By the end of the chapter you will be able to:

- Explain what Parenteral Nutrition is, why it is used and how it is administered
- Identify component ingredients and why they are used in Parenteral Nutrition products
- Explain how ingredients are mixed and the preparation techniques involved
- Describe the terms “pooling” “cracking” “creaming” “precipitation”
- Describe some potential hazards in the preparation, storage and administration of parenteral nutrition.

Introduction

In this chapter we will examine the preparation of Parenteral Nutrition (PN), the clinical indications for its use and some associated quality and safety risks.

Many of the aseptic techniques used to prepare Parenteral Nutrition products are the same as ones used in the preparation of other product types e.g. CIVA. You may already be familiar with these techniques; if not it might be helpful to study the Aseptic Technique chapter before starting your studies here.

Parenteral Nutrition and why is it used

A balanced diet requires intake of protein, carbohydrate, fat and a variety of electrolytes, trace elements and vitamins which are normally provided by the food we eat and digest each day. If a patient's medical condition results in malnutrition and/or an inability to digest food via the gastro-intestinal tract these essential daily nutrients can be supplied by Parenteral Nutrition.

Parenteral is another way of describing the intravenous route of administration, so simply put, parenteral nutrition is intravenous food which is usually supplied in daily infusion bags.
These solutions provide very good growth media for micro-organisms so it is essential that they are provided free of such contamination.

A number of disease states, injuries and some post surgery conditions are recognised as clinical indications for the use of Parenteral Nutrition. These include:

- instances where normal feeding is contra-indicated for more than 4 or 5 days e.g. after surgery
- multiple injuries, severe burns, major sepsis and other conditions that result in the body’s natural response to ‘close down’ the gastrointestinal tract due to the extreme physical trauma
- patients who are determined to be or likely to become malnourished and who cannot be fed by alternative methods e.g. nasogastric feeding
- recognised disease conditions, such as:
  - Inflammatory bowel disease
  - Crohn’s Disease
  - Ulcerative Colitis
  - Acute Pancreatitis

Parenteral Nutrition products are used to restore and/or maintain a patient’s nutritional status until the function of the gastrointestinal tract returns to normal; this may be over a period of a few days, weeks or longer period as required.

**Identifying the patients nutritional requirements**

A patient’s nutritional and fluid (hydration) requirements may change throughout their treatment and so these requirements are carefully monitored on a regular basis by e.g. blood and urine sample analysis and twenty four hour fluid outputs. The patient’s weight is also considered along with a number of other factors such as clinical condition, age, sex and height to determine the most appropriate Parenteral Nutrition solution for the patients needs.

**Administration of Parenteral Nutrition**

Parenteral Nutrition is administered directly into the bloodstream. For short term use the peripheral route may be appropriate and for long-term use a central line is required.

(A central line enables the PN mixture to be given into a very large vein close to the heart to ensure maximum mixing and dilution).

Considerable care of the patient’s central line or peripheral line must be taken by nursing and medical staff to prevent line infections. Peripheral lines can be maintained for relatively long periods of time if feeding solutions formulated to reduce the risks of thrombophlebitis are used (peripheral feeds; low osmolarity and fairly neutral pH)

**Ingredients used in Parenteral Nutrition**

As we have learned, Parenteral Nutrition products are sterile ‘feed’ solutions which provide patients with the required daily amounts of protein, carbohydrate, fat, electrolytes, trace elements, vitamins and fluid.

A number of sterile parenteral nutrition ingredients and products are available for use.

