Nutrition Information at Your Fingertips—Using Apps, Videos and Online Resources

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I. Using ASPEN resources
   a. Videos
   b. eBooks

II. YouTube videos
   a. Feeding tubes
   b. Central lines
   c. Healthcare provider focus
   d. Patient focus

III. Organization resources
   a. Individual hospitals
   b. Professional organizations
   c. Consumer resources
      i. Oley Foundation
      ii. Feeding Tube Awareness Foundation
      iii. CCFA
Central Venous Access Devices and Troubleshooting Recurrent Line Infections

Disclosures
I have no commercial relationships to disclose.

Presentation Overview/Summary
- This presentation will focus on central venous access devices (CVAD) commonly used with parenteral nutrition. Discussions will focus on device selection, basic care and management, and line infection prevention strategies. Participants will have the opportunity to directly interact with commonly used CVADs and training tools.

Learning Objectives
At the conclusion of the presentation, the learner will be able to:
1. Differentiate between central and peripheral venous access devices.
2. List the different types of central venous access devices.
3. Recall two strategies for reducing a patient's risk for line infection.

Key Takeaways/Fast Facts
- Central venous access devices are an important part of nutrition support.
- All nutrition support staff should have a basic understanding of central venous access devices.
- Patients with frequent central line infections may benefit from additional infection prevention measures beyond the standard central line care bundle.

Learning Assessment Questions
1. Question 1: Where should the distal end of a CVAD terminate in the body when compared with a peripheral IV catheter?
   A. Within the inferior vena cava above the level of the diaphragm
   B. Radial vein
   C. Lower 1/3 of the superior vena cava or cavoatrial junction
   D. Both A & C

2. Question 2: At what osmolality does ASPEN recommend PN administration via a CVAD?
   A. Below 700 mOsm/L
   B. Above 900 mOsm/L
   C. Above 1100 mOsm/L
   D. Below 1350 mOsm/L

3. Question 3: Which of the following strategies is most likely to reduce a patient's risk for developing a central line-associated bloodstream infection (CLABSI)?
   A. Flush with additional saline before and after PN infusion
   B. Use ethanol lock therapy when PN is not infusing
   C. Increase heparin lock concentration
   D. Exchange central line for one with more lumens

4. Question 4: Which of the following is an indication for placement of a central venous access device (CVAD)?
   A. Parenteral nutrition
   B. Chemotherapy
C. Vasoactive medication infusion  
D. All of the above

5. Question 5: The medical provider of a patient with a central line that is presenting with a fever of 38°C or greater should be notified immediately.
   A. True  
   B. False

Learning Assessment Answers:
1. Answer = D; Rationale: According to the Journal of Infusion Nursing 2016 Infusion Therapy Standards of Practice, the safest position of the CVAD tip is the cavoatrial junction (CAJ). In patients with lower extremity CVADs, tip placement in the inferior vena cava above the level of the diaphragm is recommended. Cardiac arrhythmias can occur if the tip of the CVAD is positioned too deeply and makes contact with tricuspid valve or right ventricle. If the CVAD tip is distal to the CAJ, the patient is at greater risk for complications like infection, thrombus, and occlusion.
2. Answer = B; Rationale: A.S.P.E.N recommends infusing parenteral solutions with osmolalities greater than 900 mOsm/L via a central venous catheter. Although some adult studies show limited safety data with infusion of parenteral solutions with osmolalities greater than 900 mOsm/L, the infusion of high osmolality solutions can lead to the development of thrombophlebitis. Parenteral solutions with osmolalities below 900 mOsm/L are considered safe to infuse via a peripheral venous catheter.
3. Answer = B; Rationale: Ethanol lock is used in place of heparin or saline locks as a means of CLABSI prophylaxis. Ethanol lock kills infection causing pathogens in CVADs to reduce the risk of CLABSI. Answers A and C will not reduce a patient’s CLABSI risk. Answer D will increase the patient’s CLABSI risk.
4. Answer = D; Rationale: Parenteral nutrition, chemotherapy, and vasoactive medications should all be administered via a CVAD. Infusion of these types of medications via a peripheral catheter is unsafe in most cases and can lead to patient harm.
5. Answer = A, True; Rationale: A patient with a central venous access device is at risk for a central line associated bloodstream infection (CLABSI). A CLABSI can be life-threatening if not immediately treated.

References
Pediatric Skills Lab Nutrition Science and Clinical Practice

Nutritional Assessment in children with mobility impairment & neurodevelopmental challenges: is this child nutritionally ready for a big surgical procedure?

