeding syndrome.</p> <p>DECREASED in overhydration, SIADH, and salt-wasting conditions.</p> <p>-consider whether all the other electrolytes are increased or decreased.</p> <p>-check total fluid input, and whether IV fluids are saline or dextrose</p> <p>-serum osmolality can help determine fluid status</p> <p>-urinary sodium and osmolality can help identify SIADH or salt wasting.</p>	<p>Daily in the acute setting</p> <p>Monthly if possible, for long term feeding</p>
Potassium	<ul style="list-style-type: none"> * major intracellular electrolyte * influences fluid balance * also involved in nerve conduction and muscle contraction (esp. cardiac) 	<p>INCREASED in dehydration, renal failure (acute, or serious chronic), or when K⁺ shifts out of the cell (as in acidosis or insulin deficiency)</p> <p>DECREASED by increased losses (vomiting, diarrhoea) or when K⁺ shifts into cell (as in refeeding syndrome, reversal of acidosis, administration of insulin)</p> <p>-consider effect of diuretics (may cause K⁺ wasting or retention)</p> <p>-consider possible losses</p>	<p>Daily in the acute setting</p> <p>Monthly, if possible, for long term feeding</p>
Magnesium	<ul style="list-style-type: none"> * intracellular * cofactor for enzymes in nearly every stage of aerobic metabolism * required in muscle and nerve function 	<p>INCREASED in renal failure or high intake (eg magnesium antacids)</p> <p>DECREASED by some diuretics, malnutrition and muscle loss, malabsorption, and when Mg²⁺ shifts into cell (as in refeeding syndrome)</p>	<p>Daily in the acute setting</p> <p>Monthly, if possible, in long term feeding</p>
Phosphate	<ul style="list-style-type: none"> * intracellular * part of ATP, so involved in all energy production / storage processes * found in bone and muscle 	<p>INCREASED in renal failure, hypoparathyroidism, laxatives</p> <p>DECREASED in muscle loss and malnutrition, malabsorption, vitamin D deficiency, hyperparathyroidism and refeeding syndrome.</p>	<p>Daily, in the acute setting.</p> <p>Monthly, if possible, in long term feeding.</p>
Urea	<ul style="list-style-type: none"> * end product of 	<p>INCREASED in renal failure,</p>	<p>Daily, in the acute</p>

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
	protein metabolism, formed by liver to detoxify ammonia * excreted in urine, rate depends on GFR (glomerular filtration rate) and urine output.	dehydration, high protein intake (from diet, or GI bleed), renal obstruction DECREASED with reduced muscle turnover (small muscle mass, low protein intake, low activity) or severe liver dysfunction - Urea:Creatinine ratio >1:10 can indicate dehydration or GI bleed.	setting. Monthly, if possible, in long term feeding.
Creatinine	* produced by body muscle, also small amounts come from meat in the diet * excreted in urine, rate depends on GFR <i>and</i> tubular secretion * proportional to muscle mass	INCREASED in renal failure, fever, large meat meal, large muscle mass (bodybuilder, acromegaly) some medications DECREASED with loss of muscle, low protein intake	Daily, in the acute setting. Monthly, if possible, in long term feeding.

Liver enzymes

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
AST, ALT	<ul style="list-style-type: none"> * “transaminases” * released in cell damage * ALT in liver cells * AST in liver, muscle and red blood cells 	<p>INCREASED in liver damage</p> <p>ALT only: mild liver damage</p> <p>AST only: chronic liver disease with tissue destruction, or damage to other body muscle</p> <p>Both AST and ALT raised: major damage; can indicate overfeeding, esp. with excessive carbohydrate.</p>	<p>Daily in the acute setting</p> <p>Monthly if possible, for long term feeding</p>
ALP, GGT	<ul style="list-style-type: none"> * “cholestatic enzymes” * produced by liver in increased quantities during biliary obstruction * GGT induced by some medications, and obesity * ALP in bone and placenta 	<p>INCREASED in biliary obstruction</p> <p>GGT only: drugs, obesity</p> <p>ALP only: bone, growth, fractures</p> <p>Both GGT and ALP: cholestasis; will increase in overfeeding, esp. with excessive carbohydrate, but not usually to abnormal level.</p>	<p>Daily in the acute setting</p> <p>Monthly, if possible, for long term feeding</p>
Bilirubin	<ul style="list-style-type: none"> * breakdown product of haem molecules * WBC in spleen produce bilirubin * liver makes bilirubin soluble and secretes it into bile 	<p>INCREASED in internal bleeding or haemolysis, or liver dysfunction, or biliary obstruction, also many drugs</p> <p>May DECREASE in overfeeding.</p>	<p>Daily in the acute setting</p> <p>Monthly, if possible, in long term feeding</p>

Iron studies

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
Haemoglobin	Iron containing portion of the RBC which binds oxygen for transport throughout the body	<p>INCREASED in haemochromatosis</p> <p>DECREASED with blood loss, acute phase and in all types of anaemia</p>	<p>Daily in the acute setting</p> <p>Monthly, if possible, in long term feeding</p>
Ferritin	Storage form of iron	<p>INCREASED in acute phase and sepsis (to reduce availability to bacteria), iron overload.</p> <p>DECREASED in iron deficiency (diagnosis of iron deficiency anemia if haemoglobin also low).</p>	<p>To assist in interpretation of abnormal iron studies. More sensitive and specific than other iron tests.</p>

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
Transferrin	Transport form of iron	INCREASED in iron deficiency DECREASED in acute phase response, malnutrition, iron overload, liver disease	To assist in interpretation of abnormal iron studies. Not a sensitive measure of protein status due to wide normal range and unpredictable response to nutrition support.
Serum iron	Free iron in the serum	DECREASED in iron deficiency	Not very sensitive or specific. Significant diurnal changes and wide normal range.
Haematocrit (also known as Packed Cell Volume or PCV)	Volume of red cells in relation to the total volume of blood	INCREASED with dehydration DECREASED in anaemia and other blood abnormalities, blood loss, nutritional iron deficiency.	To assist in interpretation of abnormal iron studies. Relatively insensitive: detects only severe iron deficiency.
Mean corpuscular volume (MCV)	Reflects RBC size, to classify type of anaemia	INCREASED in macrocytic anaemia NORMAL in normocytic anaemia DECREASED in microcytic anaemia	To assist in interpretation of abnormal iron studies.

Lipid studies

MEASURE	DESCRIPTION	INTERPRETATION	IDEAL FREQUENCY OF MONITORING
Triglycerides	Storage form of fat in the body. Consumed in diet, or made by the liver. Need fasting blood sample for accurate assessment	INCREASED in overfeeding, glucose intolerance, hyperlipidaemias, hypothyroidism, pancreatitis. DECREASED in malabsorption or very low fat intake, hyperthyroidism.	As needed
Cholesterol	Made in the liver, needed for production of hormones, bile acid and vitamin D.	INCREASED in acute phase and sepsis (to reduce availability to bacteria) as well as hyperlipidaemia and increased dietary intake. DECREASED with malnutrition, liver disease, hyperthyroidism	As needed

Vitamins, minerals and trace elements

Note: blood levels may not reflect total body stores, due to varying distribution of vitamins/minerals in body tissues.