The table below shows a small selection of some of these with a brief description of their nutritional purpose.
## PN Component Ingredients:

<table>
<thead>
<tr>
<th>Item</th>
<th>Nutritional Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino acid solution e.g. Varmin® 14 Electrolyte Free Aminoven® Synthamin®</td>
<td>Source of protein (nitrogen), containing a large number of essential and non essential amino acids (see product SPCs for individual formulae)</td>
</tr>
<tr>
<td>Glucose infusion bags (various strengths)</td>
<td>Source of carbohydrate (sugars)</td>
</tr>
<tr>
<td>Fat emulsions e.g. Intralipid® 10%, 20%, 30% Structolipid® 20% infusion ClinOleic® 20% Omegaven® 10%</td>
<td>Source of fat, contain e.g. purified soya and /or olive oil, triglycerides, glycerol, phospholipids/phosphotides (see SPCs for individual formulae)</td>
</tr>
<tr>
<td>Sodium chloride 30% Potassium chloride 15% Calcium chloride 13.6%/Calcium gluconate 10% Magnesium sulphate 50% Phosphate (Addiphos®, Sodium glycerophosphate, potassium phosphate)</td>
<td>Electrolyte solutions are necessary for maintaining the correct balance between positive and negative ions (charged particles) in body fluids, tissues and blood. Electrolytes conduct electricity in solution which is essential for normal cell and organ function.</td>
</tr>
<tr>
<td>Trace elements e.g. Additrace® Peditrace® Decan®</td>
<td>Trace elements contain e.g. iron, zinc, copper, manganese, selenium etc (see product SPCs for individual formulae) These are needed for enzyme function amongst other things.</td>
</tr>
<tr>
<td>Water soluble vitamins e.g. Cernevit® Solivito N®</td>
<td>Water soluble vitamins contain e.g. ascorbic acid, biotin, cyanocobalamin, folic acid, thiamine etc</td>
</tr>
<tr>
<td>Fat soluble vitamins e.g. Vitlipid® N (adult and infant)</td>
<td>Fat soluble vitamins contain e.g. vitamin A, phytomenadione, etc (see product SPCs for individual formulas)</td>
</tr>
</tbody>
</table>

## PN Products (Ready to use bags)

<table>
<thead>
<tr>
<th>Item</th>
<th>Nutritional Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensed (triple compartment) bags StructoKabiven® range Kabiven® range NuTRIflex® range OliClinomel® range</td>
<td>Triple compartment bags which when mixed provide ‘al-in-one’ feed solutions which can be used ‘off the shelf’ or used as base bags for further aseptic additions. These are mixtures of the component ingredients detailed above.</td>
</tr>
</tbody>
</table>
As you can see from the previous table, parenteral nutrition mixtures contain a wide range of chemical substances. They are complex medicines containing some ingredients that are only compatible with each other if correctly formulated and compounded.

**Preparation of Parenteral Nutrition and Mixing Protocols**

Parenteral nutrition solutions are prepared using standard aseptic techniques and processes. However, how the various ingredients are mixed together and the sequence of mixing is extremely important to the stability and quality of the final product.

As we have seen, the component ingredients of parenteral nutrition are divided into specific nutritional groups:

- Amino Acids (Proteins)
- Electrolytes and Trace Elements
- Glucose (carbohydrate)
- Vitamins (water and fat soluble)
- Lipid (fats)

Parenteral nutrition products can be made using automated compounding devices, vacuum fill chambers or by the traditional method of gravity fill. Regardless of the chosen compounding method, some basic rules require to be followed; these are:

- The transfer of aqueous fluids (Amino acids, Glucose) into the sterile infusion bag before addition of oil-based emulsions (Lipid), preventing destabilisation of the lipid emulsion
- Keeping incompatible ingredients that can chemically react with each other to form insoluble precipitates e.g. calcium and phosphate well separated

An approach that would achieve these basic compounding rules is described below and is an example of how a traditional gravity fill method might be employed for an adult ‘all in one feed’ solution:

1. Add phosphate to the glucose solution
2. Add electrolytes and trace elements to the amino acid solution
3. Add fat and water soluble vitamins to the lipid solution
4. Transfer glucose and amino acid solutions to sterile EVA* bag, mix well.
5. Transfer lipid solution into mixture, agitating regularly to ensure thorough mixing of all solutions

(*Ethylene-vinyl-acetate – is a type of plastic, used for its good compatibility with PN ingredients)

Always remember that mixing order is critical – keep calcium and phosphate salts well separated. Add lipids last.

