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SEEK WISDOM, ELEVATE YOUR INTELLECT AND SERVE HUMANITY !

Parenteral Nutrition in Pediatric Surgical Patients

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People

`October 2, 1978

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For patients who can't eat, Dr. Stanley Dudrick's intravenous feeding system is a lifeline.

By Kent Demaret

Dudrick was turned from a fledgling cardiac surgeon into a pioneer nutritionist one day when he was an intern in Philadelphia. **"We had three patients who had gone through successful surgery—but they all died,"** he recalls. "I was terribly discouraged. Then the chairman of the surgery department said that, if I analyzed it, **I'd see they really died of starvation.** They couldn't eat, and they didn't have enough reserve tissues to draw on. I was too dumb to make that observation myself."

Dudrick solved the problem by developing a complete nutritive compound. But he faced another obstacle: **"We couldn't put it in through the arm because the mixture was too thick** and produced problems in the small veins. **We couldn't thin it down with water either, because that produced edema**. "Then," Dudrick says, "we hit on the idea of putting it into larger veins, where the blood flow is so great that the nutritional substances would be diluted and rushed throughout the body."

Still a crusader, he worries that, while half the nation's doctors are aware of TPN, only five percent are using it. **"It takes time,"** he says, **"for doctors to accept so much responsibility for dealing with such complex advances in human chemistry, metabolism and nutrition."** Success will depend on campaigning for the technique, while simplifying it. **"I want to leave something behind when I go, rather than just practice medicine the way it has always been done."**

Intro 👋

- Pediatric age has the highest energy and nutrient requirements relative to body size
- PN provides nutritional support when EN is not possible (**Total**) or fails to meet needs (supplemental / **partial**)
- Developed in the late 1960s, but in Ethiopia?
  - Shelf life
  - Cost
  - FMHACA
  - Compounding

Case

A 26 week female is born precipitously to a healthy 20 year old G1P1 with an uncomplicated pregnancy. The baby is referred to your center with a diagnosis of gastroschisis. She was transferred to the NICU and put in an incubator. After evaluation, you are getting ready to order fluids for this baby.

- What formulas/fluids do you prefer?
- What is your goal growth for this infant?
- What is this infant's caloric requirement?
- What is your plan as you advance?

Aim

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- Basic understanding of parenteral nutrition

Outline

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1) Calculating Energy requirement
2) Indications for PN
3) Goals of PN
4) Vascular access for PN
5) Complications of PN
6) Prescription, storage, order, administration, monitoring

1) Calculating energy requirement

- **Total Energy Expenditure**
  - Resting energy expenditure (Schofield's equations)
  - Physical activity (1.2 sitting, 1.5 standing, 2.0 activity)
  - Diet induced thermogenesis (10%)
- **Nitrogen balance**
- **Normal pediatric growth** (35% at 1 mo, 3% at 12 mo)
- **Metabolic response to stress** (Ebb and flow)
- **Nutritional reserves in children** (glycogen, FA, AA)

Which nutrients are essential? 😋

Energy Vs Nutrition

Macronutrients

Energy =
40, 90-120kcal/kg/d

Carbohydrate
(3.4 kcal/g, 60-75%)

3.5, 7-14 g/kg/d

Rate 4, 5-10 mg/kg/min

Fat (10kcal/g, 25-40%)
-Polysaturated
-unsaturated & trans
-cholesterol

1, 3 g/kg/d

Linoleic acid 0.1 g/kg/d

Protein
(3.77kcal/g, 10-15%)

1, 2.5-3 g/kg/d

nitrogen = +2 g/kg/d

**** Fiber**
(dietary and functional)

Micronutrients

Physiologic functions

Vitamins
(A, B, C, D, E, K)

Minerals
(Fe, Zn, Ca, K, Na, Cl)

Water

homeostasis

2) Who should be initiated on PN?

- **Starvation**
  - Has been / Expected to be NPO for more than 3-5 days (7 days for older)
  - *earlier if malnutrition, prematurity, or hypermetabolism
- **Congenital gastrointestinal defects**
  - gastroschisis, bowel atresia, volvulus, meconium ileus
- **Intestinal Immaturity**
  - Majority of preterm infants <32 weeks gestation or <1.5kg
  - *Necrotizing enterocolitis (NEC), low nutritional reserve
- **Intestinal failure**
  - Malabsorption syndromes, ECF, short bowel syndrome
  - Ileus, ulcerative coitis, chron's, GOO
  - Chemo- radiotherapy induced, severe vomiting/diarrhea