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Feeding problems & poor nutrition are common in children with neurodevelopmental problems & motor impairments. These children are often unable to consume adequate nutrients, transition to age-appropriate foods, swallow with ease or grow according to standards for typical children. This session will provide an opportunity to explore the importance of nutritional assessment in children with neurodisabilities using appropriate measuring and monitoring tools to develop appropriate nutritional rehabilitation plans for these children before they undergo major surgery.

What is known about the nutritional status of children with neurodevelopmental challenges?

For children with neurodisabilities,

- Good nutrition improves:
  - Overall developmental progress
  - Health & longevity
  - Community participation
  - Bone health

- Poor nutrition is remedial a good nutritional care plan is important in the rehabilitation toolkit

- If children are going to be undergoing a major surgical procedure, optimizing nutrition is important for
  - Wound healing
  - Improving immune status
  - Improving respiratory muscle strength
  - Decreasing the stay in the intensive care units

What are the causes of poor nutritional status in children with neurodisabilities?

- Nutritional factors
  - Inadequate intake
  - Poor utilization of nutrients
  - Increased losses
  - Energy expenditure

- Non-nutritional factors
  - Endocrine
  - Neurological factors

If nutrition is important, how do we ensure we are assessing & monitoring it correctly?

- History & physical
- Anthropometry
  - Weight
  - Height or Length or Segmental measures
  - Head Circumference
  - Triceps skin fold
- Growth Chart
  - WHO growth charts
  - CP growth charts
- Weight gain velocity
- Body composition
- Interpreting the measurements

How do we formulate an appropriate treatment plan for children with CP before surgery?

- Use appropriate anthropometrics and monitoring tools (CP growth charts, TSF norms from WHO)
Engage parents in the nutrition treatment plan

Estimate energy requirements correctly for oral and enteral nutrition
  o You may need to aim low: 75% of the calculated caloric requirements for typical children if current calorie intake is totally unknown
  o If the child’s intake is known and weight gain velocity is low, consider increasing calories by 10%

Maximize oral nutrition
  o Manipulation of nutritional intake: calories, macro- and micro-nutrients
  o Provide appropriate texture, viscosity of food
  o Careful, well-paced feeding
  o Position well
  o Ensure the teeth are in good shape
  o Address constipation and reflux

Enteral nutrition
  o Feeding enough but not too much
  o Exact nutritional requirements not clear so frequent follow up required until the weight gain trajectories are reached
  o Enteral feeding does not solve all nutritional problems
    ▪ Does not decrease risk of pneumonias

Prior to surgery
  o Assess as early as possible
  o Measure and monitor the children regularly
  o Tweak nutritional intake by oral or enteral means
    ▪ May need to introduce enteral nutrition if the child is severely undernourished
  o Try to get the TSF >10th percentile for age
  o Improve weight so that the child no longer plots in the zone of concern (<20th percentile) on the Brooke’s 2011 CP growth chart
  o Target a weight gain velocity of 5-7 grams per day if the child is > 1 year of age

Conclusion
  • Good nutrition is an important part of neuro-rehabilitation, growth & development
  • The earlier we provide good nutrition, the better the outcome for children with CP undergoing procedures
  • Assessment of nutritional status is not always straightforward
  • Measuring and monitoring nutritional status is important
  • Parental support & engagement in nutritional care leads to better outcomes.

Questions
1. Which of the following measurements are important in deciding on appropriate growth in children with neurodevelopmental challenges?
   a. Weight
   b. Triceps Skin Fold
   c. Body Mass Index or Weight for Height
   d. a, b, c
   e. a & b

2. True or False
   Segmental measurements for children with neurodevelopmental challenges are validated measures of length & height

3. Energy expenditure in children with neurodevelopmental challenges is:
   a. Similar to age matched peers
   b. Can be estimated by simple clinical measures
   c. Determined by the degree of motor impairment
   d. a, c
   e. a, b, c

4. Gastrostomy feeding
   a. Decreases the occurrence of aspiration pneumonia
b. Is associated with weight gain

c. Is associated with weight gain prior to height gain

d. All of the above

e. “b” & “c”

ANSWERS: 1:E, 2: True, 3: D, 4: E

References:
1. Why the Neonatal Guideline for Malnutrition was made
   a. What was excluded
2. How to Use the Neonatal Guideline
3. When to Transition to the Pediatric Guideline
Neonatal Malnutrition

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Presentation Title
Pediatrics Basic Skills Lab: Pediatric Gastrostomy Site Problems: Solving Clinical Challenges in Skin Management

Disclosures
- I presented at CSPEN on gastrostomy tube management in 2018 – paid an honorarium
- I was a paid consultant for Infinity/Moog in 2018
- I presented at SPN on Creating an Enteral Access Team to management g-tubes in 2016 – no payment

Presentation Overview/Summary
- This is a skills lab to discuss complicated skin management problem at a gastrostomy tube site in the pediatric population.

