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Clinical Meeting & Exhibition

Strategies for Successful Parenteral Nutrition Order Writing

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Disclosure

The program chair and presenters for this continuing education activity have reported no relevant financial relationships, except:

- **Karrie Derenski** - Baxter: Speaker's Bureau

Learning Objectives

At the conclusion of the presentation, the learner will be able to:

- Calculate an individualized parenteral nutrition formula for a patient incorporating age, disease, and unique nutrition requirements into design.
- Assess skills for monitoring parenteral nutrition formula from initiation to achievement of composition goal.
- Justify strategies for managing electrolyte abnormalities.
- Describe safe parenteral nutrition compounding practices and parenteral nutrition formula design.

Parenteral Nutrition: Who needs PN and what does everyone need in the bag?

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Presentation Outline

- Indications
- Access considerations
- Volume requirements and limitations
- Caloric requirements
- Components of parenteral nutrition
  - Macronutrients – Initiation and Advancement

Who needs parenteral nutrition (PN)?

Is PN appropriate?

- Key questions to ask
  - Can gastrointestinal (GI) tract be utilized?
  - Can GI tract be accessed?
  - Nutritional status of patient?
  - Patient clinically stable?
  - Palliative care approach planned?

Absolute Indications

- Inaccessible GI tract
- Short bowel syndrome (SBS)
- Non-operative mechanical bowel obstruction
- Multiple enterocutaneous fistulas or high output single fistula
- Severe paralytic ileus

Braunschweig CL, et al. Am J Clin Nutr 2001;74:534-542.
Zaloga GP. Lancet 2006;367:1101-1111.
Koretz RL, et al. Gastroenterology 2001;121:970-1001.

Relative Indications

- Severe radiation enteritis
- Refractory diarrhea or vomiting
- Pseudo-obstruction
- Gut ischemia
- Intolerance to enteral feedings
- Failure to achieve enteral goals in 7 days

Braunschweig CL, et al. Am J Clin Nutr 2001;74:534-542.
Zaloga GP. Lancet 2006;367:1101-1111.
Koretz RL, et al. Gastroenterology 2001;121:970-1001.
McClave SA, J Parent Ent Nutr 2009;33:277.

Other Considerations in Pediatrics

- Prematurity
- Low birth weight infants (< 2500 grams)
- Unable to receive enteral feedings
  - Extremely premature = more than 1-2 days
  - Neonates = more than 2-3 days
  - Pediatric = more than 5-7 days
- Congenital anomalies of GI tract
- Congenital heart disease
- Necrotizing enterocolitis
- Critical illness with hemodynamic instability
- Extracorporeal membrane oxygenation (ECMO)

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Most Urgent Need

- Very low weight birth weight prematurity infants
  - < 1500 grams
  - Ideally within first few hours of life
  - Use of starter/vanilla/base PN

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

NICU Starter PN

- Known by various names: Starter PN, Vanilla PN, Base Solution
- Provides immediate protein for extremely premature neonate
- Often contains
  - Dextrose and Amino acids
    - Usually Dextrose 5-10% + Amino acids ~3-4%
      - When consider initial fluids for neonate, gives between 2-3 g/kg/day of amino acids
- Can also contain
  - Heparin, calcium, multi-vitamins

Clinical Examples – Who needs PN?

- Patient #1 – 47 yo female (wt = 85 kg) with abdominal trauma requiring minimum 14 day NPO status
- Patient #2 – 8 yo male (wt = 35 kg) s/p uncomplicated appendectomy who has been NPO for 2 days
- Patient #3 – 34 wk gestational age (GA) neonate (wt = 2.3 kg) born 2 hours ago
- Patient #4 – 23 wk GA neonate (wt = 0.654 kg) born 2 hours ago

Clinical Examples – Who needs PN?

- Patient #1 – 47 yo abdominal trauma
  - Yes; NPO status for > 7 days
- Patient #2 – 8 yo s/p appendectomy
  - No; NPO status for only 2 days
- Patient #3 – 34 wk GA neonate
  - No; Will likely be able to start feeds and advance quickly
- Patient #4 – 23 wk GA neonate
  - Yes; Risk of severe negative nitrogen balance and extended period of time until full feeds because of extreme prematurity; initiate starter PN immediately

What type of IV access does the patient have?

IV Access for PN

- Determines allowable osmolarity for PN solution
  - Peripheral
    - Pediatric/Adult max = 900-1000 mOsm/L
    - Neonates = up to 1100-1200 mOsm/L
  - Central
    - Limit???
- Osmolarity calculated based on components in solution

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012
A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Osmolarity of PN

Nutrient	Osmolarity
Amino acid	100 mOsm/%
Dextrose	50 mOsm/%
IVFE (20%)	1.3-1.5 mOsm/g
Sodium (acetate, chloride)	2 mOsm/mEq
Sodium phosphate	3 mOsm/mEq Na
Potassium (acetate, chloride)	2 mOsm/mEq
Potassium phosphate	1.7-2.7 mOsm/mEq K
Magnesium sulfate	1 mOsm/mEq
Calcium gluconate	1.4 mOsm/mEq

Remember to think per liter!

Mattox TW, et al. *Pharmacotherapy: A Pathophysiologic Approach, 9e.* New York, NY: McGraw-Hill; 2014.

Patient needs PN but how much volume?

Volume is everything. . .

- Must consider
  - Fluid status of patient
    - Dehydrated vs. fluid restricted?
  - What else is infusing into patient?
    - IV carriers
    - Intermittent IV medications
    - Continuous infusions
  - What else is the patient receiving?
    - Enteral feeds
    - Enteral medications
    - Flushes

Calculating Maintenance IV Fluids (MIVFs)

- Holliday-Segar method (mL/day)
  - Based on dry/dosing weight
  - Assumes for each 100 calories metabolized, 100mL water required
  - First calculate caloric expenditure
  - Daily fluid requirements (in mLs) equivalent to daily caloric expenditures (in Kcals)
- 4 – 2 – 1 rule (mL/hr)
  - Used by most medical residents
  - Does not completely match calculations from Holliday-Segar method

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012
A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Holliday-Segar Method

	Daily mL Requirements
Premature Infants	75-120 mL/kg
Term Infants	60-120 mL/kg
3-10 kg (> 1 month of age)	100 mL/kg
10-20 kg	1000 mL + 50 mL/kg for every kg between 10-20 kg
> 20 kg	1500 mL + 20 mL/kg for every kg > 20 kg

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

4 – 2 – 1 Rule

	mL Requirements
< 10 kg	4 mL/kg/hr
10-20 kg	40 mL/hr + 2 mL/kg/hr for every kg between 10-20 kg
> 20 kg	60 mL/hr + 1 mL/kg/hr for every kg > 20 kg

- Be aware first 10 kg only give 96 mL/kg/day
- Why some slight differences between two methods

Calculating Maintenance IV Fluids – Other Ways

- 1- 1.5 mL per every calorie provided (mL/day)
  - First calculate caloric expenditure
  - Daily fluid requirements (in mLs) equivalent to daily caloric expenditures (in kcals)
  - May not be useful if hypo-caloric or permissive underfeeding strategies in use
- mL/Kg (mL/day) use estimated feeding weight
  - > 65 years old = 25 mL/kg
  - 55-65 years old = 30 mL/kg
  - 30-55 years old = 35 mL/kg
  - 15-30 years old = 40 mL/kg

A.S.P.E.N. Parenteral Nutrition Workbook, 2016.

Volume of PN

- PN part of maintenance fluids
- PN total volume =

  (Total 24hr fluids – fluids from drips

  – intravenous fat emulsions – feeds)
- 24 hour maintenance fluid calculations general calculated in mL/kg/day
- Use weight, In's/Out's, and appropriate physical exam to assess hydration status

Clinical Examples – How much volume?

- Patient #1 – 47 yo weighing 85 kg
  - Using 4-2-1 rule,
    - 60 mL/hr + 65mL/hr = 125 mL/hr (3000 mL/day)
- Patient #4 – 23 wk GA neonate weighing 0.654 kg
  - Using Holliday-Segar,
    - 75 mL/kg/day (b/c only 2 hrs old) X 0.654 kg = 49.05 mL/day or ~ 2 mL/hr

How many calories does one need?