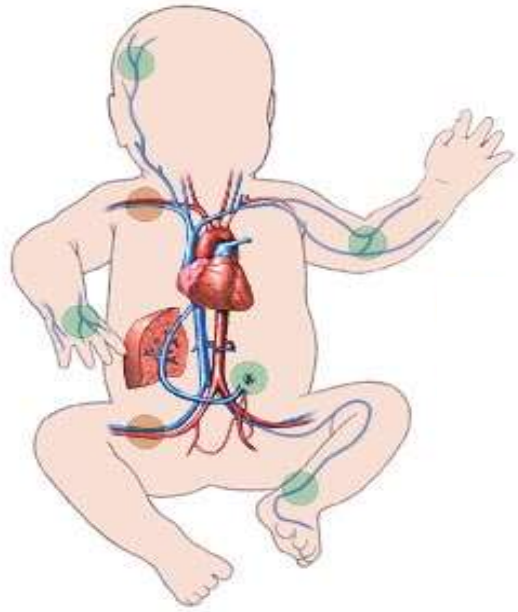
3) Goals of TPN

- Maintenance of body tissues (prevent catabolism)
- Achieve growth/weight gain (anabolism)
- Hemostasis of fluid and electrolyte
- Avoid imbalance of macronutrients
- Provide micronutrients

*neurodevelopmental, dec mortality, NEC, BPD

4) Vascular access in peds

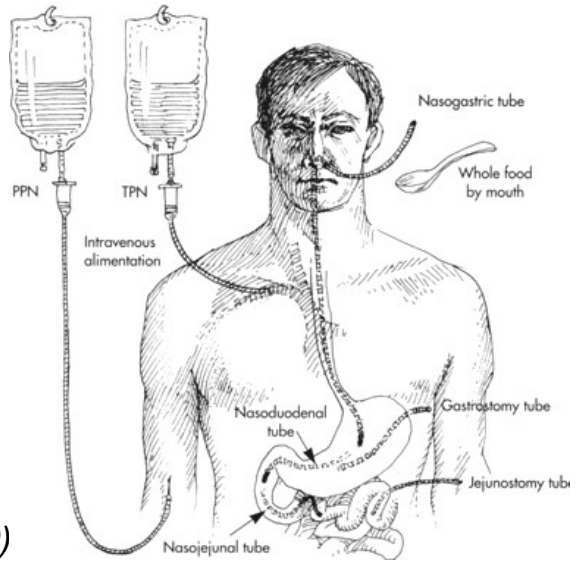
- **Venous**
  - **Peripheral** intravenous (**PIV**) cannula
    - *Dorsal foot, ventral distal forearm, scalp
  - **Central** venous catheter (**CVC**)
    - Alternate routes for CVC (AV, BCV, SVC, IVC, RA)
    - Peripherally introduced central catheter (**PICC**)
    - Surgically placed (Tunneled or Totally implanted)
  - *__Umbilical__ venous catheter (**UVC**) = 14 days
  - **Emergency access**
    - *Intraosseous (**IO**) needle
    - Venous cut down
- **Arterial** Catheters
  - *Umbilical artery catheter (**UAC**) = 5 days
- **Hemodialysis** catheters (**AVF**)



4) Peripheral VS Central

PPN or TPN?

- Duration (2 weeks)
- Fluid needs
- Nutrient needs
- **Dextrose concentration** (12.5%)
- **Osmolality** (900 mOsml/L)
  - ***PN osmolality*** = *gram/L of (dextrose x 5) + (protein x 10) + (lipid x 1.5) + meq/L of (Na + K + Ca + Mg)x 5*



It is recommended that CVADs are used for PN in neonates

5) Complications of PN

- **Metabolic**
  - Hyper/hypoglycemia, Hypertriglyceridemia, Metabolic acidosis, electrolyte disturbance
  - bone disease, Refeeding syndrome
- **Respiratory**
  - Increased respiratory quotient, CO2 retention, prolonged MV
- **Hepatobiliary & GI**
  - PNALD (cholestasis, steatosis, and cholelithiasis)
  - Intestinal atrophy
- **Catheter related**
  - Line Infection
  - Technical
    - Pneumothorax, Hemothorax, arrhythmias
    - Occlusion, Malposition, Migration
    - Thrombosis, Pulmonary embolism

6) Practical aspects

Prescription…part 1

- **Aqueous solution** (amino acid in dextrose with electrolyte)
  - **Aminolact®** (1g/15ml)
  - **Aminoven®** 25 (1g/6.7ml)
  - **25% dextrose** (1g/4ml)
  - **Electrolytes** (NaCl, KCl, CaGlu, MgSul, NaPhos)

- **Lipid solution** (10%, 20%, 30%)
  - **intralipid®** (omega-6/ soybean oil) = min 0.5g/kg/d
  - **SMOFlipid®** (4 oils) = min 1.35g/kg/d
  - **Omegaven®** (omega-3/ fish oil)