Learning Objectives
- To identify the most common complications that pediatric patients experience relating to a gastrostomy tube:
  - Skin erosion and gastric mucosal prolapse
  - Infection/Cellulitis
  - Improper resizing of gastrostomy tubes
  - Treatment of multiple complications at a g-tube site
    - Assisting families in managing the g-tube at home
- To assess complications and identify appropriate interventions.
- To implement a plan of care when the above complications around a g-tube occur.

At the conclusion of the presentation, the learner will be able to:
1. Identify and implement interventions for complicated skin concerns at a g-tube site.
2. Create a plan of care for the g-tube site
3. Establish continuity of g-tube care.

Key Takeaways/Fast Facts
- The management of skin around the gastrostomy tube is vital to ensure that pediatric patients can receive nutrition and medication. Identifying skin complications early and implementing the appropriate plan of care will ensure a safe continuity of care for these patients.

References
Learning Assessment Questions:

1. Which of the following lipid injectable emulsions (ILE) products contains the greatest percentage of alpha-linolenic acid and linoleic acid?
   a. Intralipid (soybean oil fat emulsion, SOFE)
   b. Omegaven (fish oil fat emulsions, FOFE)
   c. ClinoLipid (soybean/olive oil fat emulsion, SO-OOFE)
   d. SMOFLipid (mixed oil fat emulsions, MOFE)

2. In evaluating a patient for essential fatty acid deficiency, which of the following triene:tetraene ratios would be of concern for a severe deficiency?
   a. A triene:tetraene ratio of 0.01
   b. A triene:tetraene ratio of 0.07
   c. A triene:tetraene ratio of 0.15
   d. A triene:tetraene ratio of 0.25

3. Which of the following systems is impacted the most by essential fatty acid deficiency in neonates?
   a. Respiratory
   b. Cardiovascular
   c. Nervous
   d. Renal

4. Which of the following is the rate-limiting component to determine the minimum intake to meet estimated needs for essential fatty acids with the use of mixed oil fat emulsions (MOFE, SMOFLipid)?
   a. Linoleic acid (LA)
   b. Alpha-linolenic acid (ALA)
   c. Docosahexanoic acid (DHA)
   d. Eicosapentaenoic acid (EPA)

5. Which of the following has poised the greatest practical challenge for neonatal intensive care units utilizing mixed oil fat emulsions (SMOFLipid) as part of their standard parenteral nutrition regimen?
   a. Development of dose checks within smart pump software
   b. Limited intravenous compatibility with other medications
   c. Repackaging of lipid injectable emulsions for use in neonatal patients
   d. Concerns for allergic reaction to the mixed oil fat emulsion
Learning Objectives
At the completion of this presentation, the participant should be able to:
1. Identify the benefits and concerns with lipid injectable emulsions (ILE).
2. Describe the evolution and composition of ILE products.
3. Understand how different ILEs and dosing strategies can predispose a neonate to essential fatty acid deficiency (EFAD).
4. Discuss the use of mixed oil-based fat emulsions (MOFE) in the neonatal population.

Review of ILEs
Importance of ILEs
- Dense source of calories
- Source of essential fatty acids (EFAs)
- Alpha-linolenic acid (ALA, omega-3 FA)
- Linoleic acid (LA, omega-6 FA)
- Important component of cell membranes

Concerns about ILEs
- Soybean oil-based fat emulsions (SOFE) approved in US in 1972 and have been only FDA approved products to come to market until recently
- European products have varied in attempt to find ideal oil source(s)
- Concern for fat overload syndrome due to rapid infusion or increased dose
- Concern regarding association with development of liver disease with SOFE
  - Strategies employed to minimize or restrict soybean oil component
  - However, decreased caloric content provided to parenteral nutrition (PN) dependent patients results in less than ideal growth

Evolution of ILEs
Recent FDA approvals
- 2013 – ClinoLipid (SO:OO)
- 2016 – SMOFlipid (MOFE)
- 2018 – Omegaven (FOFE)

Composition of ILEs
Potential modifications to ILE usage
Potential options
- Use of fish oil-based fat emulsions (FOFE)
- Use of lipid minimization strategies
- Only for SOFE products
- Use of mixed oil-based fat emulsions (MOFE)

Potential concerns with options
- Essential fatty acid deficiency (EFAD)
- Potential for decreased rate of growth especially with minimization strategy