Caloric Requirements – Adult

Indirect calorimetry

Predictive equations

- Harris-Benedict
- Mifflin-St. Jeor
- Ireton-Jones
- Penn State
- Penn State modified

kcal/kg

Patient Type	kcal/kg/day
Well nourished, healthy, maintenance	20-25
Critically ill, metabolic stress, trauma, undernourished	25-30 (up to 35)
Critically ill obese (BMI ≥30)	11-14 ABW 22-25 IBW
Acute renal failure, chronic kidney disease	25-30 (up to 35)

A.S.P.E.N. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. JPEN. 2002;26(suppl 1):SA22
A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012
Derenski, et al. Nutr Clin Pract. 2016;31(5):578-595

Caloric Requirements – Pediatrics

Age (years)	kcal/kg/day
0-1	90-120
1-7	75-90
7-12	60-75
12-18	30-60
> 18	25-30

A.S.P.E.N. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. JPEN. 2002;26(suppl 1):SA25

What's in a PN?

PN Components

- Macronutrients
  - Dextrose
  - Amino acid
  - Intravenous fat emulsion (IVFE)
- Micronutrients
  - Electrolytes
  - Vitamins
  - Trace elements

Macronutrients – Amino Acids (AA)

- Source of energy and nitrogen for protein synthesis
- Caloric value: 4 Kcal/g

Macronutrients – Dextrose (hydrous)

- Source of energy and carbon skeletons for tissue accretion
- About 50% of dextrose is oxidized for energy
- 40% - 60% of total daily caloric requirements should come from carbohydrates
- Caloric value: 3.4 Kcal/g

Macronutrients – IVFE

- Source of condensed calories and essential fatty acids (linoleic acid, linolenic acid)
- Fatty acids → components of biological membranes and essential for central nervous system development
- Lipid particles cleared similar to clearance of naturally occurring chylomicrons
- Caloric value: 2 Kcal/mL (for 20% solution) or 10 Kcal/g
  - Usually 30-35% of total daily caloric requirements

Where do I start with macronutrients? Where do I go with them?

Units for Orders – Macronutrients

- Adults
  - g/day
- Neonatal/Pediatric
  - g/kg/day
  - Glucose as mg/kg/min

Ayers, et al. , A.S.P.E.N. Parenteral Nutrition Safety Consensus Recommendations *JPEN*. 2013

General Rules for Initiating Macronutrients

- Volume = start at goal for adults/pediatrics based on fluid balance of patient
  - Neonates = usually start lower and advance to goal
- Amino acids = start at goal
- Dextrose = start low and go slow
  - Dependent on glucose infusion rate (GIR)
- IVFE = start at 1 g/kg/day and advance to goal

A.S.P.E.N. Parenteral Nutrition Handbook, 2nd edition, 2014.
A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Calculating Glucose Infusion Rate (GIR)

$$Glucose\ in fusion\ rate\ (mg/kg/min) = \frac{(dextrose\ in\ g/kg/day) \times \left(\frac{1000\ mg}{1\ g}\right)}{\left(\frac{24\ hr}{1\ day}\right) \times \left(\frac{60\ min}{1\ hr}\right)}$$

or

$$Glucose\ in fusion\ rate\ (mg/kg/min) = \frac{(\%\ dextrose) \times (PN\ volume)}{(weight\ in\ kg) \times (144)}$$

or

$$Glucose\ in fusion\ rate\ (mg/kg/min) = \frac{(\%\ dextrose) \times (PN\ rate) \times (0.167)}{(weight\ in\ kg)}$$

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015
A.S.P.E.N. Parenteral Nutrition Workbook, 2016

Macronutrient Initiation and Advancement in Adult

Initiation		Advance by	Goals
Protein, g /kg/day	0.8-2	--	0.8-2
Dextrose as GIR, mg/kg/min	2.5-3	1-2	4-6
IVFE, g/kg/day	1	1	1-2 Max LIR 0.11g/kg/hr

GIR, glucose infusion rate; LIR, lipid infusion rate

A.S.P.E.N. Parenteral Nutrition Handbook, 2nd edition, 2014
A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Macronutrient Initiation and Advancement in Pediatric/Adolescent

Initiation			Advance by		Goals	
Age, yr	1-10	11-18	1-10	11-18	1-10	11-18
Protein, g/kg/day	1.5-2.5	0.8-2	--	--	1.5-2.5	0.8-2
Dextrose as GIR, mg/kg/min	3-6	2.5-3	2-3	1-2	8-10	5-6
IVFE, g/kg/day	1-2	1	0.5-1	1	2-2.5	1-2

GIR, glucose infusion rate; LIR, lipid infusion rate

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Macronutrient Initiation and Advancement in Neonate

Initiation			Advance by		Goals	
Infants (< 1 y)	Preterm	Term	Preterm	Term	Preterm	Term
Protein, g/kg/day	3-4	2.5-3	--	--	3-4	2.5-3
Dextrose as GIR, mg/kg/min	6-8	6-8	1-2[a]	1-2[a]	10-14 (max 14-18)	10-14 (max 14-18)
IVFE, g/kg/day	0.5-1	0.5-1	0.5-1	0.5-1	3 (max LIR 0.15 g/kg/hr)	2.5-3 (max LIR 0.15 g/kg/hr

GIR, glucose infusion rate; LIR, lipid infusion rate

[a] Adapted from original reference

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Clinical Examples – Initiating Macronutrients

- Patient #1 – 47 yo weighing 85 kg
  - Amino acids
    - 1 g/kg/day = 85 g/day
  - Dextrose
    - 300 g/day → GIR = 2.5 mg/kg/min
  - IVFE
    - 1 g/kg/day = 85 g/day → 425 mL/day
- Patient #4 – 23 wk GA neonate weighing 0.654 kg
  - Amino acids
    - 4 g/kg/day
  - Dextrose
    - GIR = 6 mg/kg/min → 8.6 g/kg/day
  - IVFE
    - 1 g/kg/day = 0.654 g/day → 3.27 mL/day

Clinical Examples – Advancing Macronutrients

- Assuming labs within normal limits (WNL)
- Patient #1 – 47 yo weighing 85 kg
  - Amino acids
    - Continue at 85 g/day → 340 kcal/day
  - Dextrose
    - Advance to 400 g/day → GIR = 3.3 mg/kg/min → 1360 kcal/day
  - IVFE
    - Continue at 85 g/day → 850 kcal/day
  - Total kcals = 2550 kcal/day = 30 kcal/kg/day
    - Dextrose = 53%
    - IVFE = 33%

Clinical Examples – Advancing Macronutrients

- Assuming labs WNL
- Patient #4 – 23 wk GA neonate weighing 0.654 kg
  - Amino acids
    - Continue at 4 g/kg/day → 16 kcal/kg/day
  - Dextrose
    - Advance to GIR of 8 mg/kg/min → 11.5 g/kg/day → 39.1 kcal/kg/day
  - IVFE
    - Advance to 2 g/kg/day = 1.3 g/day → 6.5 mL/day → 20 kcal/kg/day
  - Total kcals = 75.1 kcal/kg/day
    - Dextrose = 52%
    - IVFE = 27%

Parenteral Nutrition Micronutrients: Electrolytes, Vitamins and Trace Elements

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Most Common Questions…

- How do I determine electrolyte doses for parenteral nutrition orders?
- What do I do when the electrolytes are abnormal?
  - At parenteral nutrition initiation
  - During parenteral nutrition therapy

Patient Assessment

- Electrolyte panel ☺
  - Look at both absolute lab value and trends
  - Abnormal electrolyte panel may lead to delay in parenteral nutrition initiation
- Gastrointestinal conditions / fluid losses
- Renal function (normal urine output 0.5-2 mL/kg/hr)
- Medication profile (don't forget IV fluids)
- Nutrition history (risk of refeeding syndrome?, weight)
- Past medical and surgical histories

Normal Electrolyte Concentrations

Electrolyte	Newborn	Pediatric	Adult
Sodium (mEq/L)	133-145	135-145	135-145
Potassium (mEq/L)	4-6.2	3.4-4.7	3.5-5
Chloride (mEq/L)	95-105	98-108	98-108
CO_2 (mEq/L)	17-24	22-26	23-30
Calcium (mg/dL)	7-12	8.6-10	8.6-10
Phosphorus (mg/dL)	4.2-9	4.5-5.5	2.5-4.5
Magnesium (mg/dL)	1.5-2.3	1.5-2.3	1.8-2.4

Variations in lab values exist between institutions

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012
A.S.P.E.N. Fluids, Electrolyte, and Acid-Base Disorders Handbook, 1st edition, 2015.

