Parenteral nutrition: multidisciplinary management

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Parenteral nutrition may be needed to give nutritional support to patients with severe acute (temporary or reversible) or chronic intestinal failure. Parenteral nutrition needs to be given only by health workers trained in its use otherwise life-threatening complications (especially sepsis) may occur.

Parenteral literally means beside (para) the gut and theoretically includes any route of giving a drug or solution that does not involve the gastrointestinal tract. In clinical practice, parenteral nutrition (PN) is used to refer solely to the intravenous administration of nutrition. When a patient takes nothing orally and is dependant for all their nutritional needs upon PN then the phrase total parenteral nutrition (TPN) is used.

While the first reported use of PN was in 1873 when milk infusions were used to treat cholera (Lennard-Jones, 2001), PN only began to be used safely as a treatment in the 1970s after protein hydrosylates (amino acids) and lipid emulsions had been developed, and after central vein catheterization had become an established safe practice allowing hypertonic glucose solutions to be given.

The administration of nutrition directly into the circulation is not physiological and may result in gut atrophy and cholestasis; it can also be dangerous and is expensive. For these reasons, oral or enteral nutrition are used in preference to PN when possible (*Figure 1*). PN should not be condemned on the basis of trials performed in the 1970s and 1980s when it was often given to patients who would no longer be considered to need it, who may have had septic complications because of poor techniques, and who may have received too much energy (e.g. about 3000 kcal daily). Enteral nutrition and PN are not mutually exclusive and often both are used in combination.

INDICATIONS

PN is given to patients with intestinal failure (IF), when it may be harmful to feed through the gut, when enteral nutrition has failed, or rarely as a specific treatment (e.g. active Crohn's disease). IF occurs when there is reduced intestinal absorption so that macronutrient and/or water and electrolyte supplements are needed to maintain health and/or growth (Nightingale, 2001). IF is categorized as severe when PN and/or additional parenteral sodium and water are required. Acute IF is reversible and most commonly a result of surgical (e.g. ileus, sepsis or fistula) causes, although medical causes (post-chemotherapy) are becoming more common. Chronic IF may be a result of bowel dysmotility (e.g. scleroderma, visceral myopathy or neuropathy) or, more commonly, a result of intestinal resections that leave behind a short length of small bowel (*Figure 2*) (*Table 1*). The main circumstance in which it is harmful to feed through the gut is when there is a perforation that is not draining externally. Previously, pancreatitis, enterocutaneous fistula, oesophageal perfora-

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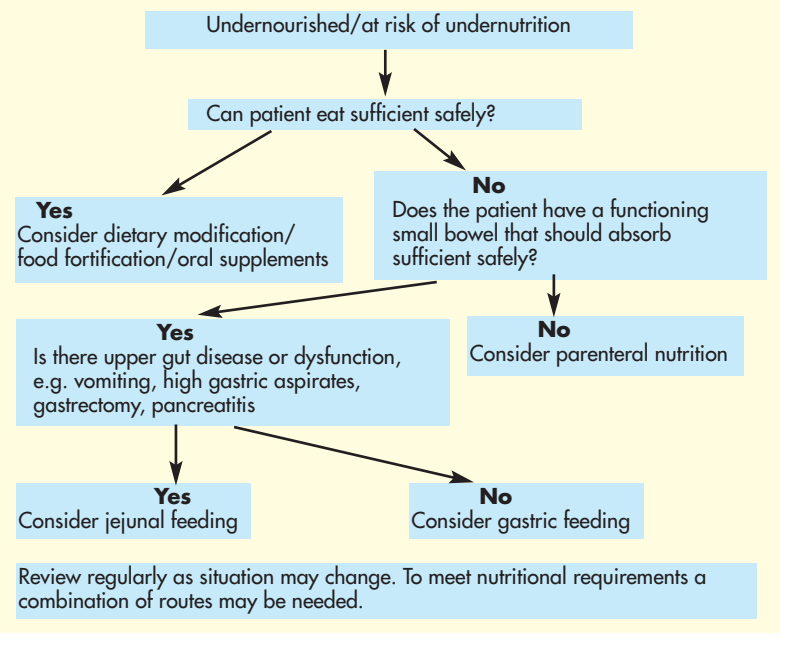


Figure 1. Assessment of patients for nutritional support.