MEASURE	DESCRIPTION	INTERPRETATION	MONITORING
Fat-soluble vitamins	Vitamin A (retinol and carotenoids, essential for vision, growth, iron metabolism. Deficiency symptoms include night blindness, anaemia, immune impairment, follicular hyperkeratosis.)	DECREASED in fat malabsorption.	Usually test Vitamins A and D to exclude fat malabsorption. Individual tests (serum retinol,) to exclude deficiency. Blood samples for retinol testing should be wrapped (in foil/paper) after collection to avoid light exposure.
	Vitamin D (active form is 1,25-dihydroxyvitamin D, controls calcium utilisation, has immune function, interacts with serum calcium and phosphorus, and parathyroid hormone. Deficiency symptoms include bone abnormalities, low serum phosphate, raised ALP.)	DECREASED in lack of sun exposure, malabsorption (esp. in elderly)	Usually test serum level of precursor form (25-hydroxyvitamin D) as this is the major circulating form and a more sensitive test than 1,25 form.
Vitamin B12	Cyanocobalamin; acts as cofactor in fat metabolism and DNA synthesis. Stored in liver. Deficiency symptoms include neurologic symptoms (fatigue, weakness, depression), glossitis, stomatitis, pallor, gut dysfunction, megaloblastic anaemia.	INCREASED in acute phase and sepsis (to reduce availability to bacteria) DECREASED with loss of stomach or ileum function, malabsorption (eg in coeliac disease or pancreatic insufficiency), vegan diets, old age, pernicious anaemia, nitrous oxide anaesthesia.	Serum cobalamin assay checks B12 level, levels are low in deficiency. Serum methylmalonic acid is elevated in B12 deficiency but not in folate deficiency. Unstable, so blood sample should be frozen after collection.
Folate	Folic acid and related compounds, involved in coenzymes of many metabolic processes, esp. amino acid interconversions and DNA synthesis. Deficiency symptoms include neurologic symptoms (fatigue, weakness, depression), glossitis, stomatitis, pallor, gut dysfunction,	DECREASED in folate deficiency, and in smokers. May be INCREASED in cases of small bowel bacterial overgrowth.	<u>Erythrocyte</u> (not serum) folate is best test. Unstable, so blood sample should be frozen after collection.

MEASURE	DESCRIPTION	INTERPRETATION	MONITORING
	megaloblastic anaemia. Also increased cardiovascular risk.		
Zinc	Important cofactor for many enzymes, role in immune function.	DECREASED in malabsorption or chronic renal failure, or with poor intake or loss of skin tissue (as in burns or psoriasis). Folate supplementation may interfere with zinc absorption.	Serum value should be corrected for low albumin level. Trace element free tube should be used for collection as zinc is a common contaminant.
Selenium	Antioxidant, interacts with thyroid hormones. Absorbed in duodenum. Deficiency signs include muscle weakness, cardiomyopathy.	DECREASED in people living in regions with low-selenium soil (incl. Australia, New Zealand). Also in pregnancy, alcoholism, malabsorption and in immunocompromised patients.	Measured by testing serum selenium level or glutathione peroxidase activity.

Indicators of protein status

Interpreting these indicators can be complex.^{25,26,27,28} Note the effect of the acute phase process on all of these indicators. Acute phase markers (such as C-reactive protein, see below) may be useful in quantifying this.

MEASURE	DESCRIPTION	INTERPRETATION	MONITORING
Albumin	A non-specific carrier protein, plays important role in controlling fluid distribution between tissue compartments. Made in the liver. Half-life 18-20 days.	INCREASED in dehydration or when IV albumin is given. DECREASED in acute phase, liver failure, protein malnutrition, overhydration, loss of body tissue (as in bleeding, burns, surgery, fistula), diarrhoea.	Strong prognostic indicator, ²⁹ because it is a measure of disease severity. Cannot be used to assess nutritional status in acute phase situation. Good screening parameter as it indicates <u>long-term</u> nutritional status (not in acute phase situation).
Prealbumin, also known as thyroxine-binding protein or transthyretin	Transport protein for thyroxine, also associated with retinol-binding protein transport. Made in the liver, mostly cleared by the kidneys. Half-life 3-5 days.	INCREASED in renal failure, steroid therapy, non-hodgkin's lymphoma, head injury (? via cortisol secretion.) DECREASED in acute phase, liver failure, protein malnutrition, hyperparathyroidism.	Much earlier indicator of patient's clinical improvement, compared to albumin. Correlates with previous 5 days' cumulative nutrition intake in a stable patient (even in acute phase) and should be normal in a stable fed patient after 1-2 weeks.
Retinol-binding protein	Transport protein for retinol. Made in the liver. Half-life 12 hours.	INCREASED in renal failure, vitamin A deficiency. DECREASED in acute	Extremely sensitive indicator of patient's clinical condition. May fluctuate too much to be a useful measure.

MEASURE	DESCRIPTION	INTERPRETATION	MONITORING
		phase, liver failure, protein malnutrition.	
Total protein	Total of serum proteins. Albumin and immunoglobulins are the major components of this total.	DECREASED in acute phase, or any other situation where albumin is decreased.	Severe acute phase may cause a decrease in alb:total protein ratio, due to falling albumin and increasing contribution by acute phase proteins (such as c-reactive protein)
Nitrogen balance	Most direct measurement of actual protein status, by comparing nitrogen output and input.	Positive nitrogen balance (input > output) indicates anabolism. Negative nitrogen balance indicates lean tissue loss. (Will be negative in acute phase, and improvement may not be possible.) Less accurate if there are unquantifiable additional protein losses (such as from wounds/fistulae)	24-hour urine collection is tested for urea (or, preferably, total nitrogen ³⁰) content. Calculation then estimates nitrogen balance: Nitrogen input (g) = protein intake (g) ÷ 6.25 Nitrogen output = 24-hour urinary urea + “insensible losses”, usually use 3-5 g but may be more.
C-reactive protein (CRP)	An acute phase protein – a non-specific marker of infection and inflammation.	INCREASED very rapidly in acute phase, sensitive correlation with disease severity. NORMAL level is around 0.	Helps in interpretation of other indicators, by quantifying acute phase situation. Should have inverse correlation with prealbumin etc, in an adequately nourished patient.
Erythrocyte sedimentation rate (ESR)	A less specific indicator of acute phase response.	INCREASED in acute phase and inflammation. DECREASED in CCF, sickle cell anaemia and polycythaemia.	C-reactive protein is a better indicator of the acute phase response.
White cell count (WCC)	(= total of lymphocytes, neutrophils, basophils, eosinophils.) A good general indicator of infection and stress.	INCREASED in tissue damage and infection. DECREASED in immunocompromised patients.	Decreases promptly as infection resolves.
Lymphocytes (Total lymphocyte count: TLC)	Marker of bone marrow and immune function. Good predictor of healing. ³¹	DECREASED in the acute phase response and in immunocompromised patients.	Daily in the acute setting, monthly if possible in long term care.
Neutrophils	Immune cell that engulfs and destroys bacteria. A marker of bacterial infection.	INCREASES in infection DECREASES in neutropaenic immunocompromised patients.	Decreases promptly as infection resolves.