Replacement Fluids for Upper GI Losses

		mEq/L			
Body Fluid Type	Volume (mL/day)	Na	Cl	K	HCO_3
Saliva	1000-1500	10	10	26	0
Stomach/NG (↑acid)	1000-9000	20	120	10	0
Stomach/NG (↓acid)	1000-2500	80	90	15	0

Ideal replacement fluid:

0.225% (38 mEq/L) or 0.45% (77 mEq/L) NaCl plus KCl 10-20 mEq/L

Replacement Fluids for Lower GI Losses

		mEq/L			
Body Fluid Type	Volume (mL/day)	Na	Cl	K	HCO_3
Duodenum	Variable	140	80	5	0
Pancreas	Variable	140	75	5	115
Bile	Variable	145	100	5	35
Ileum	3000	140	104	5	30
Colon	Variable	60	40	30	0

Ideal replacement fluid:

0.9% (154 mEq/L) NaCl or Lactated Ringer's (130 mEq Na, 4 mEq K, 110 mEq Cl, 3 mEq Ca, 28 mEq Lactate per/L)

Refeeding Syndrome

- Metabolic and physiological shifts of fluid, electrolytes, and minerals from ECF to ICF as a result of dextrose administration
- Extracellular to intracellular shift in K, Mg, and Phos (levels ↓)
- Decreased serum Na due to fluid retention and dilution
- Patients at risk
  - Malnourished
  - Poor oral intake > 7 days
  - Severe metabolic stress
- Prevention is key!

Nutr Clin Pract 2005;20:625-633.

Designing the micronutrient part. . .
(get out your paintbrush!)

Typical Electrolyte Requirements for Adult Patients

Electrolyte	Requirements
Sodium	60-100 mEq/day or 1-2 mEq/kg/day
Potassium	60-100 mEq/day or 1-2 mEq/kg/day
Chloride	As needed to maintain acid-base balance
Acetate	As needed to maintain acid-base balance
Calcium	10-15 mEq/day
Phosphorus	20-40 mMol/day or 0.25-0.5 mmol/kg/day
Magnesium	8-20 mEq/day or 0.25-0.5 mEq/kg/day

*Consider lower doses for those with renal insufficiency

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012

Typical Electrolyte Requirements for Pediatric Patients

Electrolyte	Preterm Neonates	Term Neonates/ Infants/Pediatrics
Sodium	2-5 mEq/kg/day	
Potassium	2-4 mEq/kg/day	
Chloride	As needed to maintain acid-base balance	
Acetate	As needed to maintain acid-base balance	
Calcium	2-4 mEq/kg/day	0.5-4 mEq/kg/day
Phosphorus	1-2 mMol/kg/day	0.5-2 mMol/kg/day
Magnesium	0.3-0.5 mEq/kg/day	

Don't forget what "normal" IV fluids are for a neonate

- 1st 24hrs of life = no electrolytes (i.e., D10W)
- After 24hrs, add sodium (i.e., D10 0.2%NS)

A.S.P.E.N. Pediatric Nutrition Support Core Curriculum, 2nd edition, 2015

Available Micronutrients

Electrolyte	Salt Form
Sodium	Chloride, acetate, phosphate
Potassium	Chloride, acetate, phosphate
Chloride	Sodium, potassium
Acetate	Sodium, potassium
Calcium	Gluconate*, chloride
Phosphorus	Sodium, potassium
Magnesium	Sulfate*, chloride

*Preferred salt forms for use in PN formulations

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012

Electrolyte Dosing Considerations

- Renal function
  - Impairment: start at 50% recommended dose
- Obesity
  - Adjusted body weight for weight-based dosing
- Electrolyte disorders
  - Acute vs. chronic disorder
  - Symptomatic?
  - More than 1 disorder is usually present
- Wide vs. narrow therapeutic window

Kraft MD, et al *AJHP* 2005;62:1663-82.

Magnesium

- Hypomagnesemia reported in 6.9-47% of hospitalized patients
  - Primarily from GI and renal losses
- 8.12 mEq $MgSO_4$ intravenously increases serum ~0.1 mg/dL
- Infuse at rate $\leq$ 8 mEq/hour
- Provide as magnesium sulfate
- Hypomagnesemia affects potassium and calcium homeostasis
- Maintaining high-normal range serum Mg $\leq$ 2.7 mg/dL reduces ventricular ectopy & improves K^+ retention

Kraft MD, et al *AJHP* 2005;62:1663-82; Crit Care Med 1996; 24: 38-45

Magnesium Dosing Considerations

< 0.25 mEq/kg/day	0.25 – 0.5 mEq/kg/day	> 0.5 mEq/kg/day
Renal failure (AKI, CKD, ERSD)	Normal dosing range	Alcohol abuse
Excessive intake		Diarrhea, malabsorption
Hypermagnesemia		Hypomagnesemia
<u>Medications</u> Mg-containing antacids lithium		<u>Medications</u> aminoglycosides amphotericin B cyclosporine/tacrolimus cisplatin diuretics (loop/thiazide) foscarnet insulin PPIs (chronic)
Tumor lysis syndrome		Refeeding syndrome
Wide Therapeutic Index!		

Phosphate

- Hypophosphatemia reported in 30-100% of patients receiving nutrition support
- 20 mmol of PO_4 intravenously increases serum ~ 1 mg/dL
- Infuse at rate $\leq$ 7 mmol/hour
- Provide as either sodium or potassium salt
  - 1 mmol K_3PO_4 = 1.5 mEq K^+
  - 1 mmol $NaPO_4$ = 1.33 mEq Na^+
- Severe hypophosphatemia < 1 mg/dL associated with hemolysis and reduced diaphragmatic contractility
- Hidden PO_4 in FreAmine III, HepatAmine, Hepatasol amino acids

Kraft MD, et al *AJHP* 2005;62:1663-82

Phosphate Dosing Considerations

< 0.25 mmol/kg/day	0.25 mmol/kg/day	> 0.25-0.5 mmol/kg/day
Renal failure (AKI, CKD, ERSD)	Normal dosing range	Alcohol abuse
Excessive intake		Chronic malnutrition
Long term immobilization		Vitamin D deficiency
Hyperphosphatemia		Hypophosphatemia
<u>Medications</u> phos-containing antacids vitamin D excess		<u>Medications</u> diuretics (loop) foscarnet glucocorticoids insulin
Tumor lysis syndrome		Refeeding syndrome
Wide Therapeutic Index!		

Potassium

- Hypokalemia most common electrolyte abnormality in practice
  - Primarily from GI and renal losses
- Most common cause of hyperkalemia is over supplementation
- Homeostasis regulated by insulin, aldosterone, beta-adrenergic catecholamines, acid/base status
- 10 mEq of K intravenously increases serum ~ 0.1 mEq/dL
  - Normal renal and GI function
- Infusion rate dependent on line status and location of patient
  - 10 mEq/hr: no cardiac monitoring / peripheral IV access
  - 20 mEq/hr: cardiac monitoring / central IV access

Kraft MD, et al *AJHP* 2005;62:1663-82
Gennari FJ. N Engl J Med 1998; 339: 451-8

Potassium Dosing Considerations

< 0.5-1 mEq/kg/day	1-2 mEq/kg/day	> 2 mEq/kg/day
Renal failure (AKI, CKD, ERSD)	Normal dosing range	Metabolic alkalosis
Excessive intake		Poor intake
Metabolic acidosis		Diarrhea, malabsorption
Hyperkalemia		Hypokalemia
<u>Medications</u> ACEI/ARBs cyclosporine/tacrolimus K-sparing diuretics (amiloride, spironolactone) NSAIDs trimethoprim		<u>Medications</u> beta agonists insulin amphotericin B diuretics (loop/thiazide) hypomagnesemia hydrocortisone
Tumor lysis syndrome		Refeeding syndrome
NARROW Therapeutic Index!		