6) Practical aspects

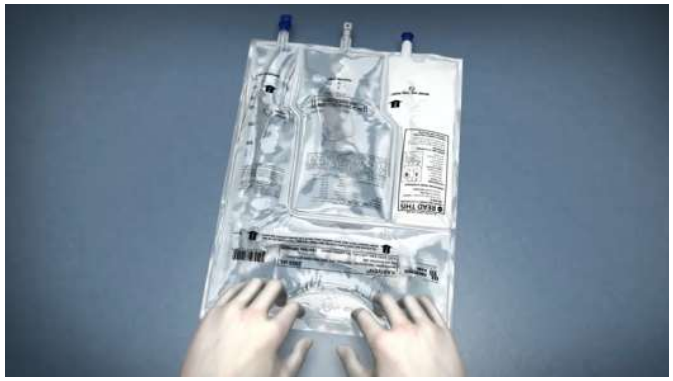
Prescription…part 2

- **Vitamin** (added to aqueous / lipid solution)
  - **SolivitoN®** (Vit B & C) = 1ml/kg/d (max 15ml)
  - **VitlipidN®** (Vit A,D,E,K) = 4ml/kg/d (max 10 ml)
- **Trace elements** (Cu, M, I, F, Se, Zn/ + Fe, Cr, Mo)
  - **Peditrace®** (<40 kg) = 1ml/kg/d (max 15ml)
    - ****FeCl** = 1ml/kg/d
  - **Additrace®** (>40 kg)= 10ml/d
- **Other additives** (acetate, carnitine, medications)

6) Practical aspects

Storage & Administration…part 1

- **Delivered** from the manufacturer on same day
- **Shelf life / Expiry date** is usually ---;
- **Stored** in refrigerator at 2 to 8°C
- **Removed** from fridge 1-2 hour prior to infusion
- Multi chamber bags should be activated (**mixed**)



- Play video => **Activation of multi-chamber TPN**

6) Practical aspects

Storage & Administration…Part 2

- Gently shake to dislodge formed particles; **micron filter**
- Ensure infusions (bag & lipid line) are **light protected**
- Administered using **volumetric pumps**
- Lipid infusion & line should be **changed** every 24 hr

6) Practical aspects

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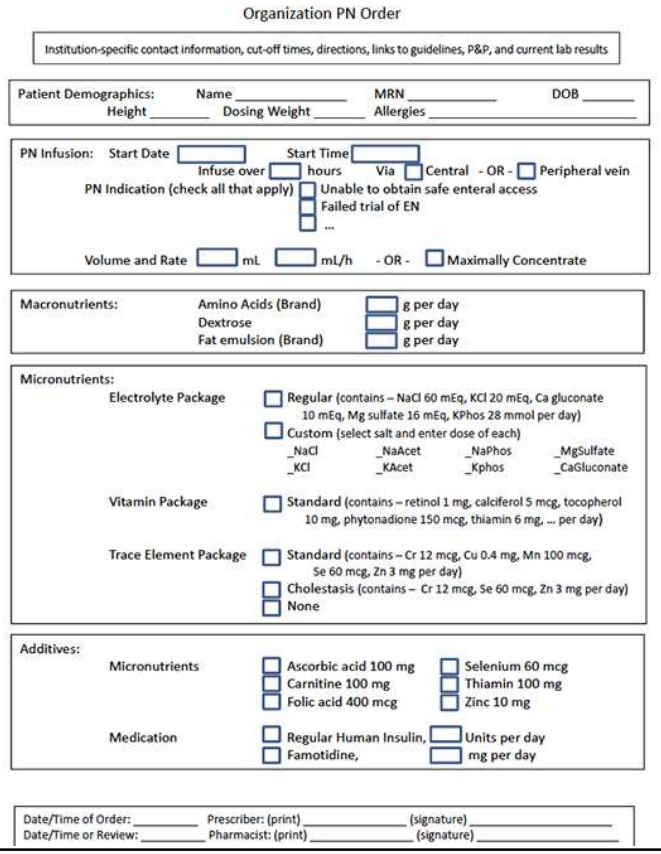
Order

- PN **Volume** (ml per kg), infusion **rate** (ml per hr) and **route** (Central or peripheral)
  - Volume of Glucose, Lipid, Amino acid, vitamin
  - Rates for both aqueous and lipid solutions
  - Glucose infusion rate
- **Continuous infusion Vs Cycling**
  - reduce infusion time by 1-2hr each day to 12 hr
- **Weaning**
  - enteral >30ml/kg in preterm, 25% in older



Organization PN Order

Institution-specific contact information, cut-off times, directions, links to guidelines, P&P, and current lab results

Patient Demographics: Name _____ MRN _____ DOB _____
Height _____ Dosing Weight _____ Allergies _____

