Strategies for Parenteral Nutrition Management in Adult Patients

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Faculty Disclosure

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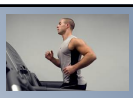
Has no financial interest/arrangement that would be considered a conflict of interest.

Objectives

1. Identify appropriate indications for parenteral nutrition support (PN).
2. Understand how to write a safe and accurate PN prescription.
3. Recognize complications associated with PN.
4. Address how to manage complications associated with PN.

PN Indications



- Nourished Patients:
  - Unable to use GI tract for > 7 – 10 days
    - Bowel Obstruction
    - Mesenteric Ischemia
    - GI fistula (unless EN can be given posterior to fistula) (1)
  - Critically Ill unable to tolerate EN
    - Withhold for first 7 days
    - If unable to meet > 60% of needs over the first week, supplemental PN (3)

PN Indications

- Nutritionally-At-Risk Adult
  - Definition:
    - Involuntary weight loss 10% within 6 months or 5% within 1 month
    - Involuntary weight loss of 10 lb within 6 months
    - BMI < 18.5
    - Increased metabolic requirements
    - Inadequate intake for > 7 days
  - Initiate PN within 3-5 days in those in whom it's unlikely to achieve desired oral or EN (5)

PN Indications

- Malnourished Patients:
  - Unable to use GI tract or unable to meet nutritional requirements with EN
  - Moderate/severe malnourished patients who are expected to have a prolonged period of GI dysfunction should receive PN perioperatively
  - In critical illness, if EN is not feasible start PN as soon as possible (except in severe sepsis) (1,3)

Prior to starting PN

- Past medical history and nutritional status
- Determine estimated needs
- Ensure appropriate access device
- Check baseline labs
- Correct electrolyte or acid/base imbalances

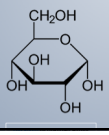
Prior to starting PN

- Medical history/ current medical diagnoses
- Nutritional status

Prior to starting PN

Refeeding Syndrome

- Starvation: decrease in insulin secretion and use of glucose, reliance on fat for energy, reduced protein breakdown, depletion of intracellular K/PO4/mag
- Refeeding: hyperinsulinemia, shift to CHO metabolism, cellular uptake of minerals, increased need for coenzymes
- Complications: antinatriuresis, decreased levels of K/PO4/mag, vitamin deficiencies, cardiac changes (6)



Prior to starting PN: Estimating Nutrient Needs

General suggested Nutrient Intake for Adult Patients on PN

PN Component	Critically Ill Patients	Stable Patients
Protein	1.5 – 2 g/kg/d	1 g/kg/d
Carbohydrate	<= 4 mg/kg/min	<= 7 mg/kg/min
IV fat emulsion	None for 7 days (<= 1 g/kg/d)	1 g/kg/d
Total energy	80% (25 – 30 kcal/kg/d)	20 – 30 kcal/kg/d
Fluid	Minimum needed to deliver	30 – 40 mL/kg/d
	Adequate macronutrients	

Acutely ill patients, depending on disease state, may require higher levels of protein (1)

Prescribing PN: Estimating Nutrient Needs

Daily Electrolyte Guidelines for Adult PN Formulations (1)

Nutrient	Standard Daily Requirement	Factors That Increase Needs	Dosage Form
Calcium	10 – 15 mEq	High Protein Intake	Calcium Gluconate
Magnesium	8 – 20 mEq	GI losses, drugs, refeeding	Magnesium sulfate
Phosphorus	20 – 40 mmol	High dextrose intake, refeeding	Na Phos, K Phos
Sodium	1 – 2 mEq/kg	D/V, NG suction, meds, refeeding, GI losses	Na Phos, NaCl, Na Acetate
Potassium	1 – 2 mEq/kg	D/V, NG suction, meds, refeeding, GI losses	K Phos, KCL, K Acetate
Acetate	PRN for acid/base	Renal insuff, met acidosis, GI losses of bicarb	Na Acetate, K Acetate
Chloride	PRN for acid/base	Metabolic alkalosis, volume depletion	NaCl, KCL

Prior to starting PN: Ensure appropriate access

- Peripheral or Central Access - Defined by the position of the distal catheter tip
  - Peripheral Catheter:
    - Tip is outside of the central vessels (inferior or superior vena cava)
    - Examples: Std peripheral cannulas, midline catheters, midclavicular catheters
  - Central Catheter:
    - Tip lies in distal vena cava or right atrium
    - Subclavian, jugular, PICC (cephalic, basilic veins) (1)