Sodium

- Hyponatremia is a common electrolyte abnormality varying in presentation
- Workup
  - Serum and urine osmolality
  - Extracellular fluid volume measurement
- Correct serum slowly – no more than 8 mEq/L/day
- Focus on treatment of the underlying cause
- Symptomatic hyponatremia requires 3% NaCl dosing
- Hidden sodium in Aminosyn amino acid products

Spasovski G, et al. *Nephrol Dial Transplant* 2014;0:1-39;
Verbalis JG, et al. *Am J Med*. 2007; 120: S1-S21.

Sodium Dosing Considerations

< 38 mEq/L	38-77 mEq/L	≥ 120-130 mEq/L
Heart failure	Normal dosing range	Cerebral salt wasting
Edema/anasarca		High output fistula
Ascites		Short bowel syndrome
Hypernatremia		Severe diarrhea
Refeeding syndrome		
	Wide Therapeutic Index!	

Chloride vs. Acetate

- It's all about acid-base!
  - Metabolic acidosis: acetate > chloride
  - Metabolic alkalosis: chloride > acetate
- Chloride is the predominant salt used in parenteral nutrition
  - Amino acid solutions are acetate-based
- Acetate converted by liver to bicarbonate
- Bicarbonate is incompatible with parenteral nutrition

Amino Acid Brand	Cl (mEq/L)	Acetate (mEq/L)
Aminosyn II® 15%	0	107.6
Aminosyn II® 10%	0	71.8
FreAmine III® 10%	0	89
Travasol® 10%	40	88

Chloride Dosing Considerations

< 38 mEq/L	38-77 mEq/L	≥ 120-130 mEq/L
Metabolic acidosis	Normal dosing range	Metabolic alkalosis
Severe diarrhea		Nasogastric losses
		Refractory vomiting
		Diuretic use (loop/thiazide)
	Wide Therapeutic Index!	

Acetate Dosing Considerations

0 mEq/L	38-77 mEq/L	≥ 110 mEq/L
Metabolic alkalosis	Normal dosing range	Metabolic acidosis
Dehydration		High output fistula
Diuretic use (loop/thiazide)		Severe diarrhea or ostomy losses
Severe vomiting		Short bowel syndrome
Large nasogastric losses		Urinary diversion
		Renal bicarbonate wasting
	Wide Therapeutic Index!	

Calcium

- Hypocalcemia common, especially in critically ill
- Ca^{2+} and PO_4 important for bone mineralization and growth
  - Ca^{2+} may be removed for short periods in adults
- Restrict if Ca-PO_4 product > 55 mg^2/dL^2
- Gluconate salt preferred in parenteral nutrition and peripheral IV
  - Less elemental calcium on a per gram basis
  - 1 g calcium gluconate = 4.65 mEq Ca^{2+}
  - 1 g calcium chloride = 13.6 mEq Ca^{2+}
- Albumin-corrected calcium equations not reliable in critically ill

Kraft MD, et al *AJHP* 2005;62:1663-82

Calcium Dosing Considerations

< 5 mEq/L	10-15 mEq/L	> 15 mEq/L (> 1000 mg elemental Ca^{2+}/day)
Hypercalcemia	Normal dosing range	Severe hypocalcemia
Hyperphosphatemia		Severe pancreatitis
Metastatic cancer		Parathyroidectomy
Prolonged immobilization		<u>Medications</u> foscarnet pentamidine
$CaPO_4$ product > 55 mg^2/dL^2		Vitamin D deficiency
Narrow Therapeutic Index!		

Let's work up a patient. . .

PN Electrolyte Case

- 58 year old female with post op ileus (day 7).
- PMH: HTN, C-section x 2
- Vitals: BP 125/68, HR 75, RR 16, Weight 60 kg, Height 65 in
- Ins/Outs: IV 3210 mL / Urine 2200 mL, NG 1000 mL, no stool
- Medications:

  D5 ½ NS + 20 mEq KCl/L at 100 mL/hr

  Metoprolol 5 mg IV every 6 hr

  Famotidine 20 mg IV every 12 hr

  Morphine sulfate 1 mg IV every 4 hr prn

  Ondansetron 8 mg IV every 8 hr prn
- Nutrition history:

  PO intake good prior to admission

  No recent weight loss
- Social history unremarkable

Lab	Result	Lab	Result
Na	136	BUN	12
K	3.9	SCr	0.9
Cl	105	Glu	90
CO_2	25	Ca	9
Mg	1.6	Phos	2.8

PN Electrolyte Case - Patient Assessment

- Electrolyte panel
  - Magnesium 1.5 (low end of normal), others (normal)
  - No need to delay PN start based upon labs ☺
- Gastrointestinal conditions / fluid losses
  - NG tube in place – 1 L output
    - ~1/2 NS or 77 mEq Na/L plus 10 mEq KCl/L
  - No stool
- Renal function
  - 2200 mL/day = 1.5 mL/kg/hr (normal)

PN Electrolyte Case - Patient Assessment

- Medication profile (don't forget IV fluids)
  - Not receiving medications known to affect electrolytes
  - Morphine and ondansetron can cause constipation
  - IV fluids: D5 ½ NS + 20 mEq KCl/L at 100 mL/hr (~2.4L/day)
    - ½ NS = 77 mEq Na/L
    - 20 mEq KCl/L x 2.4 L = 48 mEq KCl from IV fluids
- Nutrition history (risk of refeeding syndrome?, weight)
  - No previous weight loss – current weight 60kg (BMI 22)
  - NPO x 7 days – at risk for refeeding syndrome
- Past medical, surgical, and social histories unremarkable

PN Electrolyte Case – Macronutrients

- 90 g protein (goal)
- 120 g dextrose (2 g/kg/day since at refeeding risk)
- 50 g IV fat emulsion
- Total PN volume = 1320 mL/day (55 mL/hr)
- Once PN starts, change IV fluids to ½ NS + PN = 100 mL/hr

- Now off to the electrolytes….

PN Electrolyte Case – Magnesium

- Magnesium is 1.6 mg/dL (normal range 1.8-2.4 mg/dL)
- Standard dosing
  - 8-20 mEq/day
  - 0.25-0.5 mEq/kg/day (15 – 30 mEq magnesium/day)
- PN dose = 24 or 32 mEq magnesium sulfate
  - Stock magnesium sulfate 4.06 magnesium sulfate/mL

PN Electrolyte Case – Phosphorus

- Phos 2.8 mg/dL (normal range 2.5-4.5 mg/dL)
- Standard dosing
  - 20-40 mEq/day
  - 0.25-0.5 mEq/kg/day (15 – 30 mEq phosphorus/day)
- Sodium and potassium are normal, so just choose a salt
  - Potassium phosphate (K Phos)
- PN dose = 24 or 30 mmol K Phos
  - Stock K Phos is 3 mmol Phos/mL

PN Electrolyte Case – Potassium

- Potassium is 3.9 mmol/L (normal range 3.5-5 mmol/L)
- +NG output (loss of Cl and K)
- IV fluids provide 48 mEq KCl/day
- Standard dosing 1-2 mEq/kg/day (60 – 120 mEq K/day)
- PN total potassium dose = 60-80 mEq/day
  - Subtract K Phos dose
    - Remember 1 mmol K Phos = 1.5 mEq K
    - 30 mmol K Phos = 45 mEq K
  - Choose KCl instead of K Acetate due to NG losses
    - PN KCl dose = 15-35 mEq KCl $\Rightarrow$ 30 mEq

PN Electrolyte Case – Sodium

- Sodium is 139 mmol/L (normal range 135-145 mmol/L)
- Tolerating ½ NS in IV fluids (77 mEq/L)
- +NG output (loss of Cl) ⇒ choose sodium chloride (NaCl)
- PN dose = 100 mEq NaCl
  - PN is 1.32 L
  - To make final concentration ½ NS
    - 77 mEq/L x 1.32 L ≅ 100 mEq (1.67 mEq/kg/day)

The other stuff. . .

