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Parenteral nutrition

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ABSTRACT Over the last 50 years, parenteral nutrition has been recognised as an invaluable and potentially lifesaving tool in the physician's arsenal in the management of patients with intestinal failure or inaccessibility; however, it may also be associated with a number of potentially life-threatening complications. A recent NCEPOD report (2010) identified a number of inadequacies in the overall provision and management of parenteral nutrition and recommendations were made with the aim of improving clinical practice in the future.
This paper focuses on the practical aspects relating to parenteral nutrition for adults, including important concepts, such as patient selection, as well as general management. We also explore the various pitfalls and potential complications and how these may be minimised.

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OVERVIEW

Definition

Parenteral nutrition (PN) is defined as the intravenous delivery of an artificial, nutritionally balanced combination of sterile nutrients. This may be provided to supplement limited oral or enteral feeding, or as the sole form of sustenance, i.e. total parenteral nutrition.

INDICATIONS FOR PARENTERAL NUTRITION

The preferred method of nutritional support for patients should always be via the oral/enteral route, this being safer and more physiological. However, there are some circumstances in which this may not be possible or appropriate. Parenteral nutrition should be considered when there is inadequate or unsafe oral/enteral intake and the gastrointestinal tract is short, leaking, obstructed, non-functional, or inaccessible (see Box 1).

Clear examples of situations where PN is indicated include:

- Extensive small bowel resection and residual short gut inadequate to maintain nutritional status
- Peritonitis from a persisting intestinal leak
- A newly developed proximal small intestinal high output fistula

However, the decision to start PN may not always be clear-cut, such as under the following conditions:

- Post-operative ileus
- Acute severe pancreatitis
- Distal small bowel fistula

BOX 1 CLUES THAT ENTERAL NUTRITION MAY BE INSUFFICIENT OR INAPPROPRIATE

- Inability to tolerate adequate caloric intake
- Continued vomiting
- Increasing abdominal distension
- Inability to gain or maintain weight (think also of sepsis in this case)
- Clinical/biochemical evidence of malabsorption
- High output fistula
- Evidence of intestinal obstruction

In such cases it may be appropriate to initiate a controlled and closely monitored trial of oral, gastric or post-pyloric feed under strict supervision with a view to starting PN if enteral nutrition is unsuccessful.

OBJECTIVES AND DOCUMENTATION

It is vital to establish and document the goals and objectives of PN at the outset. These may include:

- Awaiting resolution of paralytic ileus
- 'Bridging therapy' – before elective surgery (e.g. intestinal obstruction, high enterocutaneous fistula, or re-establishment of bowel continuity) – during chemotherapy
- Time-defined trial of total PN (gut rest) for resolution of fistulae or postoperative small bowel leaks
- A long-term plan for home PN for inoperable disease or permanent short bowel syndrome.

Such documentation should include the specific indications, treatment targets and expected duration of PN from the outset. Details should be reviewed on an ongoing basis to maintain focus on the goals of intervention. Along with regular monitoring, any adverse events should also be documented.

Supervision/provision of parenteral nutrition

All acute hospital trusts should have a multidisciplinary nutrition support team to oversee and monitor PN. The team may include doctors, dieticians, specialist nutrition nurses, pharmacists, chemical pathologists, and microbiologists, as well as other allied healthcare professionals (e.g. speech and language therapists, stoma care and tissue viability nurses, physiotherapists).

ROUTES OF ADMINISTRATION OF PARENTERAL NUTRITION

Complications arising from the insertion or management of intravenous catheters for the administration of PN are common, may be serious or even life-threatening, and are largely preventable when handled correctly. Therefore, only appropriately trained healthcare professionals should place such lines, preferably under ultrasound guidance.

Access for PN should be provided into a large central vein; either directly (via a simple central venous catheter), or via a peripherally inserted central catheter line. If PN is planned to last for more than 30 days, a tunnelled central venous catheter (e.g. Hickman line) should be considered.

To minimise the risk of line sepsis, there should be a dedicated catheter for the administration of PN. However, in situations where access is difficult or there is requirement for intravenous access for other purposes (e.g. regular blood sampling, IV drugs), a multilumen catheter can be considered, with one lumen reserved (and labelled) exclusively for PN.

Rarely PN may be administered via a peripheral cannula if planned for less than two weeks, but frequent catheter changes are inevitable. Only PN solution with a low osmolarity (ideally < 800 mosmol/L) should be given through this route to avoid chances of thrombophlebitis or local tissue necrosis due to extravasation injury. Therefore, it is not suitable for patients with poor peripheral venous access, higher nutritional requirements or strict fluid restrictions. The tip of a central line needs to be at the vena caval/right atrial junction, more proximal placement risks central vein thrombosis.