Agitate solutions thoroughly after each fill stage/addition to mix ingredients thoroughly.

Remember to flush additions into the bag to avoid local concentrations remaining in the additive port.

**Adult Parenteral Nutrition Bags**

Adult parenteral nutrition bags are usually large volume, containing up to 3 litres of solution. A range of parenteral nutrition solutions are available from commercial manufacturers as licensed ready to use bags. If these are not suitable for the patient’s requirements, feed solutions can be compounded from component ingredients into sterile EVA bags.
Multiple Chamber semi-prepared bags

Two or three chamber pre-filled (‘ready to use’) commercial bags are often used now when supplying adult parenteral nutrition. This is because they are quick and easy to prepare helping to reduce workload pressures and compounding risks in busy aseptic dispensaries. If required, additions to these bags can be made to tailor them to the individual patient’s needs.

The following bench simulation shows the principles of how to mix and make further additions to these multi-chamber bags.

Note: the aqueous ingredients (indicated by the arrow) should be almost colourless. The increased colouration (deterioration) seen in the pictures below is the result of a damaged/defective seal between the amino acid and glucose chambers which has allowed the solutions to mix during storage. It is essential to inspect these products before mixing to ensure their suitability for use.

Multiple chamber PN Bags – Mixing and addition principles:

Starting from the top of the container (larger end) roll the bag up towards the ports by hand.

Break the seals between the chambers by rolling.

Continue rolling until the seals are open and the contents begin to mix together.

Mix the contents of the three chambers by inverting the bag gently a number of times until thoroughly mixed.

Snap off the additive port cover on the bag.

Swab the additive port and tops of all additive ingredients with a sterile 70% Isopropyl Alcohol swab and allow to dry.
Aseptic Processing

Draw up required volumes of additives and inject into mixed bag via additive port as directed on written instructions (worksheet/SOP). Follow mixing sequences accurately.

Mix well after each addition, remember to flush the port.

Seal the additive port with a port cover.

This is a sample method. You will have your own departmental SOPs which may be different from the method described here.

Individually Prepared Parenteral Nutrition Bags

Individually tailored Parenteral Nutrition solutions are usually prepared for patients whose requirements are changing on an almost daily basis. Such patients are often referred to as having unstable urea and electrolyte (U&E) results and require more careful clinical monitoring and tailoring of their Parenteral Nutrition regimen.

The following bench simulation shows the traditional approach to the gravity fill method.

Adding the phosphate to the glucose infusion:

**Ingredients:** Glucose bag and phosphate solution ampoule

- Draw up the required volume of phosphate solution into a syringe.
- Ensure the process check of ingredients and volumes is completed before continuing.
- Swab additive port of infusion bag and allow to dry.
- Inject the phosphate solution into glucose infusion bag
- Mix well

Adding electrolytes and trace elements to the amino acid solution:

**Ingredients:** Amino acid solution, electrolyte and trace elements in ampoules and vials

- Swab the tops of all additive ingredients (ampoules and vials)
- Draw up the required volumes of electrolytes and trace elements into syringes. Ensure the process check of all ingredients and volumes is completed before continuing.
- Swab bung of bottle and allow to dry.
Inject the additives via a 5 micron particulate filter into the amino acid solution in bottle.

Mix well after each addition.

**Note:** Picture one in the sequence above illustrates how NOT to position materials within a horizontal laminar air flow (HLAF) workspace. Observe that the bottle is ‘blocking’ (impeding) the clean air flow to the ampoules which increases risks of contamination.

Picture two in the sequence shows good positioning in HLAF. The items are ‘lined up’ horizontal to the air flow with good adjacent distance between them to minimise the affects of vortices in the air flow due to the size and shape of the items.

**Adding fat-soluble and water-soluble vitamins to the lipid bag:**

**Ingredients:** lipid bag, fat soluble vitamin solution in ampoule and water soluble vitamins in dry powder vial.

Swab the tops of the ingredient vial and ampoule.