Determination of EFAD
- Triene:Tetraene ratio
  - Mild EFAD = Triene:Tetraene ratio > 0.05
  - Severe EFAD = Triene:Tetraene ratio > 0.2

Implications of EFAD
- Loss of EFAs leads to number of consequences
- How to detect EFAD?
  - Biggest changes are in neural system
Potential benefits of MOFEs
- Prevention and treatment of intestinal failure-associated liver disease (IFALD)
- Decrease in bronchopulmonary dysplasia (BPD)
- Decrease in retinopathy of prematurity (ROP)

Concerns with MOFEs
- Not FDA approved in pediatrics
- Provision of EFAs

Akon Children’s Hospital usage of MOFE
- Practical challenges with MOFE

Answers to Learning Assessment Questions:
1. Answer = A. Each of the ILE products contain varying amounts of alpha-linolenic acid. The greatest percentage is found in 100% soybean oil fat emulsions such as Intralipid with 50% linoleic acid (LA) and 9% alpha-linolenic acid (ALA) (Answer A is correct). The second highest would be a mixed oil fat emulsion such as SMOFLipid which is 30% soybean oil based and contains 21.4% LA and 2.5% ALA (Answer D is incorrect). The third highest would be a soybean/olive oil fat emulsion such as ClinoLipid which is 20% soybean oil based and contains 18.5% LA and 2% ALA (Answer C is incorrect). Finally, a fish oil fat emulsion such as Omegaven which does not contain any soybean oil and contains only 4.4% LA and 1.8% ALA (Answer B is incorrect). However, a fish oil fat emulsion contains the most eicosapentaenoic acid and docosahexaenoic acid of any of the products.

2. Answer = D. Mild essential fatty acid deficiency is defined as a triene:tetraene ratio of greater than 0.05 (Answer A is incorrect). A severe essential fatty acid deficiency with biochemical evidence of a deficiency is defined as a triene:tetraene ratio of greater than 0.2 (Answer D is correct; Answers B and C are incorrect).

3. Answer = C. Signs and symptoms of essential fatty acid deficiency include: diffuse dry, scaly rash, alopecia, thrombocytopenia, anemia, and impaired wound healing. The biggest impact primarily in the neonate is the impact on the nervous system due to the importance of essential fatty acids in the development of the central nervous system (Answer C is correct; Answers A, B, and D are incorrect).

4. Answer = B. If one calculates the amount of each of the essential fatty acids or conditionally essential fatty acids for premature infants which would be provided by a mixed oil fat emulsions such as SMOFLipid to meet the estimated accretion rates of the third trimester, one would determine the rate-limiting minimum intake to be the alpha-linolenic acid (ALA) content found in 2 g/kg/day of SMOFLipid (Answer B is correct). Other minimum intakes are less and can be minimally met with this same 2 g/kg/day with the exception of arachidonic acid (ARA) needs which cannot be met with any of the currently available lipid injectable emulsion formulations (Answers A, C, and D are incorrect).

5. Answer = B. The greatest challenge for neonatal intensive care units utilizing mixed oil fat emulsions as part of their standard parenteral nutrition regimen is the lack of intravenous compatibility with other medications (Answer B is correct). Limited compatibility with other medications proves problematic in patients with already limited intravenous access and often requires the nurse to pause the lipid injectable emulsion (ILE) infusion while infusing the other medication. This has led to potential occlusions of the 1.2 micron filter for ILE. As with other ILEs, current recommendations caution against the repackaging of these products due to concerns for contamination and would recommend infusion from the unaltered manufacturer’s intravenous bag. If syringes are utilized for repackaging, the infusion should be completed within 12 hours. While this may pose a challenge in neonatal patients, it is frequently handled without extreme difficulties with the soybean oil fat emulsion which has been previously used in the United States. However, caution should be given to developing a process in which mixed oil fat emulsion syringes and soybean oil fat emulsion syrings are not confused during the repackaging process of both ILEs are utilized in the hospital (Answer C is incorrect). If the intravenous bag from the manufacturer is utilized, dose checks should be incorporated in the pump as with any other intravenous medication (Answer A is incorrect). While the mixed oil fat emulsion product contains more than soybean oil, neonatal patients rarely develop allergic reactions to oil or fish products during this period of life (Answer D is incorrect).

References:
Learning Objectives

At the completion of this presentation, the participant should be able to:
1. Identify the benefits and concerns with lipid injectable emulsions (ILE).
2. Describe the evolution and composition of ILE products.
3. Understand how different ILEs and dosing strategies can predispose a neonate to essential fatty acid deficiency (EFAD).
4. Discuss the use of mixed oil-based fat emulsions (MOFE) in the neonatal population.