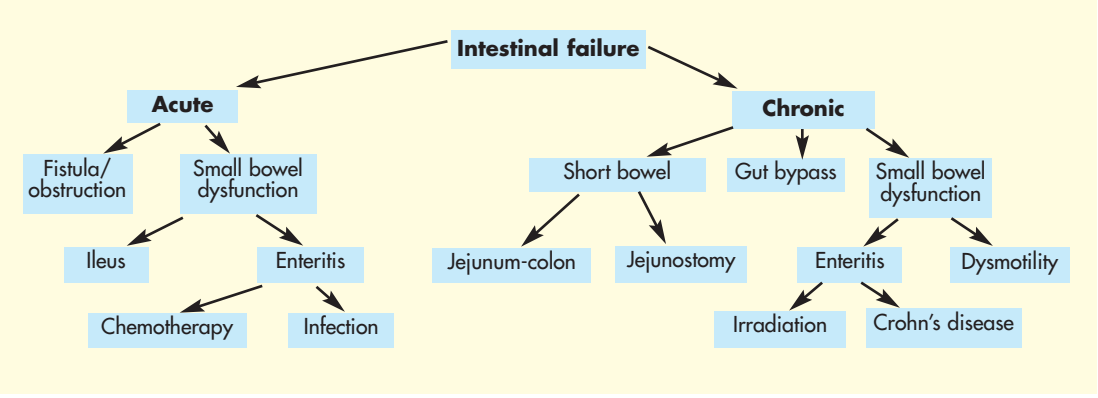


Figure 2. Reasons for intestinal failure.

tion, high nasogastric aspirates and/or vomiting, protection of anastomosis and mucositis were considered reasons for giving PN; however, in most circumstances, it is safe to give nutrition into the jejunum (Shah et al, 2002a). A postoperative ileus is rare and the small bowel function is usually retained after abdominal surgery, although there may be reduced gastric and colonic motility for 1–5 days.

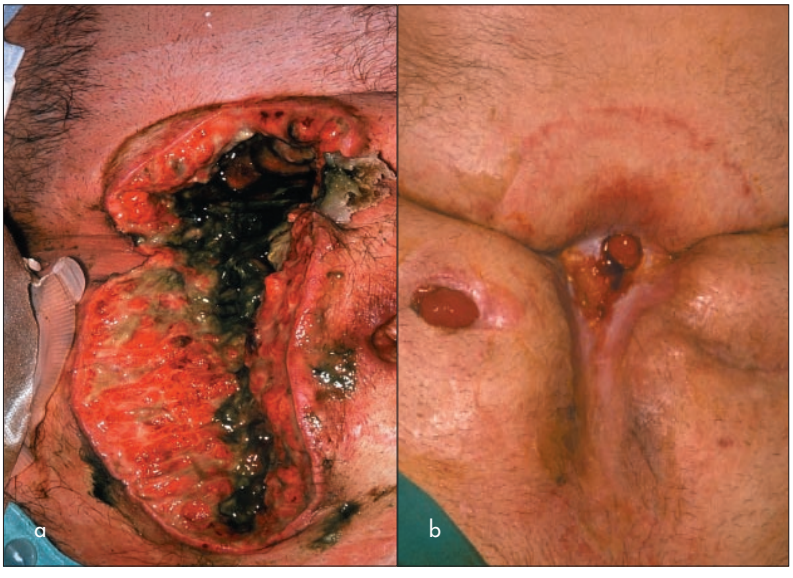
The most common reasons for giving PN in hospital are fistula (*Figure 3*) or anastomotic leak, small bowel obstruction, ileus, graft versus host disease, chemotherapy, short bowel, and failed jejunal feeding (Kennedy et al, 2002). Long-term parenteral nutrition at home (HPN) in the UK is most commonly given for Crohn's disease, mesenteric infarction, and irradiation damage. Cancer (mainly of gut or ovarian origin) is a rare indication for HPN in the UK, France and Denmark but is the most common reason in USA, Japan and most of Europe (Messing et al, 2001).