Draw up the required volume of fat soluble vitamin solution into a syringe.

Ensure the process check of all ingredients and volumes is completed before continuing.

Reconstitute the water soluble vitamin powder by adding the required volume of fat soluble vitamin emulsion.

Shake gently to dissolve.

**Note:** the water soluble vitamins may be reconstituted with Water for Injections e.g. in fat free PN mixtures.

Withdraw the total contents of the vial into a syringe.
Aseptic Processing

- Swab additive port of infusion bag and allow to dry
- Inject the vitamin additives e.g. via a 5 micron filter into the lipid bag
- Mix well after addition.
- Remember to flush the additive port

**Filling the sterile 3L EVA bag with prepared solutions**

- Swab all bungs and additive ports of the prepared solutions
- Align all line clamps to the "spike end" of the filling leads and close all clamps.

- Remove the empty 3 litre EVA bag from the outer packaging.
- Check that the main lead is firmly connected to the bag.

**Note:** When pushing the spike through the bung do not twist the spike. This minimises the risk of "coring".

- Hang all containers on the rail or support frame.
Open the clamps of the leads to the glucose and amino acid solutions and run the contents into the EVA bag, ‘chase’ the remaining solution down the open lines into the bag and then re-clamp the leads.

Mix the solutions well in the bag, by gently turning the bag upside down once or twice.

Open the clamp of the lead to the lipid bag.

Allow the contents to run into bag, mixing the resultant solution frequently.

Chase the remaining lipid solution out of the lead into the bag and re-clamp the lipid lead.

Invert the bag several times to ensure thorough mixing of all ingredients.

Open a lead clamp to one of the solution bags.

Sit the bag upright allowing any air in the bag to collect at the top, around the central inlet.

Apply pressure to the base of the bag to force this excess air out of the bag and back into the open lead and emptied solution bag.

Once all the air is removed, hold the position until the open lead is re-clamped off.

Close the bag clamp to seal off the filling port.

Close the large clamp on the filling leads.

Detach the filling leads from bag. Attach sterile closure (provided with the 3L bag) to seal the filling port end. Note: the tube must be free of liquid when the clamp is applied.

Pack the worksheet, all ingredient components, equipment and filled bag into product work tray.

Pass out for reconciliation, inspection and accuracy and release checks.
Aseptic Processing

After products and ingredients are reconciled, the bag is carefully inspected and labelled. At this stage the bag and associated documentation may progress to checking and release.

This is a sample method for this topic. You will have your own departmental SOPs which may be different from the method detailed here.

Paediatric Parenteral Nutrition Bag

Paediatric Parenteral Nutrition is prepared for children; typically the age range is from 6 months to 15 years. Neonatal Parenteral Nutrition is prepared for babies who are premature with an age range of 0 to 6-12 months. Parenteral Nutrition bag volumes for neonates are much smaller than for adult bags, usually up to 250 ml in size, when bags are prepared for paediatric patients these volumes can increase to above 1 litre. Ingredient and additive quantities vary greatly being dependent upon the baby/child’s weight and clinical condition. Unlike adult Parenteral Nutrition mixtures the fats (oil based lipid and fat soluble vitamins) are not usually mixed with the aqueous ingredients as it is not frequently possible to create stable emulsion solutions due to the relatively small volumes of oil based emulsions used in ratio to the aqueous content. This means that neonatal and paediatric Parenteral Nutrition are often supplied in two containers; the amino acids, glucose and water in a small EVA bag and lipids in either a small volume bag or syringe. The two component parts are then administered via a Y-site infusion set.

The following bench simulation shows a method for the preparation of an aqueous Parenteral Nutrition bag and lipid syringe combination. Neonatal and paediatric bags can also be prepared using automated compounding devices.

Ingredients and components for a paediatric bag

- Starting materials for the aqueous solution bag; glucose, water and amino acid solution and empty paediatric EVA bag.

