Parenteral Nutrition Essentials for Safety: Review of Best Practices

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Phil Ayers - Fresenius Kabi; speaker, consultant

All other persons in control of content do not have any relevant financial relationships with an ineligible company.

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Learning Objectives

- Apply recommendations for the use of filters in parenteral nutrition (PN) to ensure patient safety.
- Apply strategies for photoprotection of PN for premature infants.
- Develop strategies for ensuring safe and effective therapy when PN components are in short supply.

Parenteral Nutrition and Filter Recommendations

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Clinical Research

Lipid Injectable Emulsion Survey With Gap Analysis

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Christensen ML et al. *Nutr Clin Pract*. 2017; 32(5):694-702. doi: 10.1177/0884533617719671.

Lipid Injectable Emulsion (ILE) Survey With Gap Analysis

Type of Parenteral Nutrition Formulation-Adults (n= 443)

Compounded dextrose/amino acid (2-in-1)	42.1%
Compounded total nutrient admixture (TNA) (3-in-1)	41.9%
Commercial multichamber bag (MCB) with ILE	1.7%
Commercial multichamber bag (MCB) without ILE	12%
Commercial multichamber bag (MCB) without ILE and pharmacy adds ILE to bag	2.3%

Christensen ML et al. *Nutr Clin Pract.* 2017; 32(5):694-702. doi: 10.1177/0884533617719671.

How is ILE Administered?

Patients	TNA %	Separate ILE Infusion %	Both TNA and Separate ILE Infusion %
Adult	38.4	43.1	18.5
Pediatric	17.5	57.1	25.4
Infant	5.6	88.8	5.6

ILE, lipid injectable emulsion; TNA total nutrient admixture (aka 3-in-1)

Christensen ML et al. *Nutr Clin Pract.* 2017; 32(5):694-702. doi: 10.1177/0884533617719671.

Percentage of Respondents Using Filters for Administering PN Admixtures and Components

Types of Admixture/Component	Adults %	Pediatrics %	Infant %
Total Nutrient Admixture (3-in-1)			
Use 1.2-micron filter	79.4	81.4	NA
Do not filter	20.6	18.6	NA
Dextrose/Amino Acids (2-in-1)			
Use 0.22-micron filter	77.5	79.3	87
Use 1.2-micron filter	15.4	19.0	12
Do not filter	7.2	1.7	1
ILE Separate Infusion			
Use 1.2-micron filter	84.9	90.3	80.6
Do not filter	15.1	9.7	19.4

Christensen ML et al. *Nutr Clin Pract.* 2017; 32(5):694-702. doi: 10.1177/0884533617719671.

Special Report

Nutrition in Clinical Practice
Volume 0 Number 0
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Update on the Use of Filters for Parenteral Nutrition: An ASPEN Position Paper

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Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

PN Administration and Filter Guidelines

- Food and Drug Administration
- American Society for Parenteral and Enteral Nutrition (ASPEN)
- Infusion Nurses Society (INS)
- Manufacturers

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

Chronology of Filter Recommendations

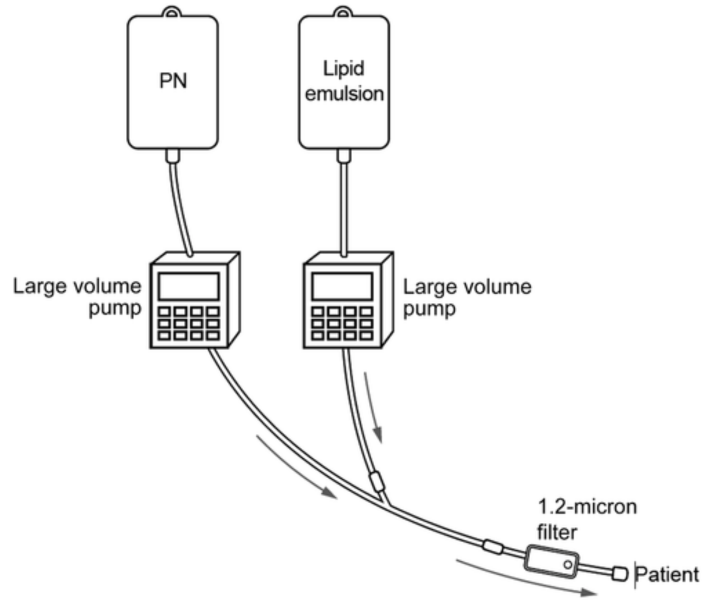
- 1994: FDA Alert after 2 deaths and 2 cases of respiratory distress
- 2002: CDC recommends against routinely using filters for infection-control purposes
- 2004: ASPEN Safe Practices for Parenteral Nutrition called for using a 0.22-micron filter for dextrose-amino acids (2-in-1) and a 1.2-micron filter for TNA (i.e., 3-in-1)

