Parenteral Nutrition in Intestinal Failure

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Parenteral Nutrition Solution
Multi-chamber bags

Developed in response to NHS demands to:

- Reduce PN compounding time
- Reduce pressure on capacity limits
- Access to products with pre-defined stability limits for additions

Why needed?

- Reduction in the investment of aseptic units resulting in rationalisation of products that can be produced
<table>
<thead>
<tr>
<th>Type of Parenteral Nutrition</th>
<th>Multi-chamber bags</th>
<th>Compounded bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Licensed</td>
<td></td>
<td>□ Unlicensed</td>
</tr>
<tr>
<td>□ Good stability already tested</td>
<td></td>
<td>□ Stability needs to be assessed</td>
</tr>
<tr>
<td>□ Ready to use?</td>
<td></td>
<td>□ Need to be compounded</td>
</tr>
<tr>
<td>□ Room temperature storage</td>
<td></td>
<td>□ Need refrigeration</td>
</tr>
<tr>
<td>□ Are not nutritionally complete</td>
<td></td>
<td>□ Are nutritionally complete</td>
</tr>
</tbody>
</table>
MCB and IF

- Do not make the patient fit the bag
- Macronutrient content must fulfil patient’s requirements
- Electrolytes must be added to replace losses
- Are not useful in the extremes of volume
NICE recommendations

- “Always add micronutrients and trace elements to parenteral nutrition; additional electrolytes and other nutrients may also be needed”
- “All additions are to be done with pharmacy”
- No pre-compounded bags contain vitamins & trace elements
The Ideal Bag

- Contain all ingredients:
  - Amino acids
  - Carbohydrate
  - Lipid
  - Electrolytes
  - Vitamins
  - Trace Elements

- Stable for home delivery
Amino Acid

- Based on blood amino acid profile
- Amino acid solution profiles are different between companies
- Synthamin and Aminoven do not contain cysteine or tyrosine
- Changing amino acid source (no cysteine and a higher pH) may result in better stability for home
- Culkin et al, found that glutamine was of no benefit in long term patients
Carbohydrate = glucose

- Consider the long term complications from the beginning
- On initiation of PN – use glucose oxidation rate (GOR) as a guide
- Can exceed GOR if blood glucose is normal, liver function is reasonable and patient metabolically stable
- If liver function deteriorates, reduce glucose load to GOR
- Monitor blood glucose and urinalysis for tolerance
Lipids

How much should we give?

What type should we use?
How much?

Cavicchi et al, 2000

90 HPN patients enrolled from 1985 – 1996 to assess the prevalence of PNALD

65% developed chronic cholestasis after median of 6 months

41.5% developed complicated PNALD after a median of 17 months

Prevalence of complicated PNALD was 26% at 2 years and 50% at 6 years
### How much?

| Chronic cholestasis significantly associated with | • PN independent risk for liver disease  
| | • Bowel remnant shorter than 50cm  
| | • Parenteral lipid intake of 1g/kg/day or more  
| Complicated PNALD significantly associated with | • Chronic cholestasis  
| | • Parenteral lipid intake of 1g/kg/day or more  
| **Lloyd et al, 2008** | • Prevalence of 28% in the PN  
| | • Significance with parenteral energy intake and not with parenteral lipid intake  

Lloyd et al, 2008
Evolution of parenteral lipid

- Soyabean: Intralipid (100%)
- MCT/LCT: Structolipid, Lipofundin (50:50%)
- Olive/Soyabean: ClinOleic (80:20%)
- MCT/Soybean/Fish: Lipoplus (50:40:10%)
- Fish: Omegaven (100%)- dilute with another lipid
- Soybean/MCT/Olive/Fish: SMOF Lipid (30:30:25:15%)
- Soya bean / MCT / Fish: Lipidem

Inflammatory activity of lipids

More Pro-inflammatory

- Safflower Oil
- Soybean Oil

Less Pro-inflammatory

- Medium Chain Triglyceride Oil
- Parenteral nutrition without Fat Emulsion

- Olive Oil
- Fish Oil
Which lipid?

**Soy bean LCT lipid emulsion**
- Long term safety data
- High phytosterol content

**Olive oil based lipid emulsion**
- Long term data to show safety and tolerability
- No increase in adverse events (Thomas-Gibson et al, 2003)

**Fish oil lipid emulsion**
- Evidence in paediatrics in reducing incidence and reversing PNALD
- Long term data for safety for adults available
Lipids - in practice

- Cannot give very small volumes of lipid in a PN bag, so reduce number of days lipid is given.
- Need to choose a lipid that is stable in your formulation and that the patients can tolerate.
- If patients are on warfarin, ensure that lipid bags are taken on the same days each week.
Electrolytes