Clinical assessment and monitoring

Physical examination of the patient is important during the initial assessment, particularly in critical illness when other indicators are affected by the patient's acute condition.

Nutritional assessment

MEASURE	DESCRIPTION	METHOD OF MONITORING	IDEAL FREQUENCY OF MONITORING
Lean tissue stores	<ul style="list-style-type: none"> * muscle mass * main determinant of resting metabolic rate * decreases in critical illness and immobility * lost during rapid weight loss, regained only slowly 	Assess: <ul style="list-style-type: none"> * temporal muscles (should be flat or plump, not hollowed) * clavicle (should not be prominent with hollowing; should not be visible at all in men) * shoulder (should be rounded, not square looking with prominent bones) * scapula (should not be prominent; surrounding ribs should not be prominently visible) * quadriceps (should be plump with good tone, and without bone dent or bony prominence at knee) * calf (should be plump with good tone) * interosseus muscle (between thumb and forefinger, should be plump or flat, not depressed) 	Baseline and then weekly-monthly in longer term care.
Adipose tissue	<ul style="list-style-type: none"> * fat mass * minimal metabolic activity at rest, but the added weight increases energy expenditure during activity. * gained particularly with rapid weight gain 	Assess: <ul style="list-style-type: none"> * fat pads under eyes (should be slightly plump, not hollowed) * triceps skin fold (should have substantial fold, not thin or loose) * biceps skin fold (should have substantial fold, not thin or loose) 	
Skin condition	Indicator of general nutritional status, also protein, zinc, vitamin C and vitamin E nutrition.	Examine skin appearance with particular attention to wound sites, check areas not exposed to sun which should be intact without significant blemishes, soft, dewy. Wounds should look clean and pink, without very red or gummy edges. Sores, bruising, dryness or flaking can all be significant. Breakdown at corners of eyes, nose and mouth (and tongue, gums) are significant in vitamin deficiencies.	Better for initial assessment than for monitoring as changes are often slow and difficult to quantify. Objective tools are useful (such as the PUSH tool for wound healing). ³²
Hair/nails	Indicator of general nutritional status, also protein, zinc, vitamin C and vitamin E nutrition.	Inspect hair, test pluckability of individual hair. Should be shiny, not coarse / dry. Loss of pigmentation, and easy pluckability may be significant. Fingernails should have a slight gloss, pink	Good for initial assessment but not for monitoring in most patients, as changes are

MEASURE	DESCRIPTION	METHOD OF MONITORING	IDEAL FREQUENCY OF MONITORING
		nail bed and white lunula. Horizontal ridges, yellowing, pale nail bed, loss of lunula, raised nail edges can all be significant.	extremely gradual. Indicates long term nutritional status.
Fluid status	Patients who can drink to thirst and have normal renal function and no abnormal losses should maintain normal fluid status. Involuntary nutrition, altered renal function, or increased losses will all increase risk of abnormal fluid status.	<p>Assess dehydration by:</p> <ul style="list-style-type: none"> * dry skin, reduced skin turgor, dry mucosa * reduced urine output * very yellow or dark urine * low blood pressure, increased heart rate <p>Abnormal fluid (such as ascites, oedema) should be taken into consideration. (Dehydrated patients can still be oedematous.)</p> <p>Note: in the critically ill, fluid balance would normally be monitored closely by medical/nursing staff. The dietitian should still be aware of the patient's fluid status and the team's goals for fluid management. On the ward level, the dietitian may need to take an active role in ensuring that the patient's fluid requirements are met.</p>	Daily

Day-to-day management of an enterally fed patient requires attention to practical aspects of tube feeding. (See *Troubleshooting* section for management of feeding problems.)

Nutrition support management

MEASURE	DESCRIPTION	METHOD OF MONITORING	IDEAL FREQUENCY OF MONITORING
Feeding tolerance	<ul style="list-style-type: none"> * gastric aspirates * abdominal distension or discomfort * bowel activity 	<p>Hospital flowsheet or fluid balance charts, medical record documentation. Daily abdominal girth measurements (using a tape measure, at umbilicus) if increasing abdominal distension. Bowel charts to record stool amount and frequency. (Can use Bristol Stool Chart for objective classification of stool consistency.)</p>	Daily in acute care situation; 2-3 times weekly in stable hospital patients; weekly – monthly in long term care.
Feed delivered	<ul style="list-style-type: none"> * is the feed rate correct? * has the patient received the prescribed amount of formula? * reasons for interruptions to feeding 	<p>Hospital flowsheet or fluid balance charts Pump with “total volume delivered” function Medical record documentation</p>	Daily in acute care situation; 2-3 times weekly in stable hospital patients; weekly – monthly in long term care.
Care of feeding equipment	<ul style="list-style-type: none"> * regular tube flushing * PEG site care 	<p>Hospital flowsheet/ care plans; medical record documentation. Examination of PEG/NGT site.</p>	Daily in acute care situation; 2-3 times weekly in stable hospital

MEASURE	DESCRIPTION	METHOD OF MONITORING	IDEAL FREQUENCY OF MONITORING
	* correct taping of NGT		patients; weekly – monthly in long term care.
Patient positioning	* patient's head and shoulders must be elevated 30-45° above chest level	Observation	Continuous in acute care situation; at least every shift in stable patients.

Dietary intake

Adequacy of nutrition support

MEASURE	DESCRIPTION	METHOD OF MONITORING	IDEAL FREQUENCY OF MONITORING
Nutritional input	* is the patient receiving/tolerating the prescribed amount of formula? * is the formula appropriate for the patient's needs (energy and protein needs, RDI volume)? * is oral intake (if applicable) increasing or decreasing?	Hospital flowsheet or fluid balance charts Pump with "total volume delivered" function Medical record documentation Food charts/observation Patient report of intake	Daily in acute care situation; 2-3 times weekly in stable hospital patients; weekly – monthly in long term care.
	* is the patient receiving adequate fluid? ³³	Free water input should match fluid output in a stable patient. Input includes: water from feeds (only 70-80% of the formula's volume is water), tube-flushes, IV fluids, fluids given with drugs, oral fluid intake. Output includes: urine output, stoma/faecal output, losses from wounds/fistulae, discarded gastric aspirates/vomit, insensible losses (perspiration, breath moisture) increased in fever.	
Review of requirements	* have requirements changed (due to new infections or surgery, or improvement in condition, or change in activity level)? * is amount of feed still appropriate to meet needs? Has oral intake (if applicable) changed? * is feeding regimen still appropriate? Should it be stopped during physiotherapy or when an incompatible drug is being given?	Patient weight monitoring Biochem/haem Medical record documentation Estimation/measurement of energy expenditure Medication chart and Drug-Nutrient Interaction manual (or pharmacist advice) Patient's preferences	Weekly in acute care situation; monthly in stable hospital patients. 1-6 times per year in long term care.

