Parenteral nutrition

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Indications and composition of parenteral nutrition Nutrition may need to be delivered intravenously in patients in whom adequate feeding through the alimentary tract is not possible. This can be either in addition to enteral feeding (supplemental parenteral nutrition) or the sole source of nutri tion (TPN). TPN is indicated in patients who are unable to meet their nutritional requirements via absorption of nutrients from their intestinal tract. The commonest cause for this is in patients with short bowel syndrome related to massive intes tinal r esection or a significant reduction in functional small bowel, often related to intestinal fistulation. In some cases the establishment of TPN is a temporary endeavour for a few days to minimise n utritional depletion until a route of enteral nutrition is established, e.g. awaiting the siting of a nasojejunal tube in patients with delayed gastric emptying. Parenteral nutrition formulations have evolved over the years, but are currently commonly provided by the hospital pharmacy in the form of a 3-litre bag containing a lipid emul sion with a mixture of essential and non-essential amino acids, glucose, electrolytes, trace elements and vitamins. The energy content of parenteral nutrition is in the ratio of 150–250 /uni00A0 kcal Complications of enteral feeding /uni25CF /uni25CF - /uni25CF /uni25CF - /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF . The /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF - per gram of protein nitrogen, with usually 30–50% of the - energy coming from fat. This ensures su ffi cient energy pro - vision for amino acids to be utilised for tissue maintenance. Folic acid is supplemented in the solution once or twice a week at a dose of 15 /uni00A0 mg and other vitamins are given daily . Patients requiring long-term parenteral nutrition (over many months) w ould also benefit from a single-dose injection of vita - - min B12. Phosphate is an essential component of parenteral - nutrition regimens: 20–30 /uni00A0 mmol phosphate is required daily to ensure phosphorylation of glucose and pre vent hypophos - phataemia. The specific composition of parenteral nutrition can be changed daily to reflect the patient’s needs and tailored to address any electrolyte deficiencies and ongoing energy requirements. This is guided by daily assessments (including weight and electrolytes). In addition, the protein content will di ff er in pa tients who are critically ill (requiring more protein) compared with those with chronic renal failure (requiring less protein). Micronutrients such as zinc, copper, selenium, fer - ritin, folate and vitamins B12 and D will need to be checked in patients on parenteral nutrition for more than 28 days and every 3 months in patients on long-term parenteral nutrition. - Administration of parenteral nutrition Parenteral nutrition is usually administered directly into the central venous system (the superior vena cava [SVC] or the - right atrium) to minimise the risk of venous thrombophlebitis, through either a peripherally inserted central catheter (PICC) or central venous catheter (Figure 25.8). PICC lines may be inserted through the basilic (most commonly used), cephalic, brachial or median cubital vein of the arm, and can be used for parenteral nutrition administration over several weeks to months. Femoral lines should be avoided for parenteral nutri - tion because of the high risk of infection at this site. Chest radiographs should be performed after PICC or central venous - catheters are inserted to confirm the correct position of the line tip within the SVC or right atrium prior to commencing the parenteral feed (Figure 25.9).

Tube related Malposition Displacement Blockage Breakage/leakage Local complications (e.g. erosion of skin/mucosa) Gastrointestinal Diarrhoea Bloating, nausea, vomiting Abdominal cramps Aspiration Constipation Metabolic/biochemical Electrolyte disorders, including refeeding syndrome Vitamin, mineral, trace element de /f_i ciencies Drug interactions