TABLE 1.
Jejunal length and nutrition or fluid requirements

	Bowel length (cm)	Type of nutrition and/or fluid
Jejunostomy	<80	Parenteral nutrition
	80–100	Parenteral water and sodium chloride
	100–200	Oral water and sodium chloride
Jejunum-colon	<50	Parenteral nutrition

From Nightingale et al (1992)

Figure 3. (a) A postoperative enterocutaneous fistula causing the breakdown of the abdominal wound. This was treated by total parenteral nutrition, octreotide injections and good wound management. Azathioprine was introduced at 3 months. (b) 4 months after initial wound breakdown the wound had largely healed and a stoma bag could be placed over the fistula. Mucocutaneous continuity is observed and so 2 months later the fistula with underlying small bowel was excised surgically. The patient has been well since and continues to take azathioprine.



THE ADMINISTRATION OF PN

PN may be given safely and effectively in a specialist ward or by a multidisciplinary nutritional support team (NST). A NST consists of (Lennard-Jones, 1992):

- A clinician who heads the team, and may be responsible for placing (or arranging the placement of) venous catheters and prescribing the PN
- A nutrition nurse specialist who teaches and supervises protocols for the care of the line
- A dietitian who assesses nutritional status and intake, calculates the patient's requirements and designs regimens
- A pharmacist who is responsible for formulating and providing the PN.

The team should work in close liaison with the primary team responsible for the patient. When PN is begun, the aims, including duration of PN, should be clear (e.g. waiting for gut function to return or for a wound to heal before elective surgery).

Timing

The time to start nutritional support may be difficult. If a patient is undernourished, at risk of undernutrition or has, or is unlikely to eat for 5 days (Stratton et al, 2004) and cannot adequately, or safely, be fed into the gut, then it may

be appropriate to start PN. Feeding should not be delayed in patients with IF who are unlikely to be able absorb sufficient from their diet (e.g. a jejunostomy and less than a meter of small bowel remaining). It can be argued that nutritional support should be delayed for 1–2 days after major trauma (including operations) as the metabolic rate naturally slows during this (ebb) phase before the catabolic (flow) phase. Some believe nutritional support should start as soon as possible, even being continued through surgery.

Route

When the decision to start PN has been made, a dedicated (one lumen, no side ports or 3-way taps) intravenous catheter is inserted aseptically. The position of a catheter may be described based on the site of the catheter tip (*Table 2*). In general, when PN is likely to be needed for a short time (2–8 weeks) a peripherally inserted central catheter (PICC) with its tip at the superior vena cava–right atrial junction is ideal. If there is no appropriate median cubital or basilic vein available then a tunnelled uncuffed central (usually subclavian vein) line with its tip at the superior vena cava–right atrial junction may be placed. Some units use a small vein (often on the back of the hand) for giving low-osmolality PN, and even with a glyceryl trinitrate patch over the catheter tip thrombophlebitis is common and the catheter is resited every 24–48 hours. For long-term feeding a cuffed silicone (Hickman or Broviac type) catheter is usually inserted. All feeding lines are inserted using a full aseptic technique (gown, gloves, sterile towels etc).

While there have been recommendations that central lines are placed using 2-dimensional ultrasound guidance (National Institute for Clinical Excellence, 2002) with or without X-ray screening, this is often not practical and may result in long delays before feeding is started. An experienced central vein cannulator may suffice. This rarely causes serious complications and allows feeding to commence quickly. A chest X-ray is performed before starting PN to check the catheter tip position.

Feed

Nutritional requirements may be calculated from Harris Benedict or Schofield equations. They take into account age, sex and weight. In the Harris Benedict equation height is also taken into account. Consideration is given to stress, activity, weight gain and growth. In general, the total energy should be between about 1000 and 2000 kcal/24 hours (20–35 kcal/kg/day).