ISSUES IN LONG-TERM ENTERAL NUTRITION

Transitional feeding

Transitional feeding describes the process by which a tube-fed patient returns to an oral diet and ceases tube feeding. The ultimate goal of transitional feeding is that the patient's full nutritional needs will be met with oral intake alone. Ideally, the transition will be a smooth process, which may take a few days or several weeks. Abrupt cessation of tube feeding is not recommended, as nutritional status may be compromised. Reductions in the tube-feeding rate should be made in proportion to increases in oral intake.

Options for transitional feeding

Satiety and lack of appetite are common barriers to achieving an adequate oral diet. Transitional feeding strategies aim to promote the patient's normal appetite and encourage an increase in oral intake, so that reliance on the tube feeding is gradually reduced.

Ceasing feeds during meal times

This aims to improve the patient's appetite and oral intake at mealtimes. The tube feeds are stopped approximately 1-2 hours before each main meal. Feeds can resume when the patient has finished eating, or 1-2 hours afterwards.

Nocturnal feeding

Feeding during overnight hours (8-16 hours) is less satiating than daytime feeding, and therefore encourages oral intake during the day. It also has the advantage of allowing more time for patient activities such as physiotherapy. By tube-feeding overnight it is possible to satisfy nutritional requirements not met orally. The length of the overnight feeding cycle will also depend upon the patient's tolerance of increased enteral feeding rates. A more energy-dense formula (such as 1.5kcal/mL or 2kcal/mL) can be useful for meeting the patient's needs using a lower feed rate.

Bolus feeding

Bolus feeding during the day may be used as an alternative to continuous overnight infusion. Administer bolus feeds at times separate from oral meals to minimise impact on appetite. Bolus size can be adjusted according to the intake at the previous meal.

Monitoring during transitional feeding

Refer also to *Monitoring* section.

Oral intake

Food charts can be used to record the patient's oral intake. Energy, protein and fluid intakes are monitored by the dietitian and compared with the patient's requirements (for example by calculating the percentage of requirements being met by oral intake). The tube-feeding regimen should be adjusted accordingly, decreasing tube feeding rate or infusion time as the oral intake increases.

Fluid balance

When the rate or volume of tube feeding is reduced, it is important to monitor the patient's fluid input to ensure that requirements are still being met. The amount of tube-flushes may need to be increased if the patient's oral fluid intake remains inadequate. (This is particularly common when the oral diet has a modified texture and/or fluids are thickened). Any changes to the patient's IV fluids should also be noted, as these often change during the transitional period, and additional (or larger) water flushes may be needed.

Swallow function

Where dysphagia has been the indicator for enteral nutrition, a speech pathologist will assess and monitor the patient's swallow function. Speech pathologists advise on the appropriate texture and consistency of the oral diet to minimise aspiration risk. Level of alertness will affect the patient's ability to eat and to learn strategies that assist in safe swallowing. The dietitian and speech pathologist should liaise closely, to ensure successful coordination of enteral and oral feeding for the patient.

Discontinuing enteral feeds

The goal of transitional feeding is the eventual cessation of tube feeds, but it is important that this occurs at the appropriate time.

Stopping the feeds

In general, tube feeding may be ceased once the patient is able to maintain an adequate oral intake. This may require improvement in their swallowing, their gut function, or their general wellbeing, and the time required for this will differ between individual patients.

If the patient is able to consume 65-75% of their nutritional requirements orally, it may be appropriate to discontinue the tube feeding and use oral supplements to meet the remainder of the patient's requirements. For other patients, it may be prudent to ensure that the full requirements can be met orally before feeds are stopped, and perhaps continue some form of nutrition support (such as intermittent tube feeding) to achieve a further improvement in the patient's nutritional status, even when the patient has an adequate oral intake.

For some patients, additional fluids, or medications, may be easier to give via the feeding tube and this may continue for some time after tube feeding has ceased.

Removing the feeding tube

The time frame for removing the tube will vary greatly between patient types and the reason for feeding tube insertion.

After the initial insertion, it is generally recommended that a gastrostomy or jejunostomy tube should remain in place for at least 2-3 weeks, to allow time for the tract to heal fully. Where patients are discharged from hospital with a feeding tube in place, it is important for the dietitian to liaise closely with the patient's doctor(s) regarding use and/or removal of the tube. In particular, it is important to make clear any concerns about the patient's oral intake or nutritional status, where the patient would benefit from a longer period of nutrition support. This is also an opportunity to discuss the patient's possible future needs for nutrition support (such as planned chemotherapy or radiotherapy which might compromise oral intake or nutritional status).

Discharge/transfer of the tube-fed patient

When the patient is transferred from one health care facility to another, or discharged home under the care of their local doctor, it is important to provide adequate information to enable continuity of nutritional care. For the nutrition support patient, particular information that is useful to include in a handover/discharge summary would include:

1. Date when the feeding tube was inserted, type of tube (brand, size, type)
2. Date when feeding commenced, if different from tube insertion date
3. Indication for tube feeding
4. Feeding route
5. Name of feed
6. Reason for choice of the particular feeding formula
7. Feeding regimen, including water flushes and feeding times
8. Total volume of feed per day; amount of energy, protein and fluid provided
9. Type of oral intake (if relevant), or reason why patient is kept NBM
10. Other relevant information (such as nutritional assessment data, estimated requirements and how these were calculated)
11. Other recommendations (such as weight monitoring)
12. Follow-up plan

TROUBLE SHOOTING GUIDE

Blocked feeding tube

PROBLEM: BLOCKED FEEDING TUBE		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Irregular tube flushings (more likely to cause a problem with fine-bore tubes, concentrated or fibre-enhanced feeding formula, or gravity feeding.)	Flush with warm water. Repeat using a push-pull method for at least 30 minutes (see below) Avoid flushing with other substances. ³⁴ If unsuccessful, flush with activated pancreatic enzyme preparation (see note below).	Prevent by always flushing tube with at least 30mL water before and after each feed or every 4-6 hours during continuous feeding. Tube should also be flushed before and after checking gastric aspirates. Blockage risk is reduced by using a feeding pump for continuous feeding. Gastrostomy tubes are less prone to blocking due to their shorter length and larger bore. Very fine bore tubes (such as those 8FR or smaller) may need to be flushed even more frequently, eg two-hourly.
Incorrect administration of medications	Flush with warm water. Repeat using a push-pull method for at least 30 minutes (see below) Avoid flushing with other substances. ³⁴	Prevent by always flushing tube with at least 30mL water before and after each individual medication. Ensure that all prescribed medications are suitable for giving via feeding tube – discuss with doctor / pharmacist. All medications should be liquid forms, where available, or crushed well and completely dissolved, and many require quite large amounts of water.
Feeding tube deterioration	Remove and replace feeding tube.	Note tube life time recommendations. Inadequate care of the feeding tube and entry site can shorten tube life.
Kinked or twisted feeding tube	Confirm with xray. Attempt to reposition. Tube may need to be removed and replaced.	Tube should be examined prior to insertion, and discarded if faulty.
Inappropriate substances being given into feeding tube	Flush with warm water. Repeat using a push-pull method for at least 30 minutes (see below) Avoid flushing with other substances. ³⁴ If unsuccessful, flush with activated pancreatic enzyme preparation (see note below).	Ensure that patient / carer is aware that lumpy or fibrous substances are not suitable for administration via feeding tube. Ideally only enteral feeding formula should be used. Any other foods or fluids should be of a smooth consistency and well-diluted, and the tube well-flushed with water beforehand and afterwards.