- A selection of additives; includes standard electrolyte solutions and paediatric trace elements e.g. Peditrace®
Starting materials for the lipid and vitamin syringe including infant specific fat soluble vitamins e.g. Vitlipid® Infant

Preparation of the aqueous solution

- Swab the bung of the bottle and allow to dry
- Draw up the required amount of amino acid solution into a syringe (or syringes)
- Ensure the process check of all ingredients and volumes is completed before continuing

- Swab the port of the glucose bag and allow to dry
- Draw up the required amount of glucose solution into a syringe (or syringes)
- Ensure the process check of all ingredients and volumes is completed before continuing

- Swab the bung of the vial and allow to dry
- Draw up the required amount of water into a syringe (or syringes)
- Ensure the process check of all ingredients and volumes is completed before continuing

- Swab the port of the glucose bag and allow to dry
- Draw up the required amount of glucose solution into a syringe (or syringes)
- Ensure the process check of all ingredients and volumes is completed before continuing

- Remove the empty EVA bag from the outer packaging

- Inject the prepared solutions into the EVA bag one by one following the specific order in the procedure
Aseptic Processing

- Add glucose solution, water and amino acid solution
- Mix well between each addition
- Remember to flush the additive port

- Remove any air from the bag by gently squeezing the bag allowing the air to be expelled into attached syringe

- Close off the port-ensure the tube is clear of liquid before applying the clamp.

- Affix cap

- Draw up the required volumes of additives from ampoules and vials

- Remember you are dealing with very small quantities so take extra care to be accurate.

**Note:** Check the measurement graduations of syringes carefully before use.
Preparation of Parenteral Nutrition

Line up the ‘additives’ ready to be injected into the bag in their specific addition order.

**Remember:** separate the calcium and phosphates to prevent formation of precipitates.

- Ensure the process check of all ingredients and volumes is completed before continuing.

- Inject each additive e.g. via a 5 micron filter, mixing thoroughly between each addition.
- Remember to flush the port to avoid local concentrations of additives.

- On completion mix the bag contents thoroughly. Inspect the contents for correct colour, integrity and absence of particulates.

Preparing the lipid and vitamin syringe

- Draw up the required volume of WFI to reconstitute the powdered vitamins.
- Ensure the process check of ingredients and volume is completed before continuing.

- Reconstitute the vitamin vial by adding WFI diluent and shaking gently to dissolve the powder.

- Draw up the required volume of vitamin solution from the vial.
- Ensure the process check of ingredient and volume is completed before continuing.
1. Draw up the required volume of fat soluble infant vitamins
2. Ensure the process check of ingredient and volume is completed before continuing

- Swab the bung of lipid bag, allow to dry, and draw up required volume of lipid into the syringe
- Ensure the process check of ingredient and volume is completed before continuing

- The component syringes are now ready to be mixed together

- Add the vitamin additives to the larger syringe containing the lipid

- Draw sufficient air space into the lipid syringe to allow for the volumes of vitamins to be added.
- Inject each vitamin additive into the ‘air space’ inside the larger lipid syringe

- Attach a new needle and gently invert syringe to mix the contents
Remove air from the syringe

Attach syringe cap

This is a sample method for this topic. You will have your own departmental SOPs which may be different from the method detailed here.
Parenteral Nutrition Automated Compounder Device

Here are some of the features of an automated compounder:

- Easy to use touch screen controls and drop down menus
- Simple assembly/easy to clean
- Bar code reader verifies ingredients
- Uses closed system
- Warns against incompatible mixing sequences
- Highly accurate fast fill large or small volumes (down to 0.2 ml) capable of filling a 3 litre bag in less than 5 minutes
- Provides a MixCheck® report of final bag for QA
- Integrated scale verifies final bag weight

Here are some examples of typical screen displays on the compounder:

- An ingredient container is empty and the operator is reminded to change the container.
- Using the bar code to confirm the identity of the ingredient.
- The screen display is showing the results of the weight check on the bag.

This image shows the volumes about to be added to the bag.
Risks
In this section we will look at some of the risks associated with the preparation and administration of Parenteral Nutrition. Reference will be made to other chapters to support your learning.