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

Chronology of Filter Recommendations

- 2014 ASPEN PN Safety Consensus Recommendations called for using 0.22-micron filter for dextrose-amino acids (2-in-1) and a 1.2-micron filter for TNA (i.e., 3-in-1)
- 2016 INS Infusion Therapy Standards of Practice are consistent with the 2014 ASPEN Consensus Recommendations

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587



Used with permission. Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

Summary of Recommendations

- In-line filters serve a critical purpose in reducing exposure to particulate matter during PN therapy
- Particles > 2 microns, which are retained by 1.2-micron filters, appear to pose the most serious consequences for harm
- ASPEN recommends using a 1.2-micron filer for TNA
- For dextrose-amino acid solutions, ASPEN recommends a 1.2-micron filter below the Y-site where the dextrose-amino acid and ILE co-infuse

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

Summary of Recommendations

- Although 1.2-micron filters are not recommended for routine use as an infection control measure, these devices are effective in preventing infection with *Candida albicans,* a pathogen seen frequently with PN administration

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39. doi:10.1002/ncp.10587

Parenteral Nutrition and Photoprotection Recommendations

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DOI: 10.1002/ncp.10747

POSITION PAPER

Recommendations for photoprotection of parenteral nutrition for premature infants: An ASPEN position paper

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Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Photodegradation

- Light exposure at any step in storage, compounding, delivery, and infusion can alter the admixture stability
- The most common oxidants found in PN admixtures include hydrogen peroxide and organic peroxides, such as lipoperoxides and ascorbylperoxide
- Light sources facilitating photodegradation include:
  - Sunlight
  - Ambient light
  - Phototherapy for hyperbilirubinemia

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Complete Photoprotection

Implementing light-protective measures during the multiple steps of the PN process:

(1) sterile compounding in the pharmacy
(2) transport and delivery to the patient care area
(3) administration to the patient

Use of “partial photoprotection” indicates a circumstance in which light protection occurs at one or more of those steps, yet not during 100% of the process.

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Parenteral Nutrition in Pediatrics

- PN plays a critical role in improving health outcomes of premature infants
- According to the Agency for Healthcare Research and Quality (AHRQ) 2014 National Inpatient Survey data, 43% of all patients receiving PN during an inpatient hospital stay are children and infants, particularly those born preterm
- Preterm birth represents 10% of live births, and survival of those born extremely preterm continues to increase

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Infant Susceptibility to Oxidative Stress

Infants are considered more susceptible to consequences of oxidative stress than children and adults due to:

(1) Frequent exposure to external oxidative load
(2) Increased susceptibility to infections and inflammation
(3) Reduced endogenous antioxidant capacity

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Consequences of Oxidative Stress in Infants

Oxidative stress contributes to the development of morbidities associated with prematurity, including:

- bronchopulmonary dysplasia (BPD)
- retinopathy of prematurity
- necrotizing enterocolitis (NEC)
- intestinal failure-associated liver disease (IFALD)

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Components of Parenteral Nutrition

- Amino acids
- Dextrose
- Intravenous lipid emulsions (ILE)
- Multivitamins
- Trace elements

Most Susceptible

Components of Parenteral Nutrition

- Amino acids
- Dextrose
- ILE
- Multivitamins
- Trace elements

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Lipid Susceptibility

- Administration of oxidized lipid can lead to cellular damage, and the effects can be magnified in the presence of trace elements
- Laboratory research demonstrates that photoprotection of both the PN bag and infusion set minimizes peroxide generation

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Current Capabilities in Achieving Photoprotection

- Amber overwrap
- Amber sleeves
- Amber tubing (**But <u>not</u> microbore for use in infants)**

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Gaps in Resources

- The two manufacturers of PN automated compounding systems currently available in the U.S. market provide only clear tubing and supplies.
- Most individual components needed to compound PN admixtures are currently packaged in clear containers.
- Amber manifolds, tubing, and syringes are not available for proper compounding of PN admixtures.
- Amber containers that permit visual inspection of the preparation before dispensing it to the patient care area are not available.