Warning

Feeding-tube guidewires or introducers should never be reinserted into a feeding tube while the tube is in the patient. They can perforate the tube and cause serious injury.

Unblocking a feeding tube with water

Use a 5mL luer-lock syringe (or smallest syringe available that will fit onto the feeding tube). Fill the syringe with warm water and flush into the tube using moderate pressure. Clamp tube, wait 10 minutes then suck out as much of the tube content as possible. Repeat. If this does not work, pancreatic enzyme can be tried, however this is expensive and should be used only if tube replacement is not a realistic option. There is no evidence that other substances (such as fizzy soft drinks, urinary alkaliniser etc) are more effective than warm water.

Unblocking a feeding tube with pancreatic enzyme

Use a mortar and pestle to crush and mix:

* 10mL warm tap water

* 1 capsule Sodibic (Aventis) i.e. bicarb soda 840mg (or about ¼ teaspoon of bicarb)

* 3 capsules Pancrease (Janssen-Cilag) OR 2 capsules Viokase (Wyeth) or similar pancreatic enzyme product

Flush mixture into tube, clamp tube, wait 10-30 minutes, then attempt to flush tube.

Very valuable tubes that cannot be replaced may be prophylactically locked with pancreatic enzyme when not in use, to prevent blockage.³⁵

Aspiration of the feeds

Aspiration, meaning the inhalation of oropharyngeal or gastric contents into the larynx and lower respiratory tract, is not completely prevented by tube feeding. While the risk is less than with oral intake, there is little difference between PEG tubes, duodenal tubes and nasogastric tubes in terms of aspiration risk. Feeding into the jejunum may reduce the risk of aspirating tube feeds, but still does not affect the risk of aspirating oropharyngeal secretions, which may be laden with bacteria.³⁶

PROBLEM: ASPIRATION		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Reflux or vomiting of the feeds	Refer to sections on <i>Reflux</i> , <i>Delayed Gastric Emptying</i> , and <i>Vomiting</i> . Reduced rate of feeding, and slow advancement of feed rate, may reduce risk. For patients at high risk of aspiration, commence feeds at a slow rate (eg: 20mL/hr) and gradually progress to goal rate (eg: over 48-72 hours). ³⁶ Avoid bolus feeding.	Poor oral hygiene (eg xerostomia, dental caries, gingivitis) is associated with increased aspiration pneumonia risk. Routine oral hygiene for all patients including those who are NBM or edentate ^{36,37,38}

PROBLEM: ASPIRATION		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Incorrect patient positioning (eg feeding whilst lying flat)	Upright positioning (>30°) during feeding and >30 mins after ceasing feeds.	Head and shoulders should be >30° from horizontal.
Physical agitation of the patient (eg during showering or patient transfers)	Stop feeds at least 30 minutes before transfers or vigorous physiotherapy.	
Tube dislodgement (eg accidental displacement, or confused patient pulling at tube)	Check position of tube regularly. Replace tube if needed.	
Medications (eg those causing reduced level of consciousness, vomiting, or delayed gastric emptying (eg: antipsychotics, anticholinergics, narcotics))	Review medications and cease non-essential medications.	
Other risk factors that affect airway protection or gut motility (eg advanced age, decreased level of consciousness, neurological disorders, abdominal trauma/ surgery)³⁹	Identify risk factors and manage as above.	

Blue food colouring and enteral feeds

The use of blue dye (either methylene blue or blue food colouring) in enteral tube feeds should be avoided.

The addition of blue food colouring to enteral feeding formula has previously been used as a method for detecting aspiration of gastric contents into the tracheobronchial tree, by the appearance of blue colour in patients' respiratory secretions during suctioning. However, blue food colouring has been shown to be a poor marker for detecting aspiration, and there are possible serious adverse effects.^{40,41,42} Critically ill patients can be at risk of systemic absorption of the blue food dye. (Patients at highest risk are those with conditions in which gastro-intestinal permeability is increased, such as sepsis, severe burns, and trauma.) This can cause fatal mitochondrial toxicity. There are no accepted safe standards for the quantity of blue food colouring to be added to feeds, and this practice is no longer permitted by the American FDA. It is therefore not recommended.^{43,44,45,46}

Blue food colouring is occasionally used in gastro-surgical patients to test for leaks in the gastrointestinal tract (leaking anastomoses or fistulae), by the appearance of blue colour in the patient's drains or wound. The patient's doctor should take responsibility for the risks of this practice, and this should be clearly documented in the patient's medical record.

Nausea and vomiting

If the patient experiences nausea, assess the cause and treat appropriately. It is usually not necessary to cease the feeds. If significant vomiting occurs, tube feeding should be discontinued and reviewed by the medical officer to assess the cause.

PROBLEM: NAUSEA OR VOMITING		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Fast delivery rate of feed/ Overfeeding/ Excessive volume of feeding (eg: bolus size too large)	Reduce feed rate if possible Reduce amount of each bolus Check requirements to prevent overfeeding. Ensure patient's needs are met by feeding over a longer period, eg continuous administration rather than bolus, or give each bolus more slowly (eg: allow at least 20 minutes to give 250mL bolus).	Consider using a more concentrated feeding formula Smaller, more frequent bolus feeds may be better tolerated
Delayed gastric emptying or lower oesophageal dysfunction	Refer to section on <i>Delayed Gastric Emptying</i> . Consider postpyloric feeding. Consider prokinetic medications.	Consider changing to a more concentrated feeding formula, to meet patient's needs in a smaller volume of feed.
Incorrect patient positioning (eg feeding whilst lying flat)	Upright positioning (>30°) during feeding and >30 mins after ceasing feeds.	Head and shoulders should be >30° from horizontal.
Physical agitation of the patient (eg during showering or patient transfers)	Stop feeds at least 30 minutes before transfers or vigorous physiotherapy.	
Tube dislodgement (eg accidental displacement, or confused patient pulling at tube)	Check position of tube regularly and replace tube if needed.	Migration of feeding tube can lead to obstruction of the gastric outlet or small intestine. Ensure the tube has a flange or retaining bar (at the tube exit site on the skin) to prevent migration, and mark the feeding tube on the outside to indicate skin level.
Medications (eg opioids)	Review medications and cease non-essential medications. Consider prokinetic agent (eg: metoclopramide, erythromycin).	
Feeding formula administered too cold (when served straight from the refrigerator), or too concentrated	Measure amount of feed required and let stand at room temperature for 30 minutes before use. (Formula should be at room temperature when administered.) Consider changing to isotonic formula.	