Risks to product quality during compounding

<table>
<thead>
<tr>
<th>Risk Factor:</th>
<th>Information and Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mixing Order</strong></td>
<td>The order of filling the Parenteral Nutrition bag is crucial to prevent precipitates forming and the destabilisation of lipid emulsions in all-in-one feed solutions e.g. adult Parenteral Nutrition regimens.</td>
</tr>
<tr>
<td><strong>Contamination</strong></td>
<td>Good aseptic technique: As with all aseptic products this is of paramount importance to prevent contamination. The solutions used in Parenteral Nutrition are particularly good at supporting microbial growth, so extremely good aseptic techniques are essential. Make sure you fully understand and follow your local SOPs. Refer to Chapter 13 to reinforce your learning.</td>
</tr>
<tr>
<td><strong>Incorrect Quantities/Volumes</strong></td>
<td>Parenteral Nutrition bags for adults, paediatrics and neonates contain numerous ingredients, quantities and volumes. Make sure you read and follow the procedures very carefully to ensure accurate preparation. Paediatric and neonatal bags often require very small volumes of concentrated additives. Syringe measurements need to be accurate; preparation errors present a high risk of potential harm to the patient.</td>
</tr>
<tr>
<td><strong>‘Pooling’</strong></td>
<td>‘Pooling’ is a term used to describe the ‘sitting’ or settling out of solutions of different concentrations or densities e.g. Potassium Chloride, which can occur during additions, storage or as the result of inadequate mixing. Ensure procedures are followed carefully and that all solutions are mixed thoroughly. Pooling effects result in non-homogenous products of varying concentrations which if not corrected may cause serious harm to patients e.g. Potassium Chloride, which can slow or even stop the heart from beating.</td>
</tr>
<tr>
<td><strong>‘Creaming’</strong></td>
<td>This term is used to describe the appearance of a visible layer of lipid droplets that can form on top of Parenteral Nutrition mixtures. Such cream layers are usually easily redispersed by gentle mixing. Creaming is the result of alterations in the physical stability characteristics of the lipid emulsion when mixed with amino acids, glucose and electrolyte solutions. This effect is minimised by correct formulation and by following strict mixing protocols.</td>
</tr>
</tbody>
</table>
### Risks to product quality during compounding (continued)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Information and Actions</th>
</tr>
</thead>
</table>
| ‘Cracking’        | If lipid emulsions become more seriously destabilised the creaming effects described above form a dense layer that cannot be redispersed and that finally results in the ‘cracking’ of the emulsion. This is where free oil deposits become visible of the surface of the mixture and no amount of agitation and mixing can re-disperse the oil based and water based components of the mixture rendering the product unfit for use.  
**Note:** In PN mixtures the oil phase is lighter than the aqueous part and will rise to the surface. |
| Precipitation     | A common risk of chemical incompatibility in Parenteral Nutrition mixtures is the result of interactions between the chemicals in the mixture. This is due to reactions between cations (positively charged species) and anions (negatively charged species) which results in the precipitation of salts that are not very soluble. This effect (ionic interaction) is most commonly due to an interaction between calcium and phosphate leading to the formation of calcium phosphate which will form crystals shown in the pictures below. This risk is prevented by following the correct mixing sequence and compounding protocol. |
| Punctures         | Unless great care is taken, needles may puncture the plastic of the additive ports or EVA bags. All such containers should be carefully inspected for evidence of punctures.                                                   |
| Leaks/cracks      | Leaks or cracks can occur as a result of inappropriate storage or as the result of faulty equipment which has not been checked properly. Some parenteral nutrition mixtures are put into multi-layer bags. These have an oxygen-barrier sandwiched between an inner and an outer layer of EVA plastic. This thin barrier can be brittle, so care must be taken not to crease these bags, as they can crack the barrier layer and allow oxygen to permeate into the solution. Products should be inspected before and after preparation, and before issue to patient. Refer to Chapter 11. |
| Particles         | All products should be visually inspected for particles before and after preparation. Remember to do this in good light against both dark and light backgrounds. Refer to Chapter 15 to reinforce your learning. |
## Risks for patients from Parenteral Nutrition administration