Prior to starting PN: Ensure appropriate access

Peripheral Parenteral Nutrition (PPN)

- Recommended for <= 2 weeks
- Generally IV sites have to be rotated every 48 – 72 hours
- Osmolality of the solution must be < 900 mOsm/L
  - Dextrose 5 mOsm/g
  - AA 10 mOsm/g
  - Lytes 1 mOsm/mEq
  - Lipids (3 in 1) 0.71 mOsm/g (can be product dependent)
- Calcium and K concentrations should be kept low (<= 5 mEq/L Ca and <= 40 mEq/L K) to prevent thrombophlebitis [1]

Prior to starting PN: Ensure appropriate access

Central Parenteral Nutrition (CPN or TPN)

- Central infusions are not limited by pH, osmolarity or volume
- Can provide maximal nutrition with minimal amount of fluid
- Weeks to years [1]

Prior to starting PN: Check baseline labs

Na, K, Cl, CO2	LFTs
Ca, Phos, Mg	Prothrombin time
Glucose	Triglycerides
BUN/Cr	CBC

Prior to starting PN:

Conditions Warranting Cautious Use of PN

Condition	Suggested Criteria
Hyperglycemia	Glucose > 300mg/dL
Azotemia	BUN > 100 mg/dL
Hyperosmolality	Serum Osmolality > 350 mOsm/kg
Hypernatremia	Na > 150 mEq/L
Hypokalemia	K < 3 mEq/L
Hyperchloremic metabolic acidosis	Cl > 115 mEq/L
Hypophosphatemia	Phos < 2 mg/dL
Hypochloremic metabolic alkalosis	Cl < 85 mEq/L [1]

Prior to starting PN: Address electrolyte or acid/base imbalances

- Sodium disorders – often related to fluid status vs disorders of body sodium stores
  - Exception: Patients with high sodium losses; may require increased PN sodium to avoid hyponatremia

Electrolyte Composition of Gastrointestinal Secretions [6]

Source	Na	Cl	K	HCO3
Gastric	40 – 100	100 – 140	5 – 10	0
Small Intestine	100 – 140	100	5 – 20	30
Bile	140	100	5 – 10	35
Pancreas	140	55 – 75	5 – 10	80 – 120
Colon	25 – 140	20 – 85	35 – 60	30 – 60

Prior to starting PN: Address electrolyte or acid/base imbalances

- Sodium Disorders - often related to fluid status vs disorders of body sodium stores
  - Exception: Patients who are hypervolemic or receiving a lot of sodium from other sources such as sodium containing IVF (NS or lactated ringers or medications with sodium based carrier fluids) may need PN without sodium or reduced amounts of sodium.
- Sodium Disorders are very complex and require knowledge of patient's fluid status, serum sodium/chloride/bicarb levels and often urine electrolyte levels to appropriately diagnose the etiology which drives the appropriate treatment.

Prior to starting PN: Electrolyte Replacement Hypokalemia

Empirical Treatment of Hypokalemia

Serum K (meq/L)	IV K Dose (meq)
3 – 3.4	20 – 40
2.5 – 2.9	40 – 80
< 2.5	80 – 120

- Pt's with renal compromise, start with 50% of empirical dose [2]

Prior to starting PN: Electrolyte Replacement Hypokalemia

- IV replacement
  - Central line is recommended to prevent phlebitis & burning
  - Check for magnesium deficit
  - Rule of Thumb: For every 10meq K infused, K level should increase by 0.1 meq/L (assuming normal renal function)

⚠ Cautions: In general infusion rates should NOT exceed 10-20 meq/hour. Rates > 10 meq/hour should have continuous cardiac monitoring [2]

Prior to starting PN: Electrolyte Replacement Hypomagnesemia

Empirical Treatment

Severity	[Mag mg/dL]	IV Magnesium Sulfate Dose
Mild/Mod	1.0 – 1.5	8-32meq (1-4 g), up to 1meq/kg
Severe	< 1.0	32-64meq (4-8 g), up to 1.5meq/kg

- Pt's with renal compromise, start with 50% of empirical dose [2]

Prior to starting PN: Electrolyte Replacement Hypomagnesemia

Hypomagnesemia treatment is Largely empirical
- Serum levels often do not correlate with intracellular concentrations or total body magnesium levels.