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Summary of Recommendations

- PN and ILE integrity is optimized with light protection.
- Partial photoprotection of PN products reduces markers of oxidative stress, although it is not as effective as complete photoprotection.
- Complete photoprotection of PN admixtures and ILEs reduces indicators of oxidative stress in preterm infants and mitigates the risk of adverse clinical outcome measures.
- Statistically significant findings of benefit from light protection were sometimes found only with secondary analysis.
- ASPEN recommends photoprotection of PN admixtures and ILEs for infants.

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Summary of Recommendations

- Materials required for complete photoprotection are not currently available in the U.S.
- Individual healthcare organizations should convene key stakeholders to define which steps in photoprotection can be achieved and implement such strategies.
- Outsourcing sterile compounding facilities should review processes that may be amenable to reducing light exposure during compounding and transport.
- Research and development of cost-efficient materials are necessary for complete photoprotection of PN admixtures and ILEs.

Robinson DT et al. *Nutr Clin Pract.* 2021; 36:927-41. https://doi.org/10.1002/ncp.10747

Managing PN Component Shortages

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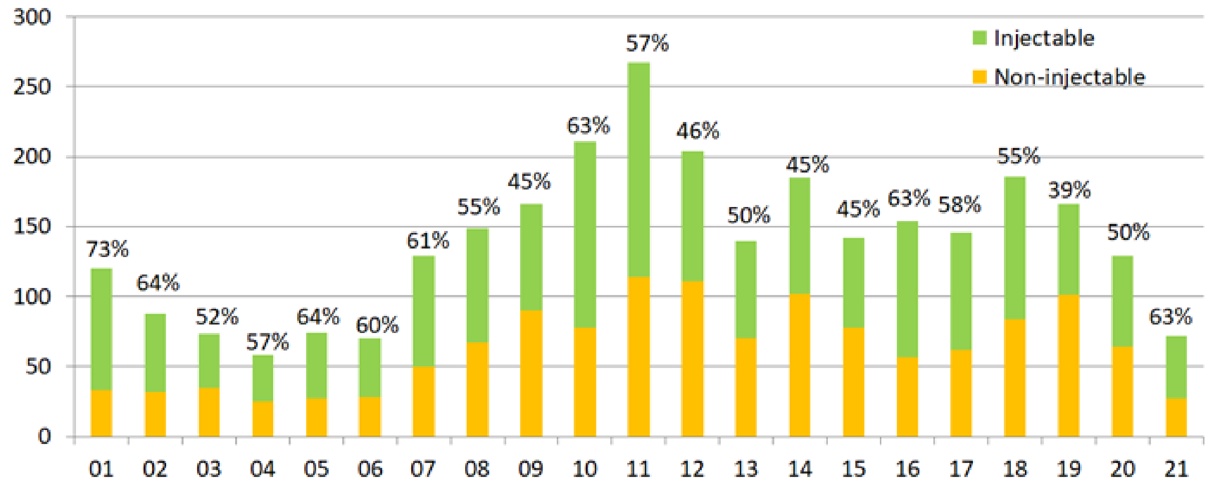
National New Drug Shortages by Year:
Percent Injectable (January 2001 - September 2021)



University of Utah Drug Information Service. https://www.ashp.org/drug-shortages/shortage-resources/drug-shortages-statistics (accessed Nov 21).

Drug Shortage Resources

- American Society of Health-System Pharmacists (ASHP)
- American Society for Parenteral and Enteral Nutrition (ASPEN)
- United States Food and Drug Administration (FDA)
- Institute for Safe Medication Practices (ISMP)

Holcombe B, et al. *Nutr Clin Pract*. 2018; 33(1):53-61.

Drug Shortages: A Challenge for PN Management

- Complexity of PN formulations
- Limited ability to change to oral/enteral formulation if gastrointestinal (GI) absorption compromised
- Few manufacturers for generic sterile injectables

Holcombe B, et al. *Nutr Clin Pract*. 2018; 33(1):53-61.