Other Additives

- Multivitamins
- Trace elements
  - Copper (biliary)
  - Manganese (biliary)
  - Zinc (renal)
  - Chromium (renal)
  - Selenium (renal)
- Additional neonatal needs
  - L-cysteine
  - Carnitine
  - Heparin
- Special situations
  - H_2 blockers
  - Insulin – regular only!
  - Iron dextran

PN Electrolyte Case – Put It All Together

- 90 g protein
- 120 g dextrose
- 50 g IV fat emulsion
- Total PN volume = 1320 mL/day (55 mL/hr)
- Sodium chloride 100 mEq
- Potassium chloride 30 mEq
- Potassium phosphate 30 mmol
- Magnesium sulfate 32 mEq
- Multivitamins 10 mL
- Multiple trace elements 1 mL
- Famotidine 40 mg (don't forget to discontinue IVPB order)

Monitoring Parenteral Nutrition

Monitoring Parenteral Nutrition

- Monitoring protocol is essential
  - Minimize complications
  - Optimize therapy advancement and delivery
- Initial laboratory assessment is critical
  - When to delay PN initiation
  - When to delay PN advancement

Parameter	Critical Level (Adults)
Glucose	> 300 mg/dL
BUN	> 100 mg/dL
Sodium	> 150 mg/dL
Potassium	< 3 mmol/dL
Phosphorous	< 2 mg/dL
Magnesium	< 1 mg/dL

A.S.P.E.N. Adult Nutrition Support Core Curriculum, 2nd edition, 2012

Laboratory Monitoring Protocol

Parameter	Baseline	Initiation	Critical Illness	Stable Inpatient
CBC with differential	✓		Weekly	Weekly
BUN, creatinine	✓	Daily X 7 days	Daily	1-3 X week
Electrolytes (Na, K, CL, CO2)	✓	Daily X 7 days	Daily	1-3 X week
Mg, P04, ICa	✓	Daily X 3 days	Daily	1-2 X week
Glucose	✓	Daily X 7 days	Daily	1-3 X week
Capillary blood glucose		Every 6 hours	Every 6 hours	Every 6 hours
Triglycerides	✓		Weekly	Weekly
Liver function tests	✓		Weekly	Weekly

Monitoring Parenteral Nutrition – Neonates

- Often start a starter PN without labs
- Usually obtain first set of electrolytes at 24 hours of life unless critically ill
- Strong push to minimize lab draws
  - Baby only has 80 mL of blood/kg of body weight
    - Think 500 g baby only has 40 mL of blood in total body
  - Most labs take 1 to 3 mL of blood to be analyzed
- Some electrolytes are naturally higher in neonates
  - Potassium
  - Phosphate

Monitoring Parenteral Nutrition – Other Thoughts

- Consider how long changes to PN take before see results
  - Often get labs early in the morning but the new PN wasn't hung until late in the previous day
  - Has enough time passed to see true effect of changes
- Consider how labs were obtained
  - Heel stick vs. capillary blood vs. line draw
- Do I need to IVPB bolus and/or increase electrolytes in PN
  - Is there a continual need for additional electrolytes?
  - Was this due to a 1 time dose of a medication?
  - Is the patient symptomatic?
  - Is the electrolyte value severely depleted?

Parenteral Nutrition: Compounding Considerations

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Safe Practice Issues

- PN Order - Review and Verification
- Delivery methods
- Drug shortage challenges
- Contamination
- Compatibility
- Stability of PN formulations
- Preparation
- PN labeling

PN Order - Review and Verification

PN Order Prescribing and Communication

- Use a standardized process for PN management
  - Policies and procedures, education, competency training
- Patient medical problems, PN indication and IV catheter type documented in medical record
- Therapeutic goal of PN documented in medical record
- Use a standardized process for PN order (computerized or electronic order sets) and PN review based on age and disease state(s)
  - Sequence of components should match PN label
- All of the above applied to home PN orders
- Most appropriate PN formulation type should be made available with criteria for use
- Environmental recommendations provided (light, sound)
- Reordering policies and procedures should be in place and centered on patient monitoring needs

JPEN 2014; 38:296-333.

Table 1. Required Components for PN Orders and Preferred Sequence.

Components for the PN Order
Patient Information
Patient identifiers (patient name, medical record number or other unique identifiers, birth date/age, patient location)
Patient location (home address for home PN patients)
Allergies and reactions
Height and dosing weight (metric)
Diagnosis(es)/indication(s) for PN
Vascular access device/location
Administration date/time
PN Ingredients (should match PN label)
Amino acids
Dextrose
IVFE
Sodium phosphate
Sodium chloride
Sodium acetate
Potassium phosphate
Potassium chloride
Potassium acetate
Magnesium sulfate or magnesium chloride
Calcium gluconate
Multivitamins
Trace elements
Additives (eg, cysteine, regular insulin) as clinically appropriate and compatible
PN Instructions
Total volume, infusion rate, start and stop times, cycle information
Prescriber and contact information

Nutrient ordering

Adults – amount per day

Pediatrics –amount per kg per day

as complete salts and full generic names

JPEN 2014; 38:296-333.

PN Order Review and Verification

- Policies and procedures in place
  - PN verification, labeling, drug shortages, competency
- Ideal system – CPOE prescribing directly to automated compounding device (ACD)
  - Limits need for multiple transcription and possible errors
  - This is not easy to set up – few CPOE vendors offer templates for compliance
- ALL components MUST be reviewed to assure that a complete & balanced nutrient formulation is provided
  - Clinical review
  - Pharmaceutical/safety review
- Deviations shall be questioned, modified, and clarified with the provider prior to compounding

JPEN 2014; 38:296-333.

PN Order Review and Verification

- Documentation of interventions shall be completed in patient medical record.
- All PNs requiring calculations, conversions of units of measure, or additional transcription steps should undergo an independent double check
- Pharmacists who verify PN should demonstrate competency annually
- Quality improvement efforts should be in place to document, track, and analyze errors related to these processes.

JPEN 2014; 38:296-333.

PN Order Review and Verification – Clinical Review

- Appropriate indication
- Appropriate PN osmolarity (peripheral PN)
- Appropriate dose (adjustments) of nutrients based on
  - Age
  - Clinical condition
  - Organ function
  - Laboratory results
- Comparisons should be made to the previous day's PN order to identify possible transcription or omission errors

Knowledge of fluid requirements, macro- & micronutrient dosing ranges very IMPORTANT!!!

JPEN 2014; 38:296-333.

PN Order Review and Verification – Pharmaceutical/Safety Review

- Centers around compatibility and expected stability
- 3 main areas
  - Calcium-phosphate precipitation risk
  - Compatibility of nutrient and non-nutrient components
  - Vitamin stability
  - IV lipid emulsion stability in total nutrient admixtures (TNA)

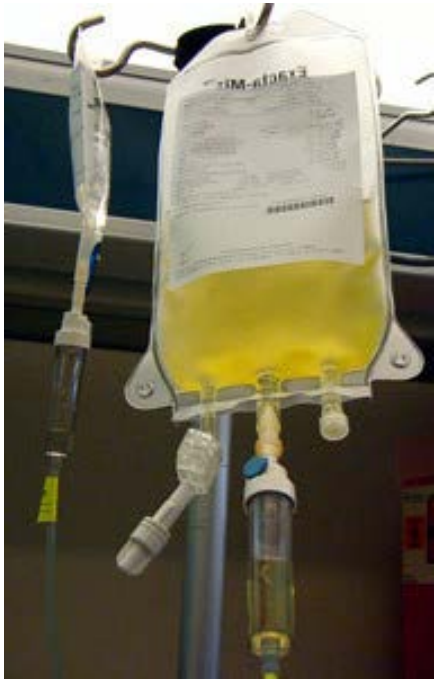
JPEN 2014; 38:296-333.