In patients who are likely to require long-term parenteral nutrition, an implantable port or a Hickman line may be more appropriate. These are implanted via fluoroscopic or ultra sound guidance with a subcutaneous port or cu ff and a cathe ter attachment sitting within the SVC. Rarely , parenteral nutrition can be administered through a peripheral venous catheter; however, the high osmolarity of parenteral nutrition produces an increased rate of thrombo phlebitis at these sites because of the narrower calibre and low rate of flow in peripheral veins, making it an appropriate option only wher e the duration of parenteral nutrition admin istration is less than 14 days. The risk of thrombophlebitis can be reduced to some extent by the use of soft polyurethane pae diatric cannulae and using feeds of low osmolarity and neutral pH. The cannulae used will need to be changed every few days. T he parenteral nutrition bag should be covered at all times, including during infusion, with an opaque protective bag to pr event the vitamins from degradation. If the parenteral nutrition infusion is disconnected from the line for any reason during administration the bag will need to be discarded. It is important to remember tha t parenteral nutrition administra tion contributes to fluid intake, and thus the volume infused should be carefully recorded on the fluid balance chart to avoid fluid overload. In patients in whom parenteral nutrition is a temporary measure, oral nutritional input or enteral feeding should be monitored, and par enteral nutrition withdrawal planned in a stepwise manner and stopped once the patient is established on adequate oral or enteral support. Complications of parenteral nutrition The complications of parenteral nutrition are best considered to fall within one of three categories: insertion complica tions, line complications and metabolic complications (see Summary box 25.4). Robert O Hickman , 1926–2019, formerly paediatric nephrologist, Seattle Children’s Hospital, Seattle, WA, USA. - - Summary box 25.4 - Complications of parenteral feeding /uni25CF - /uni25CF /uni25CF - /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF - /uni25CF Insertion complications The most common complication of line insertion is an inad - vertent pneumothorax, which occurs in around 0.5–1% of cases, most commonly during insertion of subclavian lines. It is managed by insertion of a chest drain, which can be removed once the pneumothorax has resolv ed. Line misplacement can also occur and is diagnosed on chest radiograph, which is - mandatory following central line insertion. The line is consid - ered to be in the correct place if the tip is in the inferior third of the SVC or at the atriocaval junction (see Figure 25.9).

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NJ tube passing below diaphragm Figure 25.9 A chest radiograph showing correct positioning of the internal jugular and peripherally inserted central catheter lines within the superior vena cava, as well as the tip of the nasogastric (NG) tube in the stomach and the nasojejunal (NJ) tube passing into the abdomen. Insertion complications Pneumothorax Misplacement Line complications Sepsis Thrombosis Metabolic complications Electrolyte disorders, including refeeding syndrome Blood sugar derangement Liver dysfunction Metabolic bone disease Vitamin de /f_i ciencies

One of the most important line complications is line sepsis, which can occur in up to 15% of patients and is associated with significant morbidity and mortality . Insertion of the line and administration of parenteral nutrition requires strict aseptic technique as line infections can rapidly progress to septicae mia. Catheter entry sites should be checked daily . Patients with suspected line sepsis will need paired blood cultures taken from the line and a separate peripheral site and use of the line should be stopped until culture results are available. Positive cultures will require line removal and commencement of antibiotics. Fungal line infections in particular can be associated with uveitis and bacterial endocarditis. Line thrombosis is not uncommon and can occasionally occur in major veins in association with line infection, causing serious complications such as SVC occlusion and pulmonary embolism. Treatment is by anticoagulation, rarely requiring fibrinolysis for acute SVC occlusion and endovascular inter vention in the longer ter m. Line blockage is relatively common and can be prevented by regular line flushing after manipula tion and the use of a dedicated parenteral nutrition line or, in the case of a multilumen centrally placed catheter, a dedicated lumen. Blocked lines can be unclogged by locking the a ff ected line with heparin–saline or thrombolytic agents. Metabolic complications Refeeding syndrome One of the most significant meta bolic complications of both parenteral and enteral feeding is refeeding syndrome. This occurs in the first days after feeding is commenced in patients who have been severely malnourished. Patients due to start nutritional support need to be screened f the risk of refeeding syndrome. The degree of risk is related to their BMI, amount and rate of unintentional weight loss, period of starvation and electrolyte levels (see Summary box 25.5 The main underlying pathological process is one of hypophosphataemia, resulting in fluid and electrolyte shifts between the intra- and extracellular compartments. Patients Summary box 25.5 Refeeding syndrome /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF cardiac failure, oedema, lethargy or seizures; at its most severe the syndrome can be fatal. Laboratory tests will reveal low levels of phosphate, potassium, calcium and magnesium and a lactic acidosis. Nutritional support in this group of patients should be started at a maximum of 10 /uni00A0 kcal/kg per day , aiming to - increase levels slowly to meet full needs by 4–7 days. Frequent monitoring and replacement of