Gut dysmotility problems

Delayed gastric emptying

PROBLEM: DELAYED GASTRIC EMPTYING		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
May be due to effect of illness, medications, post-surgical “fight-or-flight” response, hyperglycaemia.	<p>Assess patient tolerance by considering gastric aspirate volume, abdominal distension, abdominal discomfort, nausea/fullness.⁴⁷ (Refer to <i>Monitoring</i> section)</p> <p>Consider a gastric aspirate >500mL as “large”; aspirates greater than 200mL require care to minimise aspiration risk.⁴³</p> <p>Replace gastric aspirates (up to 500mL) into the patient. If in doubt, place patient on right side to check gastric aspirate. Note <i>trend</i> of gastric aspirates rather than reacting to a single large aspirate.</p>	<p>Discuss with team. Consider post-pyloric feeding. Consider prokinetic medications. Consider tighter BSL control. Note drugs given into stomach may not be effective / may be discarded in aspirates.</p> <p>Some patients have better tolerance of a more concentrated feed, at a lower feed rate. Others may respond to a lower feed osmolality or a reduced level of fat.</p>
Gastrointestinal obstruction	Refer to medical team. Cease feeding.	

Diarrhoea

PROBLEM: DIARRHOEA		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Antibiotics	Either oral or IV route can affect the gastrointestinal tract and cause diarrhoea; discuss with medical team / pharmacist	<p>Probiotics (eg supplements or probiotic-containing food products) and prebiotics (eg fibre in feeding formula or fibre supplements) can help to normalise gut flora after antibiotics.</p> <p>Check for <i>Clostridium difficile</i> infection as this can appear when normal gut flora are disrupted, and may cause serious complications.</p>
Medications	<p>Review medications.</p> <p>Cease laxatives!</p> <p>Oral/enteral liquid form of many drugs may</p>	Medications often change from IV to oral form when feeding tube is inserted, and this can

PROBLEM: DIARRHOEA

CAUSE	ACTION	OTHER INTERVENTION / REMARKS
	contain a large amount of sorbitol. Prokinetic drugs, and magnesium delivered enterally, are other common causes of diarrhoea.	cause diarrhoea that is blamed on feeding due to the coincidental timing.
Decreased bulk/fibre content of liquid formula	Review enteral feed. Consider a fibre-enriched feeding formula if current formula does not contain fibre. Mixture of different types of fibre may be more effective.	Consider fibre supplementation. For some patients it may help to try a fibre-free formula if the diarrhoea is occurring with a fibre-enriched formula.
Bolus feeding or rapid administration	Use continuous feeding / slower rate over a longer time period to reduce intolerance.	
Feed administered too cold (when served straight from the refrigerator)	Measure amount of feed required and let stand at room temperature for 30 minutes before use. (Formula should be at room temperature when administered.)	
Hyperosmolar formula	It is unclear whether osmolality of the feeding formula can cause diarrhoea, ³ however some patients may be more sensitive. Consider changing to iso-osmolar feed.	Check fluid status. Note that many medications have an extremely high osmolality. ⁴⁸
Malabsorption	Change to semi-elemental / elemental formula. Malabsorption should be investigated by the team in order to plan management (need for pancreatic enzyme replacement therapy, etc.) Consider a low fat or semi-elemental formula. Note that tube feeding formulae are generally lactose free and gluten free.	
Bacterial contamination	Refer to <i>Equipment</i> section for recommendations about hygiene and hang time.	Avoid adding anything to tube feeds. Medications, protein or salt supplements or extra water is ideally given as a bolus rather than mixed with feeds.
Overflow diarrhoea (from faecal impaction due to constipation)	Check patient's history for impaction risk factors (such as previous constipation, time since last solid bowel movement, immobility, medications). Confirm impaction with PR (rectal) exam or abdominal xray. See separate section on <i>Constipation</i> for further management.	
Low serum albumin (<25g/L)		There is limited evidence that this can be a cause of diarrhoea.

Constipation

PROBLEM: CONSTIPATION		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Inadequate fluid, causing dehydration and faecal impaction	Ensure adequate fluid. Review requirements and monitor intake and output.	Discuss with team. Needs to be managed promptly, as the stool becomes harder and drier the longer it stays in the colon. Additional water can be given (ideally as extra tube-flushes, rather than by adding water to feeding formula).
Inadequate fibre	Review enteral feed. Consider using a fibre-enriched feeding formula.	Consider fibre supplementation.
Disruption of usual routine and body diurnal cycle, lack of normal food and activity, lack of toileting privacy.	Consider intermittent or bolus feeding regimen (where appropriate, and tolerated) to promote normal body processes.	Discuss issues with team. Mobilising where possible, and attention to privacy, may help.
Medications that affect gastrointestinal motility (such as anaesthetics and analgesics, anticonvulsants, diuretics). Medical conditions affecting motility (such as spinal cord trauma, cancer).	Review medications. A bowel management protocol, with regular laxatives, may help to prevent problems.	
GI tract obstruction	Refer to medical team. Cease feeding.	

Ileus

PROBLEM: ILEUS		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Postoperative (“primary”) ileus – caused by autonomic nervous system “fight or flight” response to trauma/surgery ^{49,50}	* Discuss with medical team. * Should be able to resume enteral nutrition within 24 hours of surgery or trauma, for gut and immune benefits. ⁵¹ Early feeding may help to reduce ileus risk/duration. ⁵² * Postpyloric feeding may be used if gastric emptying is delayed, as small bowel function usually recovers promptly. * A low-residue formula may be preferred initially, as colon function may be slow to recover.	* Bowel sounds are of doubtful clinical significance * Neostigmine may be used to counteract the “fight or flight” response in the gut. ⁵³
Paralytic (“secondary”) ileus	* Discuss with medical team. * Cautious enteral nutrition may help to reduce ileus	* Abdominal xray is used in diagnosis of ileus.

PROBLEM: ILEUS

CAUSE	ACTION	OTHER INTERVENTION / REMARKS
<p>– caused by ongoing inflammation and/or medications (anaesthetics, opiates etc).^{49,50} Can occur after a period of normal feeding tolerance.</p>	<p>duration.⁵² Postpyloric feeding may be used if gastric emptying is delayed, but this should be used carefully in patients with a poorly-perfused gut due to risk of bowel necrosis. A low-residue formula may be preferred.</p> <p>* The patient should be monitored closely for abdominal distension or pain, or reflux, belching, nausea or increased gastric aspirates, and feeds stopped if any of these appear to be worsening. Regular measurement of abdomen girth (if distension is present) can provide a useful objective measure.</p>	<p>* Enteral naloxone may be used to reverse opiate effect in the gut.</p> <p>* Aperients such as lactulose are gas-forming and should not be used in ileus as they exacerbate gut distension.</p> <p>* Parenteral nutrition may be needed to supplement enteral feeds in patients who are experiencing persistent ileus.</p> <p>* Low-residue enteral nutrition, delivered at a very slow rate, is not usually contraindicated in such patients unless symptoms are worsening.</p>