Delivery Methods

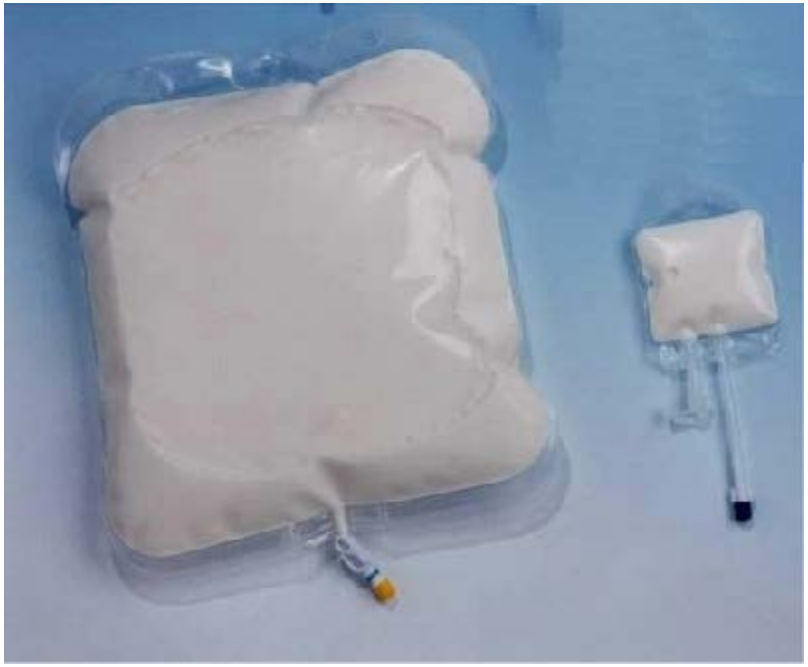
System for Delivery

- 2 in 1
  - AA + Dextrose
  - Piggybacked (PB) fat emulsion daily, intermittent, or optional
  - Better stability and compatibility
  - Improved visual inspection
  - Filter 0.2 micron
- Total Nutrient Admixture (TNA) or 3 in 1
  - AA + Dextrose + fat emulsion all in one bag
  - Single bag – decreased nursing time, decrease touch contamination and easier administration for home patient
  - Better fat utilization
  - Filter 1.2 micron

Admixture Types



2-in-1



3-in-1 (TNA)

PN Compounding

Manual Compounding

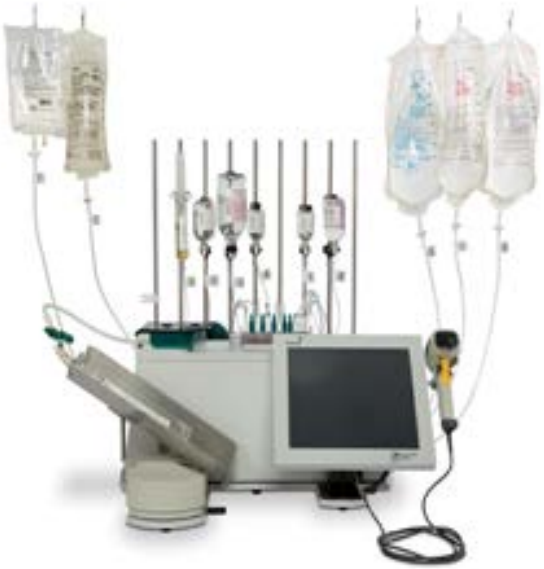
- Addition of nutrients separately into one final sterile empty container
- Transfer sets attached to large volume parenteral products
- Additives drawn up into separate syringes
  - Added one by one to final container
- Labor intensive
- Prone to errors

Automated Compounding

- RECOMMENDED in PN Safety Recs
- Use of automated compounding devices (ACDs)
- Bulk PN components are attached to device using tubing for delivery of prescribed contents into PN bag
- Prescribed doses programmed into computer which drives the device
- Decreased manipulation of PN bag and error potential
  - Less touch contamination
  - Bar-code technology
  - Built in safety checks (Ca-Phos curve analysis, dosing limits)
- Must have double checks and routine calibration of machine

JPEN 2014; 38:296-333.

Automated Compounding Devices



ExactaMix Compounding System
Baxter Healthcare Corporation

Pinnacle TPN Management System
B. Braun Medical Inc.

Multi-Chamber bags

- Promote extended stability
- Separate IVFE from rest of PN
- At the time of administration, seal/clamp is opened to mix contents
- MVI and trace elements added prior to infusion
- Advantages – Lower risk for infections, less compounding time, commercially available
- Disadvantages- Preset concentration limits customization

PN Product Shortages

- **F**ind and implement conservation strategies early.
- **E**valuate the indication for PN.
- **E**nteral first, switch to oral or enteral nutrients (excluding malabsorption syndromes).
- **D**etermine need and reserve intravenous products for those receiving PN or those with a therapeutic medical need for intravenous nutrients.
- **A**ge-specific products are used only for designated patient populations.
- **L**eave supply for those vulnerable populations --neonates, pediatrics, or malabsorption syndromes.
- **L**earn signs and symptoms of deficiencies and observe for deficiencies with the ongoing shortages.

Where to go for more information

- Product Shortage Recommendations
  - http://www.pnsafeuse.org
  - http://www.ashp.org/shortages
  - http://www.nutritioncare.org/News/Product_Shortages/Parenteral_Nutrition_Multivitamin_Product_Shortage_Considerations/

Contaminants

- Trace minerals
  - Zinc, copper, manganese, chromium, selenium and aluminum
- Manganese
  - At risk population – long-term PN patients
  - May lead to manganese deposition in the basal ganglia and neurological symptoms
- Aluminum
  - At risk population – long-term PN patients and neonate/pediatric patients on PN > 10 days
  - Safe limit is 5 mcg/kg/day
  - Products of most concern are calcium and phosphate salts

Stability of PN

- Stability –extent to which the PN retains the same properties and characteristics that it possessed at the time of mixing
  - Maillard reaction (the browning reaction)
  - Photo degradation
    - Vitamins
      - Vitamin A, folic acid, cyanocobalamine, phytonadione, pyridoxine, riboflavin, thiamin
    - Hydrolysis
      - Ascorbic acid
  - Add MVI to PN bag immediately prior to use

Nutrition 1998 14;9: 697-706

Compatibility of PN

- Compatibility – ability to combine 2 or more chemical products such that the physical integrity of the products is not altered.
- Incompatibility - refers to concentration dependent precipitation or acid-base reactions that result in physical alteration of the products when combined together.
  - Bicarbonate salts
  - Medications
  - Calcium and Phosphorus

Stability and Compatibility Factors

- Concentration
- pH
- Temperature
- Time of exposure
- Order of mixing

Calcium Phosphate Incompatibility

- Insoluble dibasic calcium phosphate precipitates
- Significant respiratory failure and death have occurred in patients infused incompatible PN formulations

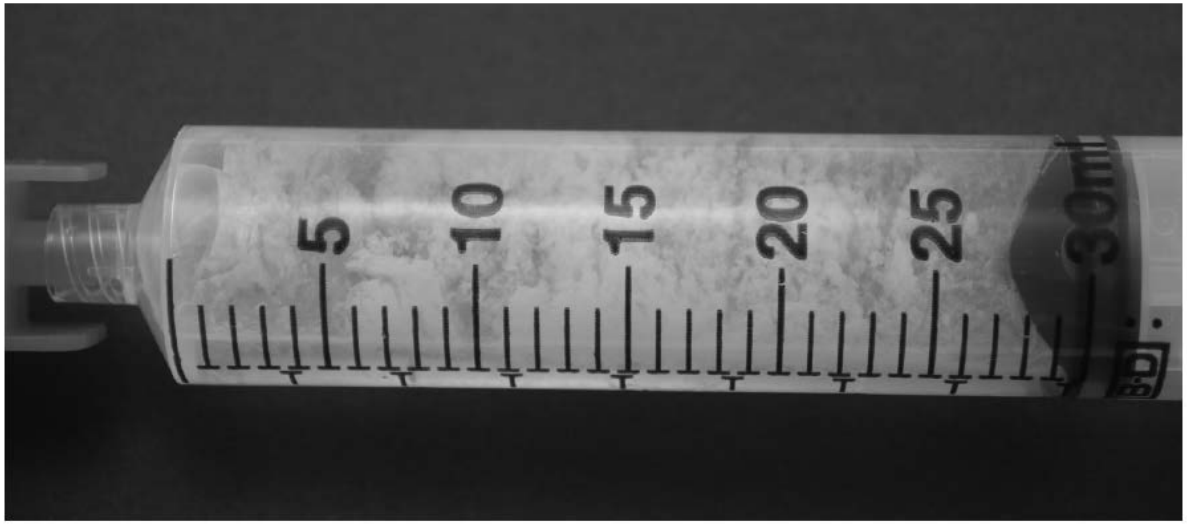


Figure 7-4 Calcium Phosphate Precipitation

Calcium and Phosphate Stability

Items that will cause instability:

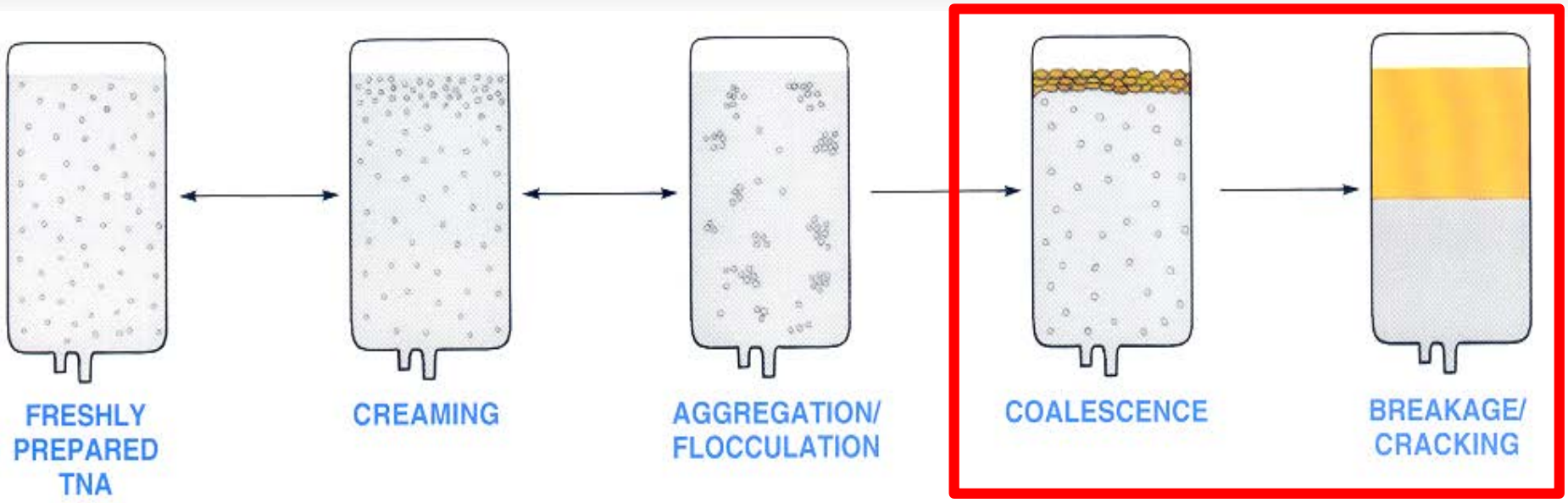
- High concentrations of Calcium or Phosphate
- pH above 5.3
- Low AA concentration
- TNA admixture
- Calcium chloride as the calcium salt
  - Calcium gluconate is preferred
  - Std compatibility graphs will not work with CaCl
- Adding calcium before phosphorus or adding them back to back
- Lack of mixing or agitation between additions
- Storage conditions
- Check amino acid brand
  - FreAmine III, Hepatamine, and Hepatasol contain phosphate

TNA Stability

Items that will cause instability:

- Amino Acids
  - pH below 5.3
  - Final concentration below 3.5 – 4%
- Dextrose
  - Final concentration below 10%
- IV Fat emulsion
  - Final concentration below 2%
- High cation concentrations
  - Trivalent (Fe) > Divalent (Ca,Mg) > Monovalent cations (Na,K)
    - Trivalent (Fe): Not recommended for use; incompatible
    - Divalent limits: ≤ 20 mEq/L
    - Monovalent limits: ≤ 150 mEq/L
- Admixture of dextrose with fat emulsion before adding amino acids

Driscoll D Lipid Injectable Emulsions: 2006. NCP 21:381-386.



UNSAFE FOR INFUSION

- **Creaming** – larger fat droplets that have aggregated rise to the surface and form a cream layer also reversed with agitation
- **Aggregation** (flocculation) – fat droplets aggregate to form larger droplets but redisperse with aggitation
- **Coalescence** – fat droplets aggregate into significantly larger droplets forming irreversible separation and unusable PN
- **Oiling out** – total separation of the oil and water phases (also unusable)

Beyond Use Dating

- Must be included on PN label
- Follows USP <797>
- Majority of PN considered medium risk

TABLE I
Beyond-use dating

USP risk level	Controlled room temperature	2°–8°C	≤−20°C
Low	≤48 hours	≤14 days	≤45 days
Medium*	≤30 hours	≤7 days	≤45 days
High	≤24 hours	≤3 days	≤45 days

*Level assigned to PN formulation compounding from USP Chapter 797.

- For home-care, can be extended to 9 days
  - If stored at 2–8°C (36–46°F) until use
  - 30 hour limit still applies once PN infusion initiated

Pharmacopeial Forum 2003;29:94065

PN Labeling

PN Labeling Recommendations

A.S.P.E.N. Clinical Recommendations	
Two patient identifiers (name, MRN, DOB)	Patient location or address
Dosing weight	Administration date and time
Beyond use date and time	Route of administration (PIV vs CVC)
Prescribed volume and overfill volume	Infusion rate (mL/hr)
Duration of infusion (continuous vs. cyclic)	In-line filter size (0.22 vs. 1.2 micron)
Complete name of all ingredients	Barcode
All ingredients must be listed in order as seen on PN order	Components ordered in amounts per day (adults) or amounts/kg/day (peds)
Pharmacy/institution name	Pharmacy/institution contact information

JPEN 2014; 38:296-333.

Patient Name_____ **Medical Record Number**_____
Birthdate/age_____
Patient location_____

Height and dosing weight: Ht: ____cm Dosing Wt: _____kg
Diagnosis(es)/Indication(s) for PN_____
Vascular access device/location CVC type_____ Location_____

Administration date _____ Administration time_____

Macronutrients	Amount/day
Amino acids*	g
Dextrose	g
IV Fat emulsion*	g
Electrolytes	
Sodium phosphate	mmol of phosphate (Sodium ___mEq)
Sodium chloride	mEq
Sodium acetate	mEq
Potassium phosphate	mmol of phosphate (Potassium __mEq)
Potassium chloride	mEq
Potassium acetate	mEq
Magnesium sulfate/chloride	mEq
Calcium gluconate	mEq
Vitamins, Trace Elements	
Multi-component Vitamins*	mL
Multi-component Trace Elements*	mL

Other Additives (eg, individual vitamins or trace elements, regular insulin)

PN Instructions

For Central (peripheral) Vein Administration Only

Total volume_____ mL Overfill volume _____mL
Infusion rate_____ mL/h
Start and Stop times_____
Cycle information_____
Do not use after date/time_____
****** Discard any unused volume after 24 hours********

Prescriber and Contact information_____

Institution/Pharmacy Name
Institution/Pharmacy Address
Pharmacy Telephone number

Figure 3. Parenteral Nutrition Label Template: Adult Patient.