⚠ Caution: Infusion rates should not exceed 1 g (8meq) magnesium sulfate per hour in asymptomatic patients, up to 12 g (100meq) over 12 hours if asymptomatic and up to 4 g (32meq) over 4-5 minutes if severely symptomatic.

- Can cause refractory hypokalemia and hypocalcemia [2]

Prior to starting PN: Electrolyte Replacement Hypophosphatemia

Empirical Treatment:

Severity	[PO4 (mg/dL)]	IV Dose (mmol/kg)
Mild	2.3 – 2.7	0.08 – 0.16
Moderate	1.5 – 2.2	0.16 – 0.32
Severe	< 1.5	0.32 – 0.64

- Pt's with renal compromise, start with 50% of empirical dose [2]

Prior to starting PN: Electrolyte Replacement Hypophosphatemia

Treatment:
- K Phos or Na Phos: should be ordered in mmol of phoshorus (not mEq of the potassium or sodium)
- If renal insufficiency give 50% of dose

⚠ Caution: Infusion rate should not exceed 7 mmol/hour to prevent thrombophlebitis and soft tissue calcium-phosphate deposition [2]

Prior to starting PN: Electrolyte Replacement Hypocalcemia

Empirical Treatment of Acute Hypocalemia

Ionized Calcium (mmol/L)	IV Calcium Dose
1 – 1.2	2 g (9.3 meq) calcium gluconate over 2 hours
< 1	4 g (18.6 meq) calcium gluconate over 4 hours

⚠ Caution: Infusion rates should not exceed 0.8 – 1.5 meq/minute to prevent cardiac arrhythmias (2)

Prior to starting PN: Understanding acid/base balance

- Two systems that affect acid/base balance
  - Lungs: retention or exhalation of carbon dioxide
  - Kidneys: retention or excretion of acids or bicarbonate
- Acid/base status can be altered by the PN formulation
  - Chloride is the acid component of TPN
  - Acetate (precursor to bicarbonate) is the basic component of TPN
- If the patient has respiratory problems, it is necessary to obtain an ABG to assess acid/base balance.

PH*NE	7.245	L*		7.35 - 7.45
PCO2*NE	63.7	H*	mmHg	35 - 45
PO2*NE	72.8	L	mmHg	80 - 95
BASE EXCESS*NE	-1.0		mmol/L	-2 - 2.0
BICARBONATE*NE	27.0	H	mmol/L	22 - 26
O2SAT MEASURED*NE	90.6	L	%	95 - 100
COHB (ABG)*NE	0.2		%	0 - 2.5
FIO2*NE	80		%	

Prescribing PN – Writing the PN Prescription

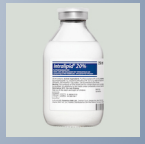
- PN Admixture:
  - Protein (AA)
  - Carbohydrate (dextrose)
  - Water
  - Lipids
  - Electrolytes, vitamins, minerals and trace elements
- "2 in 1" solution with lipids given separately
- "3 in 1" Total Nutrient Admixture (solution with lipids included in TPN bag)
- Standardized commercially prepared admixture (6)

Prescribing PN – Writing the PN Prescription Base Solution

- Determine type and amount of AA solution
  - 10% AA solution and 15% AA solution
  - Example: 120 g protein
    - Take goal amount of protein divided by 10% and then multiply it X 100
    - 120g divided by 10 (10g/100mL) = 12
      12 X 100 = 1200ml
    - Could provide 1200ml 10% AA OR 800ml 15% AA solution to give 120g protein

Prescribing PN – Writing the PN Prescription Base Solution

- Determine type and amount of IVFE (if providing lipids)
  - General recommendations: 20 – 30% of calories from lipids
  - 100ml 20% lipids = 200 kcals
  - 250ml 20% lipids = 500 kcals
  - 30% lipid solutions are used for TNAs



Prescribing PN – Writing the PN Prescription Base Solution

- Most common complication of PN is hyperglycemia
- Recommended to start with less than goal amount of dextrose
  - Adults (without malnutrition or diabetes): 150 – 200g on day 1
  - Adults (DM, hyperglycemia of stress): 100 – 150g on day 1
  - Adults (risk of refeeding syndrome): 100 – 150g (or less based on weight if severely underweight) (1)