TABLE 2.
Routes of parenteral nutrition

Catheter tip	Venous insertion site	Type of nutrition
Large vein	Subclavian/jugular/cephalic	Central
	Median cubital	Central (PICC)
Medium vein	Median cubital	Peripheral
Small vein	Dorsal metacarpal	Peripheral

PICC = Peripherally inserted central catheter

Sometimes energy requirements are expressed as non-protein energy, which gives results 200–300 kcal less than total energy. Nitrogen is given as 0.17–0.30 g/kg/day, or more if catabolic, this is usually about 9–14 g/day. In PN it is customary to refer to grams of nitrogen rather than grams of protein (1 gram nitrogen is equivalent to 6.25 gm protein). Lipid is usually given as approximately 40% of the total energy, although in the long term, lipid needs to be given at less than 0.5 g/kg/day to reduce the chance of liver function abnormalities (Vega et al, 2004). Fluid is given as 1–2 litres of water with about 60–80 mmol (1 mmol/kg/day) sodium in total, although more is needed if there are high stoma or fistula losses. The sodium concentration in most stomal fluid or fistulas is 100 mmol/litre and must be replaced as such. Minerals, trace elements and vitamins are usually added to a feeding bag. The use of novel substrates (e.g. glutamine, arginine, w3 fatty acids, ribonucleotides) in a feeding bag has not yet proved to be beneficial in adequately powered randomized controlled trials, although this may appear theoretically advantageous, especially for immune function.

If a patient is very undernourished, or has not taken any food for several weeks, they may be at risk of refeeding complications (mainly hypophospataemia, hypomagnesaemia and thiamine deficiency) thus the feed should be started slowly with regular measurements of phosphate and its correction into the normal range.

Blood glucose measurement is important especially in critical care patients, and survival may be improved with an intensive insulin regimen keeping the blood glucose between 4.4 and 6.1 mmol/litre (van den Berghe et al, 2001).

Care of catheter

The greatest risk of PN is in a catheter-related sepsis, and this usually arises from the catheter hub. Aseptic technique (not the clean technique often used to care for Hickman-type lines in oncology and haematology) is needed, and using this technique the catheter-related sepsis rate in

hospital can be less than two episodes/100 catheter days (Keohan et al, 1983; Shah et al, 2002b). The aseptic technique involves using chlorhexidine spray, sterile field and sterile gloves. Only trained nurses (or patients and/or carers) should take blood from the line, inject drugs down the line or connect and disconnect it to a feed (in general doctors should not do any manipulations to a feeding line). A parenteral feed is usually given for 24 hours continuously at first (1–2 weeks) or in a critical care setting, and if more long-term feeding is required (including HPN) the feeding time is shortened to night time only (10–16 hours) allowing the patient time free from the infusion and able to mobilize.

Monitoring

Ideally, weight, fluid balance and temperature are recorded daily. For the first week, blood tests (haemoglobin, white cell count and platelets, urea, electrolytes, liver function, calcium, phosphate and magnesium) are measured daily, then twice a week while in hospital, then every 2–3 months for patients who administer PN at home. A random urine sodium measurement gives a good idea of sodium status in patients with a high output stoma or enterocutaneous fistula; if less than 20 mmol/litre more intravenous saline may be needed (in addition to oral hypotonic fluid restriction and antidiarrhoeal drugs).

Complications

The complications of PN may be insertion related, catheter related, metabolic and/or nutritional or organ-specific (Pennington, 2001). Insertion-related complications are those of central vein catheterization (pneumothorax, subclavian artery puncture and brachial plexus injury).

Catheter-related sepsis might arise from the hub (most common), the insertion or exit site, or from the blood (e.g. from teeth, urine or another infective focus). This diagnosis is suspected when a patient develops a fever within an hour of a parenteral feed being put up (if cyclical PN). Blood cultures are taken from the line and from a peripheral vein. Vancomycin may be given down the line while blood culture results are awaited. *Staphylococcus epidermidis* is the most common infecting organism and must not be ignored as a possible contaminant. If venous access is easy it may be quickest to remove the line and insert another after 48 hours of antibiotics. If venous access is difficult and the line is very precious then it may be salvaged by a catheter lock technique. Urokinase (5000 units) is put into the line to remove a fibrin sheath then therapeutic vancomycin is given with one dose each day going through the line and being left within the line till the next infusion. After 2–5 days it may be possible to restart PN giving the vancomycin after the feeds for a further 2 weeks.

Superior vena caval occlusion may occur as a result of catheter tip position (usually high in brachocephalic vein), the hyperosmolality of the feed, catheter-related sepsis, catheter material (especially polyvinyl chloride), dehydration, a thrombotic tendency in the patient. Treatment should be aggressive if the line is likely to be used for long-term feeding and fibrinolysis used (tissue plasminogen activator, t-PA) followed by anticoagulation. The catheter may not need to be removed if the catheter tip is in good position.