Safety Implications of Shortages: MedMARx Database (May 2009 – April 2011)

- Errors associated with drug shortages (N=14)
  - Lipid injectable emulsion (ILE) (n=12)
  - Electrolytes (n=1)
  - Micronutrients (n=1)

Storey MA, et al. *Nutr Clin Pract*. 2016; 31(2):211-217.

Safety Implications of Shortages: ISMP Survey (2013)

- Survey respondents: 234 practitioners
- Medication errors reported by 3 – 28% of respondents for each PN component in short supply
- Most common: trace elements, sodium phosphate, potassium phosphate, multivitamins, calcium gluconate, ILE

https://www.ismp.org/resources/survey-links-pn-component-shortages-adverse-outcomes (accessed Nov 21).

PN Component Shortages (2010 – Present)

Category	PN Component
Macronutrients	Amino acids; ILE; dextrose 70%
Electrolytes	Calcium (chloride, gluconate); magnesium sulfate; potassium (acetate, chloride, phosphate), sodium (acetate, chloride, phosphate)
Vitamins	Multivitamins; ascorbic acid; cyanocobalamin; folic acid; phytonadione; thiamine; vitamin A
Trace elements	Multi-trace; chromium; copper; selenium; zinc (chloride, sulfate)
Other	L-cysteine hydrochloride; sterile water for injection

Holcombe B, et al. *Nutr Clin Pract*. 2018; 33(1):53-61.

Current PN Component Shortages (November 2021)

Category	PN Component
Macronutrients	Amino acids; ILE
Electrolytes	Calcium gluconate; magnesium sulfate; potassium (acetate, chloride, phosphate); sodium (acetate, 23.4% chloride, phosphate)
Vitamins	Folic acid; multivitamins; vitamin A
Other	Sterile water for injection

https://www.ashp.org/drug-shortages/current-shortages (accessed Nov 21).
https://www.accessdata.fda.gov/scripts/drugshortages/ (accessed Nov 21).

Approach to PN Component Shortages

- Switch to oral/enteral administration if feasible
- Prioritize vulnerable patients (e.g., neonates)
- Use neonatal/pediatric-specific products only for the indicated population
- Conserve additives by limiting use in daily maintenance IV fluids
- Assess availability of alternative products, including standardized, commercially available products
- Revise institutional protocols
- Consider ethics consultation

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.

Shortage: Intravenous Lipid Emulsions (ILE)

- Management:
  - Identify another available product
  - Prioritize neonatal and pediatric patients for daily ILE provision
  - Adults receiving PN < 2 weeks: withhold ILE, unless high risk
  - Adults receiving PN > 2 weeks: provide 100 g of soybean oil-based ILE weekly to prevent essential fatty acid deficiency (EFAD); daily if available for glucose intolerance, severe malnutrition, refeeding syndrome risk, pregnancy
  - Conserve by not administering if receiving concomitant propofol or clevidipine
- Safety issue:
  - Hyperglycemia from replacing calories from ILE with dextrose
  - Monitor for EFAD

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.
Plogsted S, et al. *Nutr Clin Pract*. 2017; 32(3):427-429.

Shortage: Amino Acids

- Management:
  - Ensure PN use restricted to appropriate candidates based on ASPEN guidance
  - Identify other available products/concentrations
  - Reserve highly concentrated amino acids products for fluid-restricted patients
- Safety issue:
  - Fluid overload secondary to administration of less concentrated product
  - Amino acid products may have different properties (e.g., pH, calcium-phosphorus solubilities)

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.
Plogsted S, et al. *Nutr Clin Pract*. 2016; 31(4):560-561.

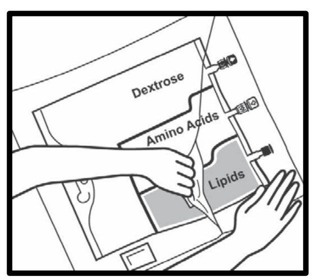
Multi-chamber Bag PN (MCB-PN): Potential Role During Shortages

- Standardized PN formulation commercially available requiring fewer compounding steps before administration
- Mixing and additives still required

Hall JW, et al. *Nutr Clin Pract*. 2015; 30(3):325-330.