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Information and Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Catheter Related</strong></td>
<td><strong>Sepsis from catheter</strong> (sepsis = infection)</td>
</tr>
<tr>
<td></td>
<td>- Use strict aseptic procedures</td>
</tr>
<tr>
<td></td>
<td>- Surgeons fit catheters in theatre where possible</td>
</tr>
<tr>
<td></td>
<td>- Line used exclusively for Parenteral Nutrition</td>
</tr>
<tr>
<td><strong>Catheter erosion</strong></td>
<td>- The catheter can rub inside the vein causing inflammation and damage.</td>
</tr>
<tr>
<td></td>
<td>- Prevented by choosing the right material and by securing the IV line.</td>
</tr>
<tr>
<td><strong>Contamination of prepared product</strong></td>
<td>Microbial contamination of PN mixtures can have serious consequences for the patient, and has occasionally proved fatal. Parenteral Nutrition is delivered directly into the bloodstream, by-passing the body's natural defences. Presence of pyrogens (bacterial endotoxins) can cause high body temperatures (fevers) and other physical symptoms. Microbial contamination can cause septicaemia (blood poisoning) which can be fatal. All contamination control procedures to protect products must be established and followed exactly. Regular staff training and monitoring is essential. Refer to Chapter 3 to reinforce your learning on micro-organisms and contamination.</td>
</tr>
<tr>
<td><strong>Metabolic complications e.g.</strong></td>
<td>- Hyperglycaemia (high blood sugars)</td>
</tr>
<tr>
<td></td>
<td>- De-hydration/over hydration</td>
</tr>
<tr>
<td></td>
<td>- Sodium or Potassium imbalance</td>
</tr>
<tr>
<td></td>
<td>- Hyperlipidaemia (excess fat in the bloodstream)</td>
</tr>
<tr>
<td></td>
<td>- Essential fatty acid deficiency (a lack of key fats)</td>
</tr>
<tr>
<td></td>
<td>Careful monitoring of the patients clinical condition and results from blood and urine analysis (U+E) will help to address these complications.</td>
</tr>
</tbody>
</table>
## Risks to Operators

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Information and Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Needlestick injury</strong></td>
<td>This is any injury from a needle. Needlestick injuries can be harmful to the operator and also to patients as there is an increased risk of contamination. Correct operating procedures and practices should be followed at all times to avoid the incidence of needlestick injuries. See your local operating procedures for action to take in the event of a needlestick injury.</td>
</tr>
<tr>
<td><strong>Upper limb disorders; ULDs (Repetitive strain injuries)</strong></td>
<td>This is caused by continued repetitive movements. To reduce the risk of harm operators should take adequate short breaks and reduce resistance and force employed during manipulations. Rotation of activities can also help. For more information on ULDs visit <a href="http://www.hse.gov.uk">www.hse.gov.uk</a> Ref:HSG60 Upper Limb Disorders in the workplace</td>
</tr>
<tr>
<td><strong>Cuts</strong></td>
<td>Operators are at risk of cuts from glass shards or ampoule tops. This poses a risk not only to the operator, but also to the product as it increases the chances of contamination.</td>
</tr>
</tbody>
</table>
Questions

Q1 Give three indications for Intravenous Nutrition:

1. 

2. 

3. 

(3)

Q2 How is Parenteral Nutrition administered?

(2)

Q3 Give two methods of compounding a Parenteral Nutrition bag

1. 

2. 

(2)
Q4. Describe briefly how to prepare a gravity-fill Parenteral Nutrition bag.

Q5. Give three examples of compounding problems which may occur and the reasons why:

1.

2.

3.
Q6 Name the main constituents of Parental Nutrition

Q7 Give two examples of complications which may arise following administration of Parenteral Nutrition fluid to a patient:

1.

2.