Composition and administration of parenteral nutrition

The composition of PN should be tailored for every patient based on individual requirements, illness, and weight. If providing the sole source of nutrition, PN solutions should be designed to include the correct quantities of all basic constituents, including protein, carbohydrates, lipid emulsion, water, electrolytes, minerals and trace elements. Clinical and dietetic assessments, as well as baseline biochemical assessments of micronutrients, electrolytes, liver and kidney function and fluid balance, are essential to decide on the composition of PN.

In hospital trusts that do not possess a compounding unit for the production of 'bespoke' PN, commercially manufactured pre-prepared bags of varying nutrient compositions are available. However, it should be emphasised that the vast majority of such bags do NOT contain micronutrients, which would therefore need to be administered separately.

Parenteral nutrition is usually started as a continuous infusion over 24 hours at ~50% of target requirements. This is built up over subsequent days to meet 100% of requirements and, once a patient is stable, this can be changed to cyclical (12–16 hours) administration allowing 8–12 hours of rest period. Close blood glucose monitoring is advised as rebound hypoglycaemia has been reported on stopping the infusion, as well as hyperglycaemia if PN is administered over too short a period of time. Lipid may be given daily for up to a month but then reduced to 2–3 times a week. This makes liver function abnormalities less likely to occur.

Monitoring

Regular monitoring and documentation of clinical/anthropometric status, PN access site, fluid balance, and serum biochemistry is the key to successfully delivering PN. These have been detailed in NICE guidelines [CG32] Nutrition support in adults.

Complications

Complications of PN can be divided into three major groups: mechanical, infective or metabolic.

Mechanical

Mechanical complications include damage to adjacent organs during line placement, haemorrhage, line displacement or line blockage. Careful line placement by trained operators preferably under ultrasound guidance minimises mechanical complications such as pneumothorax, line displacement or blockage/kinking. One of the most common non-infectious complications associated with the use of central venous catheters (namely, occlusion) can be due to mechanical obstructions, calcium phosphate or drug precipitates, and lipid emulsions. However, most are caused by a blood clot. Early signs of line-associated venous thrombosis include persistent pump alarms, inability to infuse or withdraw, and visible clots in the catheter hub. Symptoms can include swelling of the neck, face and arm, prominence

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of superficial collateral veins on the chest wall and swelling/discolouration of the arm. Thromboses, which can potentially give rise to embolic phenomena, are best treated with anticoagulation unless the line is infected, in which case the line should be removed. Superior vena caval thrombosis, especially in a long-term PN patient, is a medical emergency and needs urgent imaging and thrombolysis.

Infective

Catheter-related blood stream infection (CRBSI) is potentially life-threatening and occurs in 2–20% of patients receiving PN. The main causes are insertion without full aseptic measures or subsequent suboptimal line care.

CRBSI is defined as 'bacteraemia in a patient with an intravenously placed catheter and one or more positive blood cultures from a peripheral vein, clinical signs of infection and no apparent source of infection other than the catheter' or 'when culture of a blood sample taken from a catheter identifies the same organism as that isolated from a peripheral blood sample'. (Figure 1, which shows a protocol for catheter-related sepsis, is available with the online version of this paper.)

Indications for line removal on suspicion of CRBSI are:
- Tunnel or port abscess
- Septic shock
- Paired blood cultures positive for fungi or highly virulent bacteria
- Complicated infections e.g. endocarditis, metastatic infection or septic thrombosis

Vancomycin is generally used as a first-line empirical antibiotic in CRBSI because of its activity against coagulase-negative staphylococci and *S. aureus*, including MRSA. Additional cover against Gram-negative bacteraemia and *Pseudomonas* is also recommended. Anti-fungal treatment is restricted to situations where fungaemia is suspected.

All attempts should be made in patients on home PN to preserve the line. These patients should be admitted to hospital when appropriate and given immediate treatment (with antibiotics and sometimes anti-fibrinolytic drugs) to salvage the line. The decision to remove the line, if deemed necessary, should only be made after discussion with the team overseeing PN unless the situation is life-threatening.

Metabolic

Hyperglycaemia, abnormal liver function tests and refeeding syndrome are common metabolic complications seen in PN.

Hyperglycaemia may arise as a result of sepsis, medications (e.g. steroids), underlying diabetes or excessive carbohydrate in the PN solution. It can be managed initially by excluding infection as a possible cause, reviewing medications or modifying the PN regime; either by reducing the glucose component with respect to protein and fat, or by increasing the duration over which the PN is provided. If these measures are ineffective, blood glucose levels should be controlled by means of insulin infusion or injections. Hypoglycaemia when a feed stops is often due to high serum insulin levels and the PN can be gradually reduced over the last hour to avoid this.