Catheter occlusion is most commonly a result of a fibrin sheath round the catheter and allows fluid to be infused but no blood to be withdrawn. Urokinase injected down the line may cause dissolution of the fibrin sheath. If lipid is used daily in a 2–3 litre bag it may result in line occlusion and is best treated with 70% alcohol being put down the line, and prevented by weekly catheter flushes with an alcohol solution. In children occlusion may be a result of a calcium phosphate complex and a hydrochloric acid solution injected down the line can dissolve this.

Abnormal liver function tests may occur. Most commonly these relate to sepsis, drug administration or pre-existing liver disease. If associated with PN, abnormal liver function tests can relate to either an excess, usually of macronutrients or a hepatotoxin (e.g. phytosterols), or a deficiency. As far as deficiencies go, evidence for choline lack is most convincing in adults (Buchman, 2001) and taurine in neonates. The liver disease may start with a fatty liver and in some, progress through steatohepatitis to cirrhosis or may be a predominantly cholestatic problem. In patients with a very short bowel, or neonates, a progressive cholestatic liver disease that may lead to cirrhosis and death is most common (Nightingale, 2003). The management of abnormal liver function tests while a patient is receiving PN starts with seeking an alternative cause (especially sepsis). If thought to relate to the PN, options include reducing the energy (carbhohydrate or lipid), changing long-chain triglycerides to medium-chain triglycerides, giving the feed at night only, introducing some oral or enteral feeding, or adding choline to the feed. Changing the

bile-acid composition (e.g. to reduce the less soluble secondary bile acids) with metronidazole, ursodeoxycholic acid or taurine may help (Nightingale, 2003).

A bone disease separate from that occurring as a result of steroids, heparin or immobility may also occur with long-term PN (Pironi et al, 2002; Nightingale, 2003). It may relate to amino-acid infusions, acidosis, vitamin D toxicity, aluminium contamination of the feeds, or loss of the diurnal parathormone rhythm. Bone density is measured every 2–3 years. Lifestyle advice (stopping smoking, alcohol, exercise and sun exposure) is given, hormonal therapy or biphosphonates (usually by infusion) maybe required. Consideration may be given to daytime feeding using a portable pump.

HOME PARENTERAL NUTRITION

In the UK there are about 9 per million people having HPN at any one time (compared with 350 per million having home enteral feeding). The training for HPN can take 6 weeks and funding may be difficult to arrange. Ancillary (home care company), psychological and social issues need to have been addressed before discharge. The patient needs to be able to contact a member of the NST 24-hours a day. Additional support comes from patient groups (e.g. Patients on Intravenous and Nasogastric Nutrition Therapy (PINNT), PO Box 3126, Christchurch, Dorset BH23 2XS). Patients having HPN generally have a good quality of life, with few complications and the survival rate on HPN for non-neoplastic, non-human immunodeficiency virus infection is 70% at 3 years (Messing et al, 2001).

CONCLUSIONS

Although the recent trend has been for enteral nutrition to be used (even for a short trial) in most situations in preference to PN, opinions are changing, and good trials comparing safe and appropriate PN with enteral nutrition (e.g. in severe pancreatitis) are warranted. Providing PN is performed using a strict aseptic technique by trained staff, patients or carers, the patient should achieve a normal nutritional status with few complications. HM

Conflict of interest: none

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KEY POINTS

- Parenteral nutrition should be managed by a multidisciplinary nutritional support team.
- Catheter-related sepsis usually arises from the hub connection because of non-aseptic handling of the catheter.
- Catheter-related sepsis is most commonly caused by *Staphylococcus epidermidis*.
- Feeding lines are inserted and managed aseptically. Only trained nurses (or patients and/or carers) should take blood from the line, inject drugs down the line, or connect or disconnect it to a feed.
- A central feeding catheter should have its tip at the superior vena cava (SVC) – right atrium junction, if high SVC thrombosis is more common.
- Patients who have not been fed for 2–4 weeks are at risk of refeeding problems, and the serum phosphate must be regularly monitored.
- Abnormal liver function tests with parenteral nutrition usually relate to causes other than the parenteral nutrition (e.g. sepsis).