Requirements:
- Na, K, Ca, Mg, PO4

Losses:
- Na, Mg

Other:
- Re-feeding
- Renal factors
- Medication
- Stability

Renal factors
Medication
Stability
Vitamins

Standard vitamin preparations
- Solivito N
- Vitlipid Adult
- Cernevit

Extra requirements
- Vitamin D
- Vitamin B12
- Folic acid

Ascorbic acid
- Added to HPN to increase stability
## Vitamins

### ASPEN, 2004

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>ASPEN guidelines</th>
<th>Solivito N + Vitlipid Adult</th>
<th>Cernevit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (IU)</td>
<td>3300</td>
<td>3300</td>
<td>3500</td>
</tr>
<tr>
<td>Vitamin B1 (mg)</td>
<td>6</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Vitamin B2 (mg)</td>
<td>3.6</td>
<td>3.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Vitamin B3 (mg)</td>
<td>40</td>
<td>40</td>
<td>46</td>
</tr>
<tr>
<td>Vitamin B5 (mg)</td>
<td>15</td>
<td>15</td>
<td>17.3</td>
</tr>
<tr>
<td>Vitamin B6 (mg)</td>
<td>6</td>
<td>4</td>
<td>4.5</td>
</tr>
<tr>
<td>Vitamin B12 (mcg)</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>200</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>Vitamin D (IU)</td>
<td>200</td>
<td>200</td>
<td>220</td>
</tr>
<tr>
<td>Vitamin E (IU)</td>
<td>10</td>
<td>10</td>
<td>11.2</td>
</tr>
<tr>
<td>Vitamin K (mcg)</td>
<td>150</td>
<td>150</td>
<td>0</td>
</tr>
<tr>
<td>Folate (mcg)</td>
<td>600</td>
<td>400</td>
<td>414</td>
</tr>
<tr>
<td>Biotin (mcg)</td>
<td>60</td>
<td>60</td>
<td>69</td>
</tr>
</tbody>
</table>
Trace Elements

**Standard preparations used**
- Additrace
- Nutryelt
- Tracutil

**Extra Requirements**
- Zinc
- Selenium
- Iron
- Copper

**Toxicity**
- Manganese
- Copper
## Trace Elements

<table>
<thead>
<tr>
<th>Element</th>
<th>ASPEN guidelines(^1)</th>
<th>AuSPEN guidelines(^2)</th>
<th>Additrace</th>
<th>Nutryelt</th>
<th>Tracutil</th>
<th>Addaven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc (mg)</td>
<td>2.5 – 5</td>
<td>3.2-6.5</td>
<td>6.5</td>
<td>10</td>
<td>3.3</td>
<td>5</td>
</tr>
<tr>
<td>Selenium (mcg)</td>
<td>20 – 60</td>
<td>60-100</td>
<td>32</td>
<td>70</td>
<td>24</td>
<td>79</td>
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<tr>
<td>Copper (mg)</td>
<td>0.3 – 0.5</td>
<td>0.317-0.508</td>
<td>1.24</td>
<td>0.3</td>
<td>0.76</td>
<td>380</td>
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<tr>
<td>Manganese (mg)</td>
<td>0.06 – 0.1</td>
<td>0.55</td>
<td>0.275</td>
<td>0.055</td>
<td>0.55</td>
<td>55</td>
</tr>
<tr>
<td>Chromium (mcg)</td>
<td>10 - 15</td>
<td>10-15</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Molybdenum (mcg)</td>
<td>Not added</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>Not added</td>
<td>1.1</td>
<td>1.1</td>
<td>1</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>Iodine (mg)</td>
<td>Not added</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.127</td>
<td>0.13</td>
</tr>
<tr>
<td>Fluorine (mg)</td>
<td>Not added</td>
<td>-</td>
<td>0.95</td>
<td>0.95</td>
<td>0.57</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Micronutrients


- Causes:
  - underlying condition
  - increased intestinal losses
  - inadequate provision.

- Prevention and treatment is important during weaning from HPN to promote adaptation (DiBiase et al 2006, *J Clin Gastroenterol*. 40, S94)

- Problematic due to lack of reliable biochemical assays especially in the context of the acute phase response.

- The American Gastroenterological Association have guidelines on the provision of micronutrients in short bowel

- Importance of observing for clinical manifestation of deficiencies, regular monitoring of serum concentrations followed by suitable supplementation (Buchman et al 2003 *Gastroenterology*. 124:1111)
Practicalities of HPN

- Give the patient one night off per week if not fluid dependant
- Some patient may need intravenous fluids only, parenteral nutrition only or a mixture
- For large volume bags, can the patient lift it? Can it go on the drip stand or in the backpack?
- Use multilayer PN bags
- Use light protection bags
- If problems with stability, look at the weekly requirements rather than daily
- When at home, changes cannot normally be done immediately
Conclusion

- The choice of which type of fluids or PN is made depending on the clinical situation of the patient.
- Need to tailor the fluid or PN bag to the patient's requirements and losses.
- May need to tailor the micronutrients to the patient.
- For patients on long term PN, use a ‘liver friendly’ formulation from the start.
- Careful monitoring of the patient will allow you to make changes to the formulation appropriately as the clinical situation changes.