Abnormal liver function tests most often arise as a reflection of underlying illness, sepsis, antibiotic treatment, or other medication rather than solely as a complication of PN and these potential causes should be investigated from the outset. Abnormalities may manifest as mild cholestasis or transient rise in transaminases or alkaline phosphatase.

Measures which can be considered, to reduce hepatic 'stress' related to PN include:
- Reducing the amount of lipid in the feed
- Increasing the proportion of medium chain triglycerides:long chain triglycerides in the feed
- Cyclical feeding
- Introducing small amounts of enteral feed to reduce biliary stasis

REFEEDING SYNDROME

Refeeding syndrome is a common complication of artificial nutrition support and is defined as a potentially fatal shift in fluids and electrolytes that may occur in malnourished patients receiving artificial refeeding (whether enterally or parenterally). The hallmark of this is hypophosphataemia.

During periods of starvation or malnutrition, intracellular electrolyte stores may become depleted despite normal serum levels. Insulin released as a result of feeding stimulates the cellular uptake of these electrolytes and causes profound hypophosphataemia, as well as hypomagnesaemia and hypokalaemia. Clinical features can take up to a week to develop and include oedema, rhabdomyolysis, heart failure, arrhythmias, respiratory failure, seizures and coma. Certain individuals are more at risk and may include patients with a very low baseline BMI (<18 kg/m2), significant recent weight loss (>10% in last few months), prolonged starvation, existing serum electrolyte abnormalities, alcohol abuse or those undergoing chemotherapy. A comprehensive strategy should be in place to minimise the risk of developing refeeding syndrome and may include the following:
- Starting nutrition support at a lower rate (e.g. 10 kcal/kg/day)
- Increasing levels slowly to meet or exceed full needs by 3–7 days (dietetic advice essential here)

- Oral or intravenous replacement of vitamins such as thiamine
- Daily monitoring and supplementation, where appropriate, of plasma potassium, magnesium and phosphate levels
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HOME PARENTERAL NUTRITION

Home parenteral nutrition (HPN) was first introduced to the UK in 1977 and a significant number of patients have now been on HPN for over 20 years, with a period prevalence of 12.3 per million population in England in 2006.

Historically the most common reason for patients to be established on long-term PN at home in the UK has been development of short bowel syndrome (largely related to Crohn's disease), mesenteric vascular disease, volvulus and surgical complications. However, in recent years, it has been increasingly requested for bridging or palliative purposes in patients with high output stomas/enterocutaneous fistulae awaiting restorative surgery, pelvic malignancy and intestinal obstruction, or radiation enteropathy, bringing the UK more in line with practice in the rest of Europe.

Patients and carers may be trained in the administration and care of HPN either prior to discharge from hospital or once at home, where they may also be supported by a skilled homecare nursing team. Every patient should have an individual HPN management plan which includes their PN regimen and details of the required multidisciplinary input. Good communication between the relevant health professionals is key in achieving safe and successful HPN.

In order to provide the appropriate skilled oversight and management of HPN, it is essential that a specialised Intestinal Failure Centre is involved. This service has historically been provided by the two large designated Intestinal Failure Units – St Mark's Hospital, London, and Hope Hospital, Salford. However, over the last 20 years, as demand for HPN has risen, these centres have become increasingly oversubscribed and other units up and down the country have started offering a similar service on a smaller scale. While the advantage of such centres (now numbering approximately 50) has been recognised, in terms of providing care closer to home and relieving some of the pressure from the two main centres, the size and quality of care provided has been variable and unregulated. As a result, in 2008, a national strategic framework was established for the management of patients with complex intestinal failure, requiring PN, both as an inpatient or outpatient (HPN) (A Strategic Framework for Adult Intestinal Failure and Home Parenteral Nutrition Services in England – April 2008). Any aspiring intestinal failure unit will be required to fulfil a set of standards, in terms of infrastructure, personnel, expertise, and quality assurance. It is expected that, in the future, only designated units that meet such criteria will be funded to be able to provide such a service, thus providing security and the requisite expertise for their patients.

CONCLUSION

Parenteral nutrition is a potentially lifesaving option for those patients who do not have any other (or sufficient) means of maintaining their nutritional requirements. It has become much safer in recent years with the dissemination of knowledge and skills and the development of specialised multidisciplinary support teams. The publication of guidelines through various national and regional bodies has also helped to raise standards. However, it remains an invasive and relatively hazardous form of nutrition support with potentially life-threatening complications and therefore should be used appropriately and safely with the involvement of a skilled multiprofessional nutrition support team.

FURTHER READING

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