Patients receiving parenteral nutrition can be found in any clinical area within secondary care; clinical pharmacists should understand how it is prescribed and administered, and what monitoring is required.

Parenteral nutrition for adults — an overview of the basic principles

By Rebecca White, MSc, MRPharmS

Parenteral nutrition (PN) is arguably the most complex pharmaceutical product used in clinical practice. It is an admixture of over 60 individual chemical entities that must be chemically, physically and microbiologically sound to be safely infused. Mistakes associated with PN can have fatal consequences.

Indications
In recent years a proactive and interventional approach to enteral nutrition has seen an overall decrease in the use of PN, particularly in the perioperative period. In addition, the use of enhanced recovery programmes has reduced the incidence and duration of post-operative ileus.

The fundamental indication for PN is intestinal failure, which can be short, medium or long term. Causes of intestinal failure include:

- An inaccessible gut (e.g., a bowel obstruction secondary to adhesions, strictures or a tumour)
- A malabsorptive or high output state (such as severe mucositis, graft-versus-host disease or a high output stoma)
- A shortened or absent gut
- A dysmotility syndrome or post-operative ileus

The need to provide PN is dependent on the duration of intestinal failure and the nutritional status of the patient. Any patient with intestinal failure persisting for more than a few days should be considered for PN.

Prescription
To prescribe an appropriate PN regimen a full assessment is required by a competent practitioner or preferably a multidisciplinary nutrition team. A recent enquiry into the care of hospital patients receiving PN conducted by the National Confidential Enquiry into Patient Outcome and Death found that patients were often inadequately assessed before starting PN.

Ideally, patients’ nutritional, fluid and electrolyte requirements should be reviewed in light of their sex, age, weight, height, prior nutritional status and intake, current medical condition, past medical history, fluid balance, drug therapy and venous access.

Calorie requirements are initially calculated by the nutrition team using predictive formulae, such as the Schofield equation, and then adjusted according to stress and physical activity. These provide a starting point from which to adjust the regimen depending on the patient’s response.

Weight gain will not be achieved for patients receiving PN if they are catabolic (e.g., patients with ongoing sepsis or inflammation). Therefore, weight stabilisation is usually the goal of short- to medium-term PN. Excess calorie provision will result in central adiposity and fatty liver rather than functional weight (i.e., muscle mass).

Composition
The prescribed PN should provide a balanced supply of macronutrients (i.e., lipid, amino acids and carbohydrate) with adequate electrolytes, vitamins and trace elements.

Carbohydrate is provided as glucose, which provides approximately 4kcal/g. About 40–60% of a patient’s total energy is usually provided in this form. It is important to ensure that the glucose oxidation rate of 4–7mg/kg/min is not exceeded since this can result in hyperglycaemia, hyperosmolar dehydration or excessive carbon dioxide production.

Lipid is provided as triglycerides. The first-generation lipid emulsions were from soyabean oil and provided long-chain triglycerides (LCT), which are high in omega-6 fatty acids. Newer-generation lipid emulsions contain triglycerides sourced from olive oil (omega-9), coconut oil (medium-chain triglycerides) or fish oils (omega-3). Each of these newer emulsions has potentially beneficial properties. Lipid provision should not exceed 1.5g/kg/day and ideally should be less than this, particularly for patients receiving PN long term.
The amino acid content of PN should be sufficient to meet patients’ requirements, which will be affected by factors such as wound healing and fluid losses. This is usually 0.17–0.25g/kg/day.

The fluid and electrolytes prescribed in PN should take into consideration patients’ baseline requirements, any additional losses and concomitant administration of fluids, electrolytes and medicines. Different salts can be used to adjust the acid-base balance of the PN.

Once a patient’s nutritional requirements have been calculated, then a decision should be made about whether it will be delivered using standard PN bags or a bespoke PN formulation. A patient’s PN will be delivered using standard PN bags or if the requirements have been calculated, then a decision should be made about whether it can be used to adjust the acid-base balance of the PN.

**Administration**

Appropriate venous access should be secured before starting PN. Peripheral cannulae have been used with some success; however, patients should be monitored regularly for signs of phlebitis. For peripheral administration the osmolarity of the PN should be as low as possible; a maximum of 900 milliosmoles is recommended.

Peripherally inserted central catheters (PICCs) and midlines are used increasingly for administration of PN. Midlines can be used for three to six weeks; osmolality of the PN should not exceed 1,200 milliosmoles. PICCs can stay in place for up to a year if they are cared for well.

Temporary central lines need to be changed frequently, but are appropriate for short-term PN. Long-term venous catheters such as Hickman lines should only be considered when there is little risk of sepsis.

PN should be infused via a dedicated lumen and through an appropriately sized in-line filter (to ensure any particulate matter, precipitates or microorganisms that could be present in the PN are removed). Lipid-containing PN should be infused through a 1.2 micron filter, lipid-free PN can be infused through a 0.22 micron filter.

**Monitoring**

Effective monitoring and review is one of the most important aspects of PN provision. Routine monitoring should include vital signs, blood glucose, fluid balance and blood and urine biochemistry.

The National Institute for Health and Clinical Excellence has provided a framework for monitoring parenteral nutrition and, since there is no robust evidence relating to this aspect of care, these represent a consensus of the guideline development group.

The purpose of monitoring is to ensure that the prescribed regimen is tolerated and that any complications are detected early so that action can be taken promptly.

**Complications**

The most common complications of PN are fluid and electrolyte imbalances, which are relatively easy to correct, provided that appropriate steps to do so are taken quickly. This can be done through administering additional fluids or electrolytes or through tailoring the PN prescription.

Intravenous line sepsis can be life-threatening if not identified and treated quickly. The course of action is dependent on the type of venous access and the condition of the patient — removal of the line is appropriate for temporary lines whereas “line salvage” will be considered for those with long-term lines or limited venous access. Prevention of infection is always better than cure so comprehensive training for nursing staff administering PN and clear protocols are essential.

**DISCUSSION POINTS**

- Who is responsible for the prescription and supply of parenteral nutrition (PN) in your organisation?
- Who assesses the patient before the bag of PN is supplied?
- What input do you think pharmacists and pharmacy services should have in the provision of PN?

**References**