Clinical Practice
of Total Parenteral Nutrition
in Pediatrics

Division of Nutrition & Metabolic Disease
Department of Child Health-
TPN: Total Parenteral Nutrition

IVH: Intravenous Hyperalimentation

TNA: Total Nutrient Admixture

TPA: Total Parenteral Admixture

3-In-1 Admixture

All-In-One Admixture

PPN: Peripheral Parenteral Admixture
Nutritional assessment

Is the GI tract functional?

No

Yes

partial

PN

EN

1. Determine route of adms
2. Formula choice:
   - patient age
   - GI function

Recovery of GI function

No

Yes
General indication

- Patient who can’t eat
- Patient who won’t eat
- Patient who shouldn’t eat
- Patient who can’t eat enough

“If the gut works, use it.”

“Always feeding the gut”
Goal in TPN

“Provide all a patient’s required nutrients in a fluid volume that is well tolerated.”
A.S.P.E.N Guidelines

• Severe stress or malnutrition NPO > 4-5 days
• Moderate stress or malnutrition NPO > 7-10 days
• Non-stressed / Well nourished NPO > 10 days
• No indication for TPN < 4 days

(A.S.P.E.N. Board of Directors: Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. JPEN 26: 1, 2001)
Indication

- Burns
- Protracted diarrhea & malnutrition
- Congenital GI anomalies
- Malnourished oncology patients
- Renal or hepatic failure
- Malnourished patient before major surgery
- Require prolonged respiratory support

<table>
<thead>
<tr>
<th>Condition</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre/Post operative</td>
<td>834</td>
<td>48.5</td>
</tr>
<tr>
<td>Anti cancers treatment</td>
<td>377</td>
<td>21.8</td>
</tr>
<tr>
<td>GI symptoms</td>
<td>139</td>
<td>8.1</td>
</tr>
<tr>
<td>Inadequate oral intake</td>
<td>99</td>
<td>5.6</td>
</tr>
<tr>
<td>Post operative complication</td>
<td>77</td>
<td>4.4</td>
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<tr>
<td>Respiratory management</td>
<td>68</td>
<td>3.8</td>
</tr>
<tr>
<td>Intestinal dysfunction</td>
<td>65</td>
<td>3.6</td>
</tr>
<tr>
<td>Liver/kidney failure (multi organ)</td>
<td>29</td>
<td>1.6</td>
</tr>
<tr>
<td>Others</td>
<td>47</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Source: Okada, Nutrition 14:1, 1998
<table>
<thead>
<tr>
<th>Normal Diet</th>
<th>TPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Protein</td>
<td>Amino Acids</td>
</tr>
<tr>
<td>– Carbohydrates</td>
<td>Dextrose</td>
</tr>
<tr>
<td>– Fat</td>
<td>Lipid Emulsion</td>
</tr>
<tr>
<td>– Vitamins</td>
<td>Multivitamin Infusion</td>
</tr>
<tr>
<td>– Minerals</td>
<td>Electrolytes and Trace Elements</td>
</tr>
</tbody>
</table>
Steps in TPN

• Nutritional assessment
• Calculation of fluid & nutritional requirements
• Administration
• Monitoring
Nutritional assessment

- Clinical examination
- Anthropometry
- Laboratory indicators

Harris-Benedict
Schofield
Indirect Calorimetry

REE
## Fluid requirement

<table>
<thead>
<tr>
<th>Body Weight</th>
<th>Fluid requirement per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10 kg</td>
<td>100 ml/kg</td>
</tr>
<tr>
<td>11 - 20 kg</td>
<td>1000 ml/kg + 50 ml/kg above 20</td>
</tr>
<tr>
<td>Above 20 kg</td>
<td>1500 ml/kg + 20 ml/kg above 20</td>
</tr>
</tbody>
</table>
Carbohydrate

- Give 60-80% of non-protein calories as dextrose
- PN concentration > 10% glucose increase risk of phlebitis
  - < life span peripheral venous lines
- GIR (Glucose infusion rate)
  - premature: 5-12 mg/kg/minute
  - children/adolescents: 2-5 mg/kg/minute
• Start : 5.0 mg/kg/min
• Advance : 1.0-2.0 mg/kg/min
• Goal : 12.0 mg/kg/day