MCB-PN

- Two-chamber product
  - Amino acids; dextrose; with/without electrolytes
- Three-chamber product
  - Amino acids; dextrose; ILE; electrolytes



Hall JW, et al. *Nutr Clin Pract*. 2015; 30(3):325-330.
https://www.accessdata.fda.gov/drugsatfda_docs/label/2021/020734s037lbl.pdf (accessed Nov 21).
https://www.accessdata.fda.gov/drugsatfda_docs/label/2016/200656s001lbl.pdf (accessed Nov 21).

MCB-PN: Rapid Process Change Example

- Amino acid shortage (2017) prompted shift from use of compounded PN to MCB-PN at Mayo Clinic
- Conservation measures:
  - Use MCB-PN for stable patients
  - Restrict compounded PN to select patients (e.g., high protein requirements, volume-sensitive); reevaluate for transition to MCB-PN
  - Reduce new initiations
  - Decrease amino acid doses and discontinue when enteral nutrition feasible
- Compounded PN reduced to ~25% of prior use

Nystrom EM, et al. *JPEN J Parenter Enteral Nutr*. 2019; 43(5):583-590.

Shortage: Electrolytes

- Management:
  - Treat underlying etiology for electrolyte disturbance
  - Switch to oral/enteral administration if feasible
  - Prioritize IV supply for patients receiving PN or with other therapeutic indication
  - Modify replacement protocols that automatically supplement asymptomatic patients
  - Consider whether standardized, commercially available PN product with electrolytes is appropriate
- Safety issues:
  - Diarrhea secondary to oral electrolyte replacement
  - Acid-base disturbances due to salt form selection
  - Inadequate electrolyte replacement

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.
Plogsted S, et al. *Nutr Clin Pract*. 2016; 31(1):132-134.

Shortage: Vitamins

- Management:
  - Switch to oral/enteral administration if feasible
  - Prioritize IV multivitamins for patients receiving only PN or with other therapeutic indication
  - Ration by reducing the daily dose by 50% or administering three times a week if necessary
  - Administer individual vitamin entities daily if IV multivitamin unavailable (i.e., thiamine, ascorbic acid, pyridoxine, folic acid)
- Safety issues:
  - Vitamin deficiencies and corresponding manifestations

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.
Plogsted S, et al. *Nutr Clin Pract*. 2016; 31(1):132-134.

Shortage: Trace Elements

- Management:
  - Switch to oral/enteral administration if feasible
  - Prioritize IV trace elements for patients receiving only PN or with other therapeutic indication
  - Administer individual trace element entities if IV multi-trace element products unavailable
- Safety issues:
  - Trace element deficiencies and corresponding manifestations

Mirtallo JM, et al. *Nutr Clin Pract*. 2012; 27(3):385-391.
Plogsted S, et al. *Nutr Clin Pract*. 2016; 31(6):843-847.

Shortage Resolution: PN Management

- Resume PN dosing with full daily requirements after shortage resolution
- Inappropriate to provide partial dose for cost savings
- Communicate resolution of shortage with interprofessional team and patients

Holcombe B, et al. *Nutr Clin Pract*. 2018; 33(1):53-61.

Summary

- PN component shortages are challenging and present safety implications
- Managing PN component shortages requires an interprofessional approach
- PN dosing should be adjusted to full daily requirements after shortage resolution

Clinical Case Studies: Parenteral Nutrition and Filter Recommendations

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Case #1

67-year-old female on PN day #5 for post-op ileus. Nurse informs Pharmacy that PN is not infusing properly, suspects filter occlusion.

What would be the most appropriate intervention?

1. Remove filter and continue PN.
2. Flush tubing above filter with a thrombolytic agent.
3. Reduce the rate of PN infusion.
4. Investigate potential causes of the occluded filter.

Best Practices for Using Filters for PN Administration

- Prior to compounding, a pharmacist must verify stability and compatibility of PN.
- Perform visual inspection of PN for evidence of particulate matter or admixture instability.
- Avoid co-administration of medication with PN; when no other option exists, consult a pharmacist to verify compatibility and use appropriate flushing techniques.

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39.