Patient Name_____ **Medical Record Number**_____
Birthdate/age_____
Patient location_____

Height/Length and dosing weight: Ht/Length: _____cm Dosing Wt: _____kg
Diagnosis(es)/Indication(s) for PN_____
Vascular access device/location CVC type_____ Location_____

Administration date _____Administration Time_____

Macronutrients	Amount/kg/day[b]
Amino acids[a]	g
Dextrose	g
IV Fat emulsion[a]	g
Electrolytes	
Sodium phosphate	mmol of phosphate (Sodium _____ mEq)
Sodium chloride	mEq
Sodium acetate	mEq
Potassium phosphate	mmol of phosphate (Potassium ____ mEq)
Potassium chloride	mEq
Potassium acetate	mEq
Magnesium sulfate/chloride	mEq
Calcium gluconate	mEq
Vitamins, Trace Elements	
Multi-component Vitamins[a]	mL
Multi-component Trace Elements[a]	mL
Other Additives	
Cysteine	mg/g amino acids
Others (eg, regular insulin)	

PN Instructions

For Central (peripheral) Vein Administration Only

Total volume_____ mL Overfill volume _____mL
Infusion rate_____ mL/h
Start and Stop times_____
Cycle information_____
Do not use after date/time_____
****** Discard any unused volume after 24 hours********

Prescriber and Contact information_____

Institution/Pharmacy Name
Institution/Pharmacy Address
Pharmacy Phone Number

Figure 4. Parenteral Nutrition Label Template: Pediatric/Neonatal Patient.

JPEN 2014; 38:296-333.

PN Competency

Special Report

aspen | LEADING THE SCIENCE AND PRACTICE OF CLINICAL NUTRITION
American Society for Parenteral and Enteral Nutrition

Standardized Competencies for Parenteral Nutrition Order Review and Parenteral Nutrition Preparation, Including Compounding: The ASPEN Model

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Patient Case #1

- 53 yo (wt = 75 kg) female s/p small bowel resection now has high output fistula so NPO. The PN formulation for this patient would contain which of the following:
  - Volume
  - Amino acids
  - Dextrose
  - IVFE

Patient Case #1

- A Rate of 110 mL/hr; Amino acids of 40 g/day; Dextrose of 300 g/day; IVFE of 100 g/day
- B Rate of 110 mL/hr; Amino acids of 75 g/day; Dextrose of 275 g/day; IVFE of 75 g/day
- C Rate of 110 mL/hr; Amino acids of 60 g/day; Dextrose of 400 g/day; IVFE of 30 g/day
- D Rate of 110 mL/hr; Amino acids of 80 g/day; Dextrose of 450 g/day; IVFE of 60 g/day

Patient Case #1

- A Rate of 110 mL/hr; Amino acids of 40 g/day; Dextrose of 300 g/day; IVFE of 100 g/day
  - A Correct volume and dextrose (GIR = 2.8 mg/kg/min); too little amino acids (0.5 g/kg/day); too much IVFE (1.3 g/kg/day)
- B **Rate of 110 mL/hr; Amino acids of 75 g/day; Dextrose of 275 g/day; IVFE of 75 g/day**
  - B Correct answer (GIR = 2.5 mg/kg/min; AA = 1 g/kg/day; IVFE = 1 g/kg/day
- C Rate of 110 mL/hr; Amino acids of 60 g/day; Dextrose of 400 g/day; IVFE of 30 g/day
  - C Correct volume and amino acids (0.8 g/kg/day); too much dextrose (GIR = 3.7 mg/kg/min); too little IVFE (0.4 g/kg/day)
- D Rate of 110 mL/hr; Amino acids of 80 g/day; Dextrose of 450 g/day; IVFE of 60 g/day
  - D •Correct volume and amino acids (1.1 g/kg/day); too much dextrose (GIR = 4.2 mg/kg/min); too little IVFE (0.8 g/kg/day)

Patient Case #2

- 72 yo (ht = 72 in,wt = 78 kg) male with small bowel obstruction.
- PMH: HTN, CHF, hyperlipidemia
- Ins/Outs: 2018 mL/urine 900 mL, NG 400 mL, no BM
- Physical exam: + BLE edema
- Current medications:furosemide 40 mg IV daily, enalaprilat 6.25 mg IV every 8 hr, metoprolol 5 mg IV every 6 hr, D5 ½ NS at 75 mL/hr
- Nutrition History: minimal oral intake for 3 days prior to admission
- Based on the information provided, which of the following would be an acceptable electrolyte regimen for this patient(total PN volume 1 L)?

Lab	Result	Lab	Result
Na	135	BUN	20
K	3.9	SCr	2.1
Cl	99	Glu	112
CO2	29	Ca	9
Mg	1.8	Phos	3.7

Patient Case #2

- A NaCl 40 mEq, KCl 20 mEq, K Phos 12 mmol, magnesium sulfate 16 mEq
- B NaCl 160 mEq, K Acetate 100 mEq, K Phos 30 mmol, magnesium sulfate 40 mEq
- C NaCl 160 mEq, KCl 20 mEq, K Phos 12 mmol, magnesium sulfate 16 mEq
- D Na Acetate 40 mEq, K Acetate 20 mEq, K Phos 12 mmol, magnesium sulfate 40 mEq

Patient Case #2

- A **NaCl 40 mEq, KCl 20 mEq, K Phos 12 mmol, magnesium sulfate 16 mEq**
  - A Correct answer: Cl correct salt; Na appropriate (~1/4 NS or 40 mEq/L) for CHF/edema; K (38 mEq), Phos, and Mg appropriate for renal function and labs (50% of normal dose).
- B NaCl 160 mEq, K Acetate 100 mEq, K Phos 30 mmol, magnesium sulfate 40 mEq
  - B Cl correct salt; Na too high for CHF/edema (should be ~1/4 NS or 40 mEq Na/L or less); K (145 mEq), Phos and Mg too high for renal function (should start at 50% of normal dose); acetate not appropriate for CO2.
- C NaCl 160 mEq, KCl 20 mEq, K Phos 12 mmol, magnesium sulfate 16 mEq
  - C Cl correct salt; Na too high for CHF/edema (should be ~1/4 NS or 38 mEq Na/L or less); K (38 mEq), Phos, and Mg appropriate for renal function and labs (50% of normal dose).
- D Na Acetate 40 mEq, K Acetate 20 mEq, K Phos 12 mmol, magnesium sulfate 40 mEq
  - D Acetate not appropriate for CO2; Na appropriate (~1/4 NS or 40 mEq/L) for CHF/edema; K (38 mEq) and Phos appropriate for renal function and labs(50% of normal dose), Mg too high for renal function (should start at 50% of normal dose).

Compounding Scenario

- You have just been contacted by a physician. She is requesting that you add an additional 15 mmol potassium phosphate to the PN bag that you have already mixed. The current bag in question contains 15 mmol sodium phosphate and 10 mEq of calcium gluconate. This is acceptable because based on solubility curves the addition will remain under the curve.

A TRUE

B FALSE

Compounding Scenario

B FALSE

- It is important to remember that order of admixing is an necessary consideration with calcium/phosphate compatibility. Phosphate is added early in the admixing process and calcium gluconate injection is added last or nearly last so that it is added to the most dilute phosphate concentration in the bag as possible. Adding phosphate after admixing the bag would essentially add the ingredients back to back and create an unsafe admixing scenario. It is better to provide this dose of phosphate outside of the PN solution.

Key Takeaways

- When initiating parenteral nutrition
  - Pick the correct patient and IV access
  - Determine volume and caloric needs
  - Start at goal for amino acids
  - Start low and go slow for dextrose
  - Start at 1 g/kg/day and advance to goal for IVFE
- When developing a plan for the addition or adjustment of electrolytes in parenteral nutrition formulations
  - Use a systematic process
  - Look at both absolute laboratory values AND trends
  - Investigate all aspects of patient including the medication profile, organ function, and underlying conditions
  - Implement an appropriate monitoring plan to assess efficacy and ensure safety

Key Takeaways

- When compounding and dispensing parenteral nutrition solutions it is important to be able to:
  - Assess parenteral nutrition (PN) formulations for appropriateness and safety
  - Know proper storage of PN based on USP <797> and provide beyond use dating
  - Understand the factors that affect the stability, compatibility, and physical characteristics of PN formulations regardless of method of delivery (commercial premixed, outsourced or in-house compounded)

Questions?

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