Prescribing PN – Writing the PN Prescription Base Solution

- Determine type and amount of dextrose (3.4 kcals/g)
  - D70 (70% dextrose solution) or D50 are common for PN
  - How many calories needed to meet energy needs?
  - Example: Estimated needs of 2000 calories, 120g protein
    - Will receive 480 kcals from AA, 500 kcals from IVFE
    - Pt needs an additional 1020 kcals to meet needs
    - Take 1020 kcals divided by 3.4 kcals/g = 300g dextrose
    - 300g dextrose divided by 70 (assuming D70 is being used) = 4.29 X 100 = 429ml D70

Prescribing PN – Writing the PN Prescription Base Solution

- Determine volume that is appropriate for patient
  - Initial recommendation of 30ml/kg from all sources of fluid
  - BMI in normal range; may change based on medical condition
- Determine amount of sterile water
  - Typically micronutrients/additives provide 25 – 80mL
  - Example:
    - Desired volume: 2200ml
    - 1200ml from 10% AA solution, 429ml D70% solution, 80mL from additives = 1709ml
    - 2200ml – 1709ml = 491ml
    - Would order 490ml sterile water (6)

Prescribing PN – Writing the PN Prescription Base Solution

Base Solution:

- 1200ml 10% AA solution (120g protein)
- 429ml D70% solution (300g dextrose)
- 490ml sterile water
- ~80ml from additives
- RATE: 92ml/hr

IVFE: 250ml (run at 25ml/hr for 10 hours; 50 kcals per hour; fine unless pt is < 50 kg)

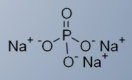
Prescribing PN – Writing the PN Prescription Electrolytes

Daily Electrolyte Guidelines for Adult PN Formulations (1)

Nutrient	Standard Daily Requirement	Factors That Increase Needs	Dosage Form
Calcium	10 – 15 mEq	High Protein Intake	Calcium Gluconate
Magnesium	8 – 20 mEq	GI losses, drugs, refeeding	Magnesium sulfate
Phosphorus	20 – 40 mmol	High dextrose intake, refeeding	Na Phos, K Phos
Sodium	1 – 2 mEq/kg	D/V, NG suction, meds, refeeding, GI losses	Na Phos, NaCl, Na Acetate
Potassium	1 – 2 mEq/kg	D/V, NG suction, meds, refeeding, GI losses	K Phos, KCL, K Acetate
Acetate	PRN for acid/base	Renal insuff, met acidosis, GI losses of bicarb	Na Acetate, K Acetate
Chloride	PRN for acid/base	Metabolic alkalosis, volume depletion	NaCl, KCL

Prescribing PN: Writing the PN Prescription Electrolytes

- It is recommended to order phosphorus in mMol
- Phosphorus is provided in the salt forms:
  - K PO4 and Na PO4
    - K PO4 provides 4.4 mEq K per 3 mMol PO4
    - Na PO4 provides 4 mEq Na per 3 mMol PO4
  - 30 mMol K PO4 = 44 mEq of K
  - 30 mMol Na PO4 = 40 mEq of Na



Prescribing PN: Writing the PN Prescription Electrolytes

- Determine amount of phosphorus
- Determine which salt form: K PO4 or Na PO4
- Determine how much of K or Na provided
- Ensure that it will not precipitate with calcium in solution

Conservative rule of thumb to avoid precipitation of phosphorus in TPN:

[mMol of Phosphorus x 2] + mEq of calcium = < 50 per liter

Prescribing PN: Additives

MVI – should be included in all PN solutions

Vial 1 (5 mL)		Vial 2 (5 mL)	
– Vitamin C	200mg	Folic Acid	600 mcg
– Vitamin A	3300 units	Biotin	60 mcg
– Vitamin D3	200 units	Cyanocobalamin (B12)	5 mcg
– Thiamine (B1)	6 mg		
– Riboflavin (B2)	3.6 mg		
– Pyridoxine (B6)	6 mg		
– Niacinamide	40 mg		
– Dexpanthenol	15 mg		
– Vitamin E	10 units		
– Vitamin K	150 mcg		

Prescribing PN: Additives

TE – should be included in all PN solutions

Vial (5 mL)
- 4mg zinc
- 0.8mg manganese
- 1mg copper
- 10 mcg chromium

Exception: TE toxicity

Example: manganese toxicity
- Can cause hyper-irritability, violent acts, hallucinations, ataxia, facial muscle spasms
- If this occurs trace elements have to be given as single-entity products