Best Practices for Using Filters for PN Administration

- Observe the filter manufacturer's directions for priming the filter before connecting to vascular access device. Some filters require holding the filter vertically while priming.
- Consider priming a small volume of ILE to flow through the tubing, allowing ILE to enter filter.
- Prime the dextrose-amino acid through the tubing completely filling the tubing and filter to the distal end of tubing.

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39.

Appropriate Response to Potentially Occluded Filter

- Verify that correct filter has been used.
- If filter is correct, assume that particulate matter is the cause.
- Remove the occluded filter and replace. Never allow unfiltered PN to continue to infuse.
- Conduct a pharmaceutical review of PN formulation to determine the underlying cause of the occlusion.

Worthington P et al. *Nutr Clin Pract*. 2021; 36:29-39.

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Clinical Case Studies: Managing PN Component Shortages

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Case #2

- **65-year-old male (NKDA)**
  - Presents with GI dysmotility and severe abdominal distension requiring PN
  - Significant ongoing daily gastric and jejunal fluid losses, 800 mL and 1600 mL, respectively
  - Transferred to long-term acute care facility for ventilator weaning

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

Case #2

- **Patient parameters**
  - **Weight:** 82 kg
  - **Height:** 6’2’’ (188 cm)
  - **Body mass index:** 23.2 kg/m^2
  - **Serum albumin:** 2.8 g/dL
- **Receiving PN with supplemental IV fluids (0.9% sodium chloride and 0.45% sodium chloride)**

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

Case #2

- **PN regimen stable >2 months:**
  - Amino acids: 150 g/day
  - Dextrose: 300 g/day
  - ILE (soybean-based): 60 g/day
  - Average chloride and acetate intake from PN and supplemental fluids, 430 mEq/day and 60 mEq/day respectively
- **Hospital day 83: alerted that IV sodium acetate and potassium acetate are no longer available**

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

Which complication is most likely to occur in this patient due to the sodium acetate and potassium acetate shortages?

a. Hypokalemia
b. Hyponatremia
c. Hyperchloremic non-anion gap metabolic acidosis
d. Chloride-responsive metabolic alkalosis

Case #2

- **Laboratory data (after 11 days of acetate-free PN)**
  - Arterial blood gas (ABG)
    - pH 7.28
    - pCO_2 36 mm Hg
    - pO_2 118 mm Hg
    - HCO_3 17 mEq/L
  - Anion gap: 12 mEq/L
  - Serum chloride: 107 mEq/L

Mild hyperchloremic non-anion gap metabolic acidosis

Anion Gap = Na – (Cl + HCO_3)

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

When the acetate shortages were identified, which therapy change for this patient may have prevented development of hyperchloremic non-anion gap metabolic acidosis?

a. Add sodium bicarbonate to PN formulation daily
b. Change all acetate to chloride salts in the PN formulation
c. Change supplemental IV fluid to lactated Ringer's solution
d. No change warranted

Case #2
Electrolyte Content of IV Fluids

IV Fluid	Bicarbonate (mEq/L)	Calcium (mEq/L)	Chloride (mEq/L)	Potassium (mEq/L)	Sodium (mEq/L)
5% dextrose in water					
0.9% sodium chloride			154		154
0.45% sodium chloride			77		77
Lactated Ringer's solution	28	2.7	109	4	130

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

Case #2

- **Management:**
  - Sodium bicarbonate 50 mEq IV daily x 3 days (external to PN formulation)
  - Supplemental IV fluid changed to lactated Ringer's solution (2 L/day)
- **Laboratory data (9 days after bicarbonate therapy):**
  - Arterial blood gas (ABG)
    - pH 7.36
    - pCO_2 54 mm Hg
    - pO_2 105 mm Hg
    - HCO_3 30 mEq/L

Metabolic acidosis resolved

Brown EW, et al. *Hosp Pharm*. 2018; 53(6):403-407.