PN Infusion: Start Date ☐ Start Time ☐
Infuse over ☐ hours Via ☐ Central - OR - ☐ Peripheral vein
PN Indication (check all that apply) ☐ Unable to obtain safe enteral access
☐ Failed trial of EN
☐ ...
Volume and Rate ☐ mL ☐ mL/h - OR - ☐ Maximally Concentrate

Macronutrients:
Amino Acids (Brand) ☐ g per day
Dextrose ☐ g per day
Fat emulsion (Brand) ☐ g per day

Micronutrients:
Electrolyte Package
☐ Regular (contains – NaCl 60 mEq, KCl 20 mEq, Ca gluconate 10 mEq, Mg sulfate 16 mEq, KPhos 28 mmol per day)
☐ Custom (select salt and enter dose of each)
_NaCl _NaAcet _NaPhos _MgSulfate
_KCl _KAcet _Kphos _CaGluconate
Vitamin Package
☐ Standard (contains – retinol 1 mg, calciferol 5 mcg, tocopherol 10 mg, phytonadione 150 mcg, thiamin 6 mg, ... per day)
Trace Element Package
☐ Standard (contains – Cr 12 mcg, Cu 0.4 mg, Mn 100 mcg, Se 60 mcg, Zn 3 mg per day)
☐ Cholestasis (contains – Cr 12 mcg, Se 60 mcg, Zn 3 mg per day)
☐ None

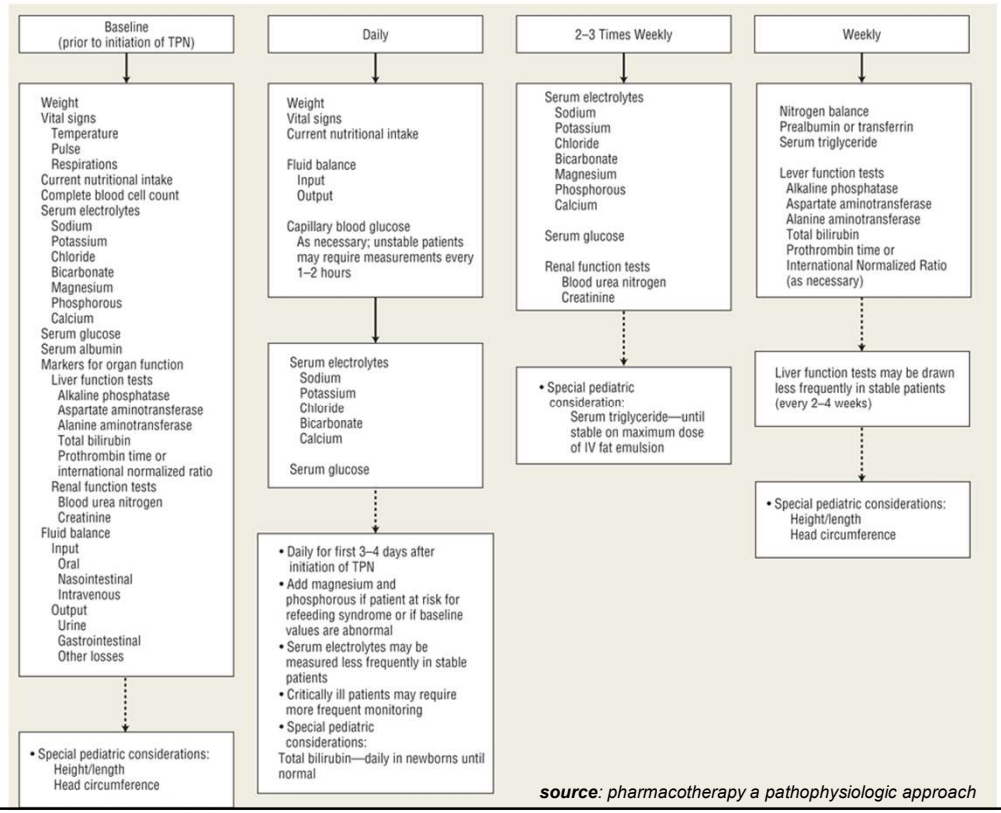
Additives:
Micronutrients
☐ Ascorbic acid 100 mg ☐ Selenium 60 mcg
☐ Carnitine 100 mg ☐ Thiamin 100 mg
☐ Folic acid 400 mcg ☐ Zinc 10 mg
Medication
☐ Regular Human Insulin, ☐ Units per day
☐ Famotidine, ☐ mg per day

Date/Time of Order: _____ Prescriber: (print) _____ (signature) _____
Date/Time or Review: _____ Pharmacist: (print) _____ (signature) _____

6) Practical aspects

Monitoring

- For?
  - Growth
  - Complications
- How?
  - Physical
  - Labs (PN panel)



source: *pharmacotherapy a pathophysiologic approach*

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Questions?

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