Injectable Iron products:
- are only available as singe-entity products

Prescribing PN: Additives

› Additional thiamine (malnourished patients)
- Patients at risk for thiamine deficiency: ETOH, long-term PN, refeeding syndrome, malabsorption
- 100mg added to prevent Beri Beri and Wernicke's Encephalopathy [1]

› Medications:
- In general, PN should not be used as a medication delivery vehicle
- H2 blockers: Can add ranitidine, cimetidine, famotidine
- Insulin:
  - › Only regular insulin is compatible with PN formulations
  - › Insulin binds to the surface of the bag and tubing
  - › The extent of binding depends on the type of bag and the PN formulation
  - › The higher the concentration of insulin in PN, the lower extent of binding because the bag/tubing has a limited number of binding sites [1]

Application

JD is a 65 year old male with PNA and a SBO. Has had minimal nutrition over the past 7 days and it is expected that he will not be able to take nutrition per gut for > 2 weeks. He is not having diarrhea or significant NG tube output at this time. He is receiving ~500ml NS per day from IV medications.

PMH: DM, HTN, HLD

Height: 72 inches BMI: 23.7

Weight: 175 lb [79.5 kg]

Estimated Needs: 1990 – 2370 kcals (25 – 30 kcals/kg)
95 – 105g protein (1.2 – 1.3g protein/kg)
~2370ml fluid (~30ml/kg)

Application

Base Solution (2 in 1 solution):
- Starting with goal protein: 100g protein (400 kcals)
  - › _____ml 10% AA solution
- IVFE: _____ml 20%
- Start with decreased dextrose to prevent hyperglycemia:
  - › _____g dextrose
  - › _____ml 70% dextrose solution
- Volume of AA, Dextrose, estimated for lytes = _____ ml
- Desired volume: 2370ml – 500ml (IV meds) = 1870ml

1870ml – _____ml = _____ml sterile water

Initial Labs

GLUCOSE^NE	141	H	mg/dL	70 - 110
SODIUM^NE	137		mmol/L	137 - 145
POTASSIUM^NE	4.3		mmol/L	3.6 - 5.0
CHLORIDE^NE	108	H	mmol/L	98 - 107
CARBON DIOXIDE^NE	23		mmol/L	23 - 33
ANION GAP^NE	10		mmol/L	10 - 20
UREA NITROGEN^NE	24	H	mg/dL	9 - 20
eGFR^NE	96			Ref. >=60
CREATININE^NE	0.8		mg/dL	0.7 - 1.5
TOTAL PROTEIN^NE	4.2	L	g/dL	6.3 - 8.2
ALBUMIN^NE	2.1	L	g/dL	3.5 - 5.0
A/G RATIO^NE	1.0	L		1.2 - 1.6
CALCIUM,TOTAL^NE	7.9	L	mg/dL	8.4 - 10.2
PHOSPHORUS^NE	3.3		mg/dL	2.6 - 4.9
MAGNESIUM^NE	2.0		mg/dL	1.6 - 2.3
BILIRUBIN,TOTAL^NE	0.6		mg/dL	0.1 - 1.3
ALKALINE PHOSPHATASE^NE	57		IU/L	38 - 126
AST^NE	18		IU/L	15 - 46
ALT^NE	29		IU/L	11 - 66

Application:

Assuming no significant electrolyte, fluid or acid/base disorders

- K 1-2mEq/kg/day (based on wt of 79.5 kg) = _____
- Na 1-2mEq/kg/day (based on wt of 79.5 kg) = _____

Could start with:

___ mmol K Phos (44mEq K)

___ mEq KCL

___ mEq NaCl

___ mEq Na Acetate

___ mEq magnesium suflate

___ mEq calcium gluc

Assessment/Management of Complications: Monitoring PN

- Weight
- Physical Examination
  - Assess fluid status
  - Assess vascular access device for patency and for infection
- Intake and Output
- Readiness for oral/enteral feeding

```
211.9 lb [96.3 kg] (3/28/18)
219.4 lb [99.5 kg] (3/23/18)
213.4 lb [97 kg] (3/22/18); bed scale (7E)
230.4 lb [104.7 kg] (3/21/18) bed scale (ICU)
205.3 lb [93.3 kg] (3/20/18); s/p surgery 3/19
194 lb [88.2 kg] (3/19/18)
183.3 lb [83.3 kg] (3/13/18)
191.7 lb [87.1 kg] (3/12/18) standing weight
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Intake PO Fluids	605 (ml)
Intake - NT Tube	0 (ml)
Intake - Irrigation	0 (ml)
Intake - IV Fluids	0 (ml)
Intake - IV Meds	1030 (ml)
Intake - IV Blood...	0 (ml)
IV Nutrition	765 (ml)
Intake	0 (ml)
	2400 (ml)
Total - Output	**Total**
Urine Output	3075 (ml)
Output - Blood	0 (ml)
Chest Tube Drains...	0 (ml)
Drain Output	0 (ml)
Emesis Output	0 (ml)
GI Tube Output	0 (ml)
Stool Output	745 (ml)
Output - Do Not C...	0 (ml)
	3820 (ml)

Assessment/Management of Complications: Monitoring PN

Laboratory Monitoring:

- New PN and Unstable clinical condition:
  - CBC, BMP, magnesium and phosphorus levels should be monitored daily
- Stable patients with no required changes in PN for 1 week
  - CBC, BMP, magnesium, phosphorus levels should be monitored every 2 – 7 days
- Triglycerides, LFTs and Prothrombin time should be monitored weekly (1)

Assessment/Management of Complications: Labs Day 2 of PN

GLUCOSE^NE	117	H	mg/dL	70 - 110
SODIUM^NE	136	L	mmol/L	137 - 145
POTASSIUM^NE	3.8		mmol/L	3.6 - 5.0
CHLORIDE^NE	104		mmol/L	98 - 107
CARBON DIOXIDE^NE	29		mmol/L	23 - 33
ANION GAP^NE	6	L	mmol/L	10 - 20
UREA NITROGEN^NE	21	H	mg/dL	9 - 20
eGFR^NE	134			Ref: >=60
CREATININE^NE	0.6	L	mg/dL	0.7 - 1.5
TOTAL PROTEIN^NE	4.1	L	g/dL	6.3 - 8.2
ALBUMIN^NE	1.9	L	g/dL	3.5 - 5.0
A/G RATIO^NE	0.9	L		1.2 - 1.6
CALCIUM,TOTAL^NE	7.7	L	mg/dL	8.4 - 10.2
PHOSPHORUS^NE	1.6	L	mg/dL	2.6 - 4.9
MAGNESIUM^NE	2.2		mg/dL	1.6 - 2.3
BILIRUBIN,TOTAL^NE	0.5		mg/dL	0.1 - 1.3
ALKALINE PHOSPHATASE^NE	53		IU/L	38 - 126
AST^NE	19		IU/L	15 - 46
ALT^NE	20		IU/L	11 - 66

Assessment/Management of Complications:

- Pt now with low calcium and phosphorus levels
- Corrected Calcium:
  [(4.0 – current albumin level) X 0.8] + calcium level
- Replacing phosphorus:
  - Replace outside TPN
  - Provide _____ mmol IV ___ PO4 over_____ hours

Assessment/Management of Complications:

Considerations regarding electrolyte management:

- Determine likely etiology
  - Body fluid losses
  - IVF contribution
  - Renal function
  - Acid/base balance
- Consider acute changes vs trends
  - Start with replacement outside of TPN
  - If trend exists, adjust amount in TPN

Application: Goal PN

Base Solution:
- 100g protein (400 kcals)
  - 1000ml 10% AA solution
- IVFE: 250ml 20% = 50g fat (500 kcals)
- How many grams of dextrose to meet energy needs?
  - ____g dextrose
  - ____ml 70% dextrose solution
- Volume of AA, Dextrose, estimated for lytes = ____ ml
- Desired volume: 2370ml – 500ml (IV meds) = 1870ml
  1870ml – _____ml = ____ ml sterile water

Assessment/Management of Complications:

Pt now with hyponatremia, lower extremity edema, increased weight and a bubbling sound upon auscultation of his lungs.

What is your concern?

How might you want to adjust the PN?

Assessment/Management of Complications:

Base Solution:
- 100g protein (400 kcals)
  - _____ml __% AA solution
- IVFE: 250ml 20% = 50g fat (500 kcals)
- How many grams of dextrose to meet energy needs?
  - 325g dextrose
  - 464ml 70% dextrose solution (1105 kcals)
- Volume of AA, Dextrose, estimated for lytes = ____ ml
- Desired volume: as concentrated as possible

Assessment/Management of Complications:

When volume changes, electrolyte quantities typically need to be adjusted

__ mmol K Phos (37mEq K)	40 mEq KCL
__ mEq NaCl	__ mEq Na Acetate
10 mEq magnesium sulfate	10 mEq calcium gluconate