Case #3

- **Cathy, a 45-year-old female**
  - Admitted to the medical intensive care unit for septic shock with high nasogastric output and abdominal distension
  - Subsequent work-up reveals small bowel obstruction

Case #3

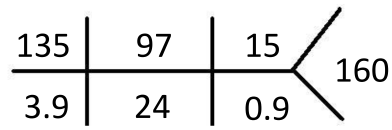
- **Past medical history:** Hypertension
- **NKDA**
- **Current medications**
  - Cefepime 2 g IV every 8 hr
  - Vancomycin 1250 mg IV every 12 hr
  - Norepinephrine 30 mcg/min IV continuous infusion
  - Hydrocortisone 50 mg IV every 6 hr
  - Pantoprazole 40 mg IV every 24 hr
  - Heparin 5000 units subcutaneously every 8 hr

Case #3

- **Vital signs:**
  - RR: 18/min
  - Pulse: 98-104 bpm, sinus tachycardia
  - BP: 70/60 mm Hg
  - Temp: 101.5°F
- **Weight:** 82 kg
- **Height:** 5’11’’ (180.34 cm)
- **Body mass index:** 25.1 kg/m^2
- **Triglycerides:** 123 mg/dL

Case #3

- **Laboratory data**
  - WBC: 19.1 x 10^3 cells/mm^3
  - Arterial blood gas (ABG)
    - pH 7.35
    - pCO_2 40 mm Hg
    - pO_2 90 mm Hg
    - HCO_3 24 mEq/L
  - Phosphorus: 3.8 mg/dL
  - Magnesium: 2 mg/dL



Case #3
PN Formulation: Amounts per Day

• Amino acids	100 g
• Dextrose	225 g
• ILE	50 g
• Micronutrients	
○ Sodium chloride	80 mEq
○ Sodium phosphate	25 mmol
○ Potassium acetate	40 mEq
○ Magnesium sulfate	12 mEq
○ MVI	10 mL
○ Trace elements	1 mL
• Cu, Cr, Mn, Se, Zn	

Case #3

- **Alert received from the compounding pharmacy:**
  - A national ILE shortage is impacting most lipid products, including soybean-based and mixed oil ILE products
- **Interprofessional team collaborates to determine their strategy to manage the ILE shortage**

Which recommendation regarding ILE provision is most appropriate for Cathy at this time?

a. Withhold ILE
b. Continue to provide ILE, but limit to 100 g/week
c. Continue to provide ILE as a daily macronutrient at the current dose
d. Intubate and initiate propofol for lipid content

Case #3

- **2 weeks elapse:**
  - Cathy's requirement for PN persists
  - Soybean-based and mixed oil ILE products remain limited

After withholding ILE for 2 weeks, which recommendation is most appropriate for Cathy at this time?

a. Continue to withhold ILE until evidence of EFAD
b. Continue to withhold ILE, but apply safflower oil daily
c. Resume ILE, but limit to 100 g/week
d. Resume ILE as a daily macronutrient at the original dose

The ILE shortage resolves. Which recommendation is most appropriate for PN management in Cathy and other adult hospitalized patients?

a. Provide ILE at full daily dose
b. Limit ILE to 100 g/week for cost savings
c. Provide ILE twice weekly to conserve supply
d. Stockpile ILE to ensure future supply

Key Takeaways

- Appropriate filtering of PN is imperative to ensure safe administration.
- Healthcare organizations should convene key stakeholders to define how photoprotection can be achieved and implement strategies.
- Interprofessional communication is essential to address the challenges and safety implications of PN component shortages.

How will you change your practice?

- Review current practice and policies at my institution in light of clinical consensus recommendations available through ASPEN
- Discuss with colleagues the recent recommendations for the use of filters in PN to ensure patient safety
- Implement strategies for photoprotection of PN for premature infants at my institution
- Develop a plan for preparation of PN to ensure patient safety when PN products are in short supply
- Implement strategies for ensuring safe and effective therapy when PN components are in short supply.

Take a moment to reflect on changes you would make based on what you learned today.

Selected Resources

- Christensen ML, Ayers P, Boullata JI et al. Lipid injectable emulsion survey with gap analysis. *Nutr Clin Pract.* 2017; 32:604-702.
- Worthington PW, Gura KM, Kraft MD et al. Update on the use of filters for parenteral nutrition: an ASPEN position paper. *Nutr Clin Pract.* 2021; 36:29-39.
- Robinson DT, Ayers P, Fleming B et al. Recommendations for photoprotection for premature infants: an ASPEN position paper. *Nutr Clin Pract.* 2021; 36:927-41.
- Holcombe B, Mattox TW, Plogsted S. Drug shortages: effect on parenteral nutrition therapy. *Nutr Clin Pract*. 2018; 33(1):53-61.