45 % of calories
Protein

- AA
- Nitrogen: non nitrogen calorie 1:150-200
- Solution:
  - 2.7%
  - 5.0%
  - 6.0%
  - 8.0%
  - 10%
## Protein requirements

<table>
<thead>
<tr>
<th>Age (year)</th>
<th>g/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 (+Preterm)</td>
<td>2.0-3.5</td>
</tr>
<tr>
<td>1-7</td>
<td>2.0-2.5</td>
</tr>
<tr>
<td>7-12</td>
<td>2.0</td>
</tr>
<tr>
<td>12-18</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt;18</td>
<td>1.0</td>
</tr>
</tbody>
</table>
• Start : 0.5-1.0 g/kg/day
• Advance : 0.5-1 g/kg/day
• Goal : 2.5-3 g/kg/day

15 % of calories
Lipid Emulsions

• Available in 10% and 20% Emulsion

• Components
  – Triglycerides
    • Primary component: Calorie and EFA source
    • Soybean oil or Soybean and Safflower Oil
  – Egg Phospholipid: Emulsifier
  – Glycerine: Makes admixture approx. isotonic
• Start: 0.5-1.0 g/kg/day
• Advance: 0.5-1.0 g/kg/day
• Goal: 3.0 g/kg/day

40% of calories
Advantages and Disadvantages

• Advantages for giving daily IV fat
  – Provides EFA
  – Decreases dextrose related complications

• Hyperglycemia
• Hypercarbemia (CO2 retention)
• Hepatomegaly and fatty infiltrates of liver
Advantages and Disadvantages

• Disadvantages for giving daily IV fat
  – More expensive
  – If mixed as a 3-In-One
    • Greater risk of microbial growth
    • Shorter stability
Precautions
& contraindications

• Contraindications
  – Severe egg allergy
  – Pancreatitis associated with hyperlipidemia
  – Baseline Trig. > 400 mg/dl
Controversies

– Sepsis
  • \( X \) LCFA may have immunosuppressant effect
  • \( \infty \) Avoid rapid administration

– Liver Failure
  • \( X \) TG broken down by capillary enzymes
  • \( \infty \) Helps prevent liver complications of glucose
  • \( \infty \) Aids in fluid restriction

– Renal Failure
  • \( X \) May clear lipids more slowly
  • \( \infty \) Aids in fluid restriction
Controversies

• Contraindications
  – ARDS
    • ✗ On the basis of one study: may decrease gas diffusion
    • ∞ Refused by other studies
    • ∞ Helps reduce CO2 production
  – Pancreatitis
    • ✗ IV fat does not stimulate pancreatic enzymes production
    • ∞ Contraindicated only in hyperlipedemia
Controversies Summary

• Sepsis : OK, Watch the rate
• Liver Failure : No problem
• Renal Failure : No problem
• ARDS : No problem
• Pancreatitis : Usually OK (watch Trig.)
## Vitamin & Electrolytes

<table>
<thead>
<tr>
<th>Electrolytes</th>
<th>Daily Requirement (mEq/KgBW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>2-4</td>
</tr>
<tr>
<td>K</td>
<td>2-4</td>
</tr>
<tr>
<td>Ca</td>
<td>0.5-2.5</td>
</tr>
<tr>
<td>Mg</td>
<td>0.25-0.5</td>
</tr>
<tr>
<td>P</td>
<td>1-2</td>
</tr>
<tr>
<td>Cl</td>
<td>2-3</td>
</tr>
</tbody>
</table>
Vitamin & Electrolytes

- Vitamin for PN currently not available
- Liquid vitamin can be given via NG as long as no contraindication
TPN Order

All in 1 / 3 in 1

- PN contains AA, dextrose, fat all in the same container
- Convenience, cost saving
- Slower infusion rates of lipid emulsion
- Inhibits visual inspection
- More likely to promote bacterial growth
- Compatibility & stability?
Stability

- Under refrigeration and before addition of vitamins
- 2-in-1: up to 30 days
- 3-in-1: up to 10 days
Routes

• Peripheral Vein
  – limited to short term feeding < 14 days
  – difficult to meet energy & protein needs in some patients due to need for high volume
  – need to keep osmolarity < 900 mOsm in order to prevent thrombophlebitis
  – necessary to use fat as primary energy source due to osmolarity of glucose
Peripherally Inserted Central Catheter (PICC)