* Rule of thumb to prevent Ca++/PO4 precipitation

[mMol of Phosphorus x 2] + mEq of calcium = < 50 per liter

Assessment/Management of Complications:

One of JD's doctors called you and said that fat just makes people fat and that he does not want his patients to receive any lipids despite the length of time the patient will be on PN. He wants you to stop the IVFE.

What concerns do you have?

What might you be looking for while examining your patient in the next few weeks?

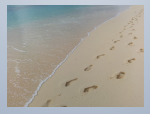
Assessment/Management of Complications:

Prevention of Essential Fatty Acid Deficiency
- Linoleic acid and alpha-linolenic acid cannot be synthesized by the body
- EFAD: scaly dermatitis, alopecia, hepatomegaly, thrombocytopenia, fatty liver, anemia
- Can occur within 1-3 weeks of IVFE-free PN
- Can be prevented with 250ml 20% IVFE twice a week of soybean oil based lipids

Assessment/Management of Complications:

Thankfully, after your intervention JD was put back on his IVFE and remained on his goal solution for the next 3 weeks. The next time his labs were checked his triglyceride level came back at 500mg/L.

What is your concern and what steps might you take?



Assessment/Management of Complications:

Hypertriglyceridemia

- Can cause impaired immune response, alter pulmonary hemodynamics, increase risk of pancreatitis
- May be caused by dextrose overfeeding or rapid infusion of IVFE (> 110mg/kg/hour)
- Limit to < 30% of total energy; 1 g/kg/day
- Provide over not less than 8-10 hours (25mL/hr over 10 hours)
- Assess for possible carnitine deficiency
- Change the type of lipids provided
- DC or reduce the frequency of lipids (1, 6)
- OR could try Smoflipid of 126 – 254ml/day
  - Contains Soybean Oil, MCT, Olive Oil and Fish Oil

Assessment/Management of Complications: Other Potential Complications

- PN-Associated Liver Complications
  - Decrease dextrose
  - Decrease IVFE
  - Provide balance of dextrose and IVFE
  - Cyclic PN infusion (1)
- Metabolic Bone Disease
  - Avoid high doses of protein or excessive sodium
  - Provide 10-15 meq/d calcium and 20-40mmol/d phosphorus
  - Treat metabolic acidosis
  - Adequate magnesium and copper intake
  - Minimize aluminum contamination (1)

Transitional Feeding/Discontinuation of PN

After 1 more week of TPN and receiving the IVFE only twice a week, JD's triglyceride level came down to 250mg/dL and he was taken to surgery to for a small bowel resection. After surgery, his surgeons advanced his diet to Advance Diet as Tolerated (per ERAS protocol). On post-op day 1 JD was eating about 25% of a soft diet.

At this time how might you adjust his TPN?

Transitional Feeding/Discontinuation of PN

- PN discontinued when able to tolerate solid food
  - Generally younger, well-nourished patients
  - Free of malignancy
  - Able to tolerate po intake within past couple weeks
- Transitional feeding
  - Elderly, debilitated, malignancy, not expected to eat well
  - PN may have negative effect on appetite
  - When po intake provides ~ 500 kcals/day, the protein and CHO amounts in PN should be decreased accordingly
  - When po intake >= 60% of goal, PN may be stopped (1)

Transitional Feeding/Discontinuation of PN

The next day JD's appetite was much improved and his intake of a regular diet was about 50 – 75% of meals and nutritional supplements.

What would your plan be for his nutrition support at this time?

Summary:

PN can be a safe and effective source of nutrition for patients that are unable to absorb adequate nutrition through their GI tract. In order to prevent the morbidity and mortality that can be associated with PN, it is imperative that providers have adequate knowledge and training in safe PN prescribing. PN outcomes and safety are improved when an active Nutrition Support Team is helping to manage the PN and guidelines such as ASPEN's Safe Practices for Parenteral Nutrition are followed.

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