Metabolic abnormalities

Refeeding syndrome

PROBLEM: REFEEDING SYNDROME ^{54,55,56}		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
<p>Resumption of nutrition in a patient who is severely malnourished or who has adapted to a state of starvation</p>	<p>Recognise the risk - patients who have:</p> <ul style="list-style-type: none"> • Alcoholism • Malnutrition • Anorexia nervosa • Loss of >10% of body weight within 3 months (including obese patients) • Low serum levels of phosphate, potassium, magnesium (however, patients with normal levels may still be at risk) • 7-10 days of fasting and evidence of physiological stress/depletion (weakness, shortness of breath, bradycardia, peripheral numbness) <p>Discuss with team. Give thiamine, multivitamin and supplement electrolytes to upper end of normal range before commencing nutrition support.</p> <p>Start feeding at 50% of the patient's basal requirement and increase gradually every second day, aiming to reach goal in 1-2 weeks. Fluid balance should be monitored as refeeding can cause fluid overload due to sodium shift. Fluid and/or sodium restriction may be required.</p> <p>Check electrolytes within 6 hours of commencing nutrition support and then at least daily during first week. Supplement as needed. Stop feeding and supplement if any electrolyte level drops to critically low level.</p> <p>Check electrolyte levels three days after stopping supplementation.</p>	<p>Refeeding syndrome may emerge as late as a week after nutrition support starts. When electrolyte levels are stable within the normal range, and the patient is tolerating feeds at the goal rate, supplementation can be ceased.</p> <p>Note: oral/enteral supplementation of vitamins and electrolytes may not be well-absorbed, and IV route may be preferred. In particular, oral/enteral magnesium can cause diarrhoea.</p>

Dehydration

Refer to *Monitoring* section for details on assessment of fluid status.

PROBLEM: DEHYDRATION		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Inadequate fluid intake	Review fluid requirements. Monitor fluid balance: review feed volume received and water flushes. Give extra/larger flushes if needed. Fluid intake may need to be supplemented with IV fluids.	Consider changing to a less concentrated feeding formula. Hypertonic dehydration (= “tube feeding syndrome”) can occur when a concentrated high protein feed is given to a patient who cannot drink to thirst or whose fluid losses are high, and who cannot concentrate urine (especially the elderly). ⁵⁷
Excessive fluid losses (from diarrhoea / vomiting / diuresis / burns / fever / fistula etc)	Ensure that the patient is receiving adequate fluid to make up for losses. Review fluid requirements and give extra/larger water flushes if needed. Fluid intake may need to be supplemented with IV fluids.	Discuss with medical team. Address individual conditions as needed

Fluid overload

Refer to *Monitoring* section for details on assessment of fluid status.

PROBLEM: FLUID OVERLOAD		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Excessive fluid intake	Review feed volume received, and water flushes; reduce flush amount if needed Consider other possible fluid sources (medications and the associated tube-flushes, IV fluids and medications)	Consider changing to a more concentrated feeding formula Check with medical team re: other sources of fluid that could be reduced (eg unnecessary IV fluids).
Compromised renal or cardiac function	Review feed volume and water flushes; reduce flush amount if needed	Consider changing to a more concentrated feeding formula: check with medical team regarding appropriate fluid restriction
Refeeding syndrome	Refeed gradually according to a set protocol. (See separate section on <i>Refeeding Syndrome</i> above for more details on this).	

Abnormal biochemical parameters

Refer to *Monitoring* section for details on assessment of biochemical parameters.

PROBLEM: ABNORMAL BIOCHEMISTRY		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Sodium – high (hypernatraemia)	Discuss with medical team. Larger or more frequent water flushes may be required.	Changing feed formula rarely makes any difference as dietary sodium is not a common cause of hypernatraemia, and enteral feeds are very low in sodium compared to oral diets.
Sodium – low (hyponatraemia)	Discuss with medical team. Fluid restriction may be required. Check that patient is not receiving excessive fluid.	If urinary sodium losses are high, it may be necessary to replace these (by giving salt tablets or ordinary table salt via NGT, or using saline to flush tube)
Potassium – high (hyperkalaemia)	It may be necessary to change to a low-potassium feeding formula. Discuss with medical team. Some medications cause potassium retention.	Potassium may be raised in situations of metabolic acidosis, when there is anaerobic metabolism (in hypoxic or poorly-perfused or damaged tissue). Reduced enteral feed rate may be needed while gut is poorly-perfused.
Potassium – low (hypokalaemia)	Check that patient is not receiving excessive fluid. Manage causes (eg vomiting, diarrhoea, inadequate intake, Refeeding Syndrome). Discuss with medical team. May need potassium supplementation.	Discuss with medical team. Some medications (eg some diuretics) may increase potassium losses.
Calcium – high (hypercalcaemia)	Check that the patient is receiving adequate fluid. Changing feed formula rarely makes any difference due to large body store in skeleton. Note need for “corrected calcium” calculation if albumin level is abnormal (most labs do this automatically).	Discuss with medical team. Can be due to excess vitamin D, A or calcium supplementation (particularly with poor renal function or alkalosis). There are many other possible causes (eg malignancy, medications).
Phosphate – high (hyperphosphataemia)	It may be necessary to change to a low-phosphate feeding formula. Discuss with medical team. Phosphate binders may be used.	Can be caused by excess vitamin D supplementation.
Phosphate – low (hypophosphataemia)	Discuss with medical team. May need phosphate supplementation. Manage causes (vomiting, malabsorption, Refeeding Syndrome).	Discuss with medical team. Some medications bind phosphate and prevent absorption (eg antacids, calcium) or increase losses (eg diuretics).

PROBLEM: ABNORMAL BIOCHEMISTRY

CAUSE	ACTION	OTHER INTERVENTION / REMARKS
Glucose – high (hyperglycaemia)	Discuss with medical team. In general, nutrition provision should not be compromised in order to control blood sugar levels. It may be necessary to review the patient’s need for insulin and/or oral hypoglycaemic medications.	Controlling BSLs improves outcomes, indicated by an influential trial (which controlled BSLs by using large amounts of insulin rather than altering nutrition input). ^{58,59}
Triglycerides – high (hypertriglyceridaemia) and/or abnormal liver function tests	Discuss with medical team. In general, nutrition provision should not be compromised in order to control blood lipid levels. Check that the patient is not being overfed.	Overfeeding, especially with excessive carbohydrate (more than about 5mg/minute/kg body weight) can lead to fatty liver (abnormal liver function tests, esp. AST and ALT) and high triglycerides. ⁵⁷
Urea and creatinine – high	Discuss with medical team. In general, nutrition provision should not be compromised in order to control urea and creatinine levels. It may be necessary to change to a feeding formula with a more moderate level of protein. In general, providing about 1.0-1.2g protein per kg body weight is a reasonable restriction unless the patient is not for dialysis. ^{60,61}	A urea:creatinine ratio of >1:10 may indicate dehydration or GI bleeding.
Albumin – low (hypoalbuminaemia)	Check that the patient is receiving adequate feeding. Review energy and protein requirements to ensure that these are both being met. (Note: feeding in excess of patient’s needs will not cause albumin level to increase more quickly.)	Level will not reach normal range if there is ongoing inflammation or infection (acute phase response). Nutritional indicators with a shorter half-life (such as prealbumin) may show faster improvements. Trend (over time) may be more informative than any single result. See <i>Monitoring</i> section for more details.