– Short-term Central Access

– Catheter insertion thru either the basilic vein or brachial vein of the arm

– Nurses trained to place PICC catheters

– Able to feed concentrated, high osmolarity solutions since tip of catheter placed in near superior vena cava which allows high blood flow
• **Central Venous Access**
  
  – Short term access with catheter placement in subclavian vein
  
  
  – Allows feeding of concentrated, high osmolarity solutions
<table>
<thead>
<tr>
<th></th>
<th>Central</th>
<th>Peripheral</th>
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</thead>
<tbody>
<tr>
<td>Duration</td>
<td>&gt; 2 weeks</td>
<td>&lt; 2 weeks</td>
</tr>
<tr>
<td>Osmolality (mOsm/L)</td>
<td>&gt; 960</td>
<td>600-800</td>
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<tr>
<td>Fluids restriction</td>
<td>+</td>
<td>-</td>
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</table>
## Osmolarity

<table>
<thead>
<tr>
<th>Component</th>
<th>Calories/L</th>
<th>MOsm/L</th>
<th>Grams/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% Dextrose</td>
<td>340</td>
<td>504</td>
<td>100</td>
</tr>
<tr>
<td>20% Dextrose</td>
<td>680</td>
<td>1008</td>
<td>200</td>
</tr>
<tr>
<td>5.5% AA</td>
<td>220</td>
<td>575</td>
<td>55</td>
</tr>
<tr>
<td>8.5% AA</td>
<td>340</td>
<td>890</td>
<td>85</td>
</tr>
<tr>
<td>10% Lipids</td>
<td>1100</td>
<td>260</td>
<td>100</td>
</tr>
<tr>
<td>20% Lipids</td>
<td>2000</td>
<td>260</td>
<td>200</td>
</tr>
<tr>
<td>Electrolytes</td>
<td>-</td>
<td>235</td>
<td>-</td>
</tr>
</tbody>
</table>
Methods of Administration (1)

- Cyclic Infusion
  - Infusion of parenteral solution of 10 - 12 hour period usually at night.
  - Allows patient to continue with normal daily activities during waking hours.
  - Must slowly taper TPN at the end of the infusion period to prevent rebound hypoglycemia.
Methods of Administration

• Continuous Infusion per volumetric pump
  – must start at slow rate ~ 50 mL/hr due delivery of high concentrations of glucose to the bloodstream
  – rates increased every 8 hours until goal reached
  – since delivery of high concentration of glucose to bloodstream, insulin levels increase.
  – if feeding abruptly stopped, rebound hypoglycemia can result
Complications

• Mechanical
  – Pneumothorax – air
  – Hemothorax – blood
  – Hydrothorax – solution (TPN)
  – Intravascular Misplacement – often IJ
  – Catheter Embolism – sheared tip
  – Air Embolism
  – Venous Thrombosis
Complications

Metabolic

- Glucose Metabolism
- Protein Metabolism
- Fat Metabolism
- Elevated LFT’s
- Electrolyte Disorders

• Septic

*Emphasis on prevention*
## Monitoring

<table>
<thead>
<tr>
<th>Lab Study</th>
<th>Baseline</th>
<th>Daily</th>
<th>Every 2-3 days</th>
<th>Weekly</th>
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</thead>
<tbody>
<tr>
<td>Electrolytes</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>BUN, creatinine</td>
<td>X</td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Blood Gluc</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Mg &amp; P</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ca</td>
<td>X</td>
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<tr>
<td>LFT</td>
<td>X</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>Alb &amp; Prealb</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chol &amp; TG</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hb, WBC</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>PT</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Urine Gluc</td>
<td></td>
<td>4-6/day</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Discontinuing

Once EN have been established and well tolerated

Suggested that PN rate be halved for 24 hours

PN discontinued if EN have reached 2/3 enteral requirements
• 1 year of age boy, BW 10 kg, L 75 cm, post laparotomy surgery, NPO will be planned for 7 days. Temp 37°C.
Conclusions

• TPN can be use as alternative nutritional support
• “Balance diet” principal should be used in ordering TPN
• Whenever possible always use oral/enteral for nutritional support, if contraindicated use TPN
• “Always feeding the GUT”
Thank you