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One of the most important line complications is line sepsis, which can occur in up to 15% of patients and is associated with significant morbidity and mortality . Insertion of the line and administration of parenteral nutrition requires strict aseptic technique as line infections can rapidly progress to septicae mia. Catheter entry sites should be checked daily . Patients with suspected line sepsis will need paired blood cultures taken from the line and a separate peripheral site and use of the line should be stopped until culture results are available. Positive cultures will require line removal and commencement of antibiotics. Fungal line infections in particular can be associated with uveitis and bacterial endocarditis. Line thrombosis is not uncommon and can occasionally occur in major veins in association with line infection, causing serious complications such as SVC occlusion and pulmonary embolism. Treatment is by anticoagulation, rarely requiring fibrinolysis for acute SVC occlusion and endovascular inter vention in the longer ter m. Line blockage is relatively common and can be prevented by regular line flushing after manipula tion and the use of a dedicated parenteral nutrition line or, in the case of a multilumen centrally placed catheter, a dedicated lumen. Blocked lines can be unclogged by locking the a ff ected line with heparin–saline or thrombolytic agents. Metabolic complications Refeeding syndrome One of the most significant meta bolic complications of both parenteral and enteral feeding is refeeding syndrome. This occurs in the first days after feeding is commenced in patients who have been severely malnourished. Patients due to start nutritional support need to be screened f the risk of refeeding syndrome. The degree of risk is related to their BMI, amount and rate of unintentional weight loss, period of starvation and electrolyte levels (see Summary box 25.5 The main underlying pathological process is one of hypophosphataemia, resulting in fluid and electrolyte shifts between the intra- and extracellular compartments. Patients Summary box 25.5 Refeeding syndrome /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF cardiac failure, oedema, lethargy or seizures; at its most severe the syndrome can be fatal. Laboratory tests will reveal low

levels of phosphate, potassium, calcium and magnesium and a lactic acidosis. Nutritional support in this group of patients should be started at a maximum of 10 /uni00A0 kcal/kg per day , aiming to - increase levels slowly to meet full needs by 4–7 days. Frequent monitoring and replacement of the electrolytes listed above is essential. Nutritional support should include supplementary thiamine, vitamin B, multivitamins and trace elements. Blood sugar derangement In patients with diabetes and those with impaired blood glucose control owing to critical illness, administration of parenteral nutrition should coincide with a variable insulin infusion regimen to avoid hyperglycaemia. Conversely , insulin dosing should be reduced accordingly when parenteral nutrition is interrupted to avoid hypoglycaemia. - Liver dysfunction Long-term use of parenteral nutrition - is associated with derangement of liver function tests in at least 25% of patients. Fatty liver is a common complication. This is worse in children, and the degree can be reduced by modifying the parenteral nutrition solution, such as alternating the use of lipid-free parenteral nutrition solutions. A smaller percentage of patients may subsequently develop liver fibrosis and cirrho - sis. Once liver disease is established in these patients the term - ‘intestinal failure-associated liver disease’ (IFALD) is used, as these cholestatic changes in liver function profile are di ffi cult to separate from the e ff ects of short bowel syndrome. Factors such as a lack of colonic continuity , extreme short bowel, lack or of enteral intake and high energy and fat content in feed have all been associated with a higher risk of the development of IFALD.). Metabolic bone disease and vitamin deficiencies Osteoporosis or osteomalacia are both known complications of long-term parenteral nutrition, leading to fractures or kidney stones. Supplementation of calcium, phosphate, vitamin D and sometimes bisphosphonates can both prevent and treat this complication. Excess or deficiency of vitamins or trace elements may occur, manifesting with non-specific symptoms such as anaemia, hair loss or neurological symptoms. Regular measurements and replacement, as well as clinical assessment, can prevent this from occurring.

. Patient is considered to be at risk of developing refeeding syndrome with EITHER One or more of the following: 2 BMI <16 /uni00A0 kg/m Unintentional weight loss >15% within the last 3–6 months Little or no nutritional intake for more than 10 days Low potassium, phosphate or magnesium levels prior to feeding OR Two of more of the following: 2 BMI <18.5 /uni00A0 kg/m Unintentional weight loss >10% within the last 3–6 months Little or no nutritional intake for more than 5 days History of alcohol abuse or on medication, including insulin, chemotherapy, antacids or diuretics . . .

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