Drug-nutrient interactions

This section discusses basic information for a few selected medications only. Drug-nutrient handbooks, and your pharmacist, can provide more details.

PROBLEM: DRUG-NUTRIENT INTERACTIONS		
CAUSE	ACTION	OTHER INTERVENTION / REMARKS
<p>Phenytoin an anticonvulsant drug with poorly-understood pharmacokinetics and very individual dosing requirements. Tube feeds and oral supplements reduce phenytoin effectiveness, mechanism(s) unclear.</p>	<p>Discuss with medical team. Feeding regimen may need to be altered if phenytoin is given enterally, to allow for a break (1-2 hours before and after the phenytoin.)⁶² Ensure that the phenytoin is well-diluted, and flush the tube well before and after the dose as for other medications.</p>	<p>Discuss with medical team. Feeds may not need to be stopped if it is possible to monitor serum phenytoin levels very closely, and adjust the dose frequently. Phenytoin may have poor absorption if delivered jejunally (i.e. via jejunal feeding tube). IV phenytoin does not interact with enteral feeds/tubes and may be preferred.</p>
<p>Mono-amine oxidase inhibitors / MAOI a group of antidepressant drugs that interact with dietary tyramine (a protein breakdown product), causing extreme hypertension. A low tyramine diet is required.</p>	<p>Discuss with medical team. It should not be necessary to make any changes to the feeding regimen, as all tube feeding formulae are low in tyramine.</p>	
<p>Warfarin an anticoagulant drug that inhibits vitamin-K-dependent blood clotting. Tube feeds reduce warfarin effectiveness, mechanism unclear. Rarely, a patient may exhibit an unusually marked warfarin resistance that causes difficulties in establishing a therapeutic dose. This is often assumed to be due to the vitamin K content of the feed, but instead appears to be caused by warfarin binding to intact protein in tube feeds or to the feeding tube itself.^{63,64}</p>	<p>Discuss with medical team. There is no evidence to support a particular strategy in managing this problem. It is important to flush the tube well before and after warfarin is given. It may help to stop the feeds for warfarin administration (eg 1-2 hours before and after dose), adjusting feed regimen accordingly. Elemental feeding formula (which does not contain intact protein) is another option.</p>	<p>Discuss with medical team when feeds are being weaned as the patient may need more careful monitoring of warfarin levels.</p> <p>Interactions may be a combination of the feed's protein, vitamins (K, C, A, E all have influences on coagulation), and the cytochrome P450 pathway and this may help to explain why it is difficult to manage in those few patients who experience problems.</p>

APPENDIX 1: GLOSSARY OF TERMS

Acute phase response

The body's natural response to injury or infection, involving a process of inflammation and alterations in metabolic pathways. In particular, the liver prioritises the manufacture of inflammatory proteins (such as c-reactive protein) and the levels of these are greatly increased. Normal proteins, such as those involved in carrying vitamins and hormones, are downregulated and their levels decrease independently of nutritional status or the current level of feeding. For this reason, increasing nutrition support during the acute phase response will not cause an increase in normal visceral protein levels such as albumin. Levels will slowly rise on their own as the acute phase response resolves.

Feeding system: closed system

Feed is presented in a sealed container, with recessed spike system and air filter, that prevents the introduction of bacteria when the giving set is attached. This permits a longer hang-time at room temperature.

open system

Feed is delivered in a system that may be exposed to bacterial contamination, either because there is no air filter, or because feed is decanted from its original container into a reservoir or feeding bag. This reduces the hang-time at room temperature to 4-8 hours, less in hot conditions.

Dumping Syndrome

One of the key functions of the stomach is to release its contents gradually into the duodenum. Normally, concentrated foods (such as those with a high fat content, or high osmolality) are released more slowly. If the stomach is removed, or if tube feeding is delivered directly into the small bowel (by a duodenal or jejunal feeding tube), this controlled release does not occur. Dumping syndrome describes the effects of concentrated food being received by the small bowel at too fast a rate.

early dumping syndrome

Sudden distension of the small bowel causes a feeling of fullness, even nausea. Fluid may shift suddenly into the small bowel to dilute the concentrated food, causing a drop in blood volume. Heart rate increases; blood pressure may decrease sufficiently to cause faintness. The now-diluted gut contents may have a fast transit which promotes malabsorption.

late dumping syndrome

The insulin response to a concentrated glucose load can cause a rebound hypoglycaemia. The drop in blood glucose levels can cause sweating, shakiness, weakness. Bloating, cramping and diarrhoea can result from malabsorption.

Osmolality

The concentration of a solution, expressed in terms of the amount of osmotically active solute particles per kilogram of solvent. (For example, a mole of sodium chloride, when in solution will dissociate into a mole of osmotically active sodium ions and a mole of osmotically active chlorine ions, so the solution contains *two* osmoles. A mole of glucose in solution is osmotically active, but does not dissociate into smaller particles, so it will contain *one* osmole.) Units are usually milli-osmoles per kilo, or mOsm / kg.

Osmolarity

The concentration of a solution, expressed in terms of the amount of osmotically active solute per litre of the final formula solution. Units are usually milli-osmoles per litre, or mOsm / L. This is a less common way of describing the concentration, because of the way that volume can change with temperature, altering the measurement.

RDI Volume

The minimum volume of a tube feeding formula that will meet the daily requirements for all macro- and micro-nutrients (including minerals and trace elements) of an 'average' patient (reference values are usually the RDI for adults aged 19-54 years)

Refeeding syndrome

A group of signs and symptoms caused by the metabolic disturbances that occur when nutrition is re-introduced to someone who has metabolically adapted to starvation. Refeeding the starved or semi-starved patient causes acute cellular uptake of phosphate, potassium and magnesium in particular, and the resulting drop in serum levels can cause a variety of problems that can be fatal if not managed appropriately. See *Refeeding Syndrome* section of the *Troubleshooting Guide* for more details.

APPENDIX 2: TUBE FEEDING FORMULA RECIPE

Home-made tube feeding formula is not recommended (for more information, refer to page 8). The following recipe is not nutritionally complete and is suitable for short-term or emergency use only.⁶⁵ More detailed recipes, for nutritionally-complete formula, can be obtained for longer-term use⁶⁶ but these are more complicated and expensive, and generally pose an even higher risk of bacterial contamination and tube blockage.

All home-made recipes need to be prepared as hygienically as possible, and stored carefully in the refrigerator. Use as soon as possible (bring to room temperature before administering).

Ingredients

1500mL whole milk

2 eggs, washed thoroughly in lukewarm soapy water, rinsed and dried before use

100g glucose powder (an alternative would be 100g sugar dissolved in minimal amount of water prior adding to the mixture)

100g vegetable oil

Method

Use a blender to mix ingredients well.

Provides approximately 2150kcal, 66g protein and 1370ml of water. Patient will need additional water to meet total fluid needs. The lactose content is too high for some patients, and diluted pureed meat or chicken could be used as an alternative to the milk.

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Questions? Comments? Ideas for improving our feeding manual?
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