Importance of ILEs

- Dense source of calories
- Source of essential fatty acids (EFAs)
  - Alpha-linolenic acid (ALA, omega-3 FA)
  - Linoleic acid (LA, omega-6 FA)
- Important component of cell membranes
- Precursor to key modulators involved in cellular pathways of immune response

Recent FDA approvals

- Soybean oil-based fat emulsions (SOFE) approved in US in 1972 and have been only FDA approved products to come to market until recently
- European products have varied in attempt to find ideal oil source(s)
- Concern for fat overload syndrome due to rapid infusion or increased dose
- Concern regarding association with development of liver disease with SOFE
  - Strategies employed to minimize or restrict soybean oil component
  - However, decreased caloric content provided to parenteral nutrition (PN) dependent patients results in less than ideal growth
Recent FDA approvals

• 2013 – ClinoLipid (SO:OO)
  o 20% Soybean (SO)
  o 80% Olive (OO)
• 2016 – SMOFlipid (MOFE)
  o 30% Soybean
  o 30% Medium-chain triglycerides (MCT)
  o 25% Olive
  o 15% Fish (FO)
• 2018 – Omegaven (FOFE)
  o 100% Fish

Composition of ILEs

So what can we do?

Potential options

• Use of fish oil-based fat emulsions (FOFE)
• Use of lipid minimization strategies
  o Only for SOFE products
• Use of mixed oil-based fat emulsions (MOFE)

So what do people in the audience do?

A. Use of FOFE
B. Use of SOFE minimization strategies
C. Use of MOFE
D. Patients on PN develop problems?

Potential concerns with options

• Essential fatty acid deficiency (EFAD)
• Potential for decreased rate of growth especially with minimization strategy
Determination of EFAD

- Triene:Tetraene ratio
  - Mild EFAD = Triene:Tetraene ratio > 0.05
  - Severe EFAD = Triene:Tetraene ratio > 0.2
- Evaluation of individual components
  - Alpha-linolenic acid
  - Alpha-linoleic acid
  - Arachidonic acid
  - Docosahexaenoic acid (DHA)
  - Eicosapentaenoic acid (EPA)

Implications of EFAD

- Loss of EFAs leads to number of consequences
  - n-3 deficient diet leads to abnormal brain waves and electroretinograms
  - Loss of 18:3n-3 leads to a loss of 22:6n-3 (docosahexaenoic acid) in brain and increased 22:4n-6 and 22:5n-6 concentrations
  - Animal studies have not precisely reported functional differences resulting from differences in CNS 22:6n-3 concentrations
- How to detect EFAD?
  - Biggest changes are in neural system
  - However, we are only monitoring absolute serum levels

Current recommendations – Premature neonates

- EFAs – minimum requirements:
  - Linoleic acid = 385-1540 mg/kg/day
  - Alpha-linolenic acid ≥ 50 mg/kg/day
- EFAs – estimated needs based on intrauterine accretion rates of FAs, third trimester:
  - Linoleic acid = 106 mg/kg/day
  - Alpha-linolenic acid = 4 mg/kg/day

Calculation of SMOFlipid to provide sufficient amount to meet estimated accretion rates

- LA: 0.54g/kg/day SMOFlipid to meet estimated 3rd trimester LA accretion rate
- ALA: 0.8 mL/kg/day or 0.16g/kg/day SMOFlipid
- ARA: 212 mL/kg/day or 42g/kg/day SMOFlipid → Impossible to meet, DO NOT GIVE THIS DOSE
- DHA: 9.3-13 mL/kg/day or 1.9-2.6g/kg/day SMOFlipid

Note: Same mathematical approach used as examples above, just using the estimated accretion rates instead of the current recommendation values.

Summary

- The rate-limiting minimum intake to meet estimated needs is the ALA content at 2 g/kg/day; other minimum intakes are less and can be minimally met with this amount as well, with the exception of ARA needs, which cannot be met by the current formulations of intravenous lipid emulsions.
Can MOFE help?

Potential benefits of MOFEs

• Prevention and treatment of intestinal failure-associated liver disease (IFALD)
• Decrease in bronchopulmonary dysplasia (BPD)
• Decrease in retinopathy of prematurity (ROP)

Concerns with MOFEs

• Not FDA approved in pediatrics
  - US Boxed Warning for death in preterm infants
    - Same warning with Intralipid product
• Provision of EFAs
  - Reduced from SOFE products
    - Exact dose still being investigated → one goal of current US multicenter trials
    - Per manufacturer, need minimum of 2 g/kg/day to prevent EFAD in neonates

Select MOFE studies – IFALD

<table>
<thead>
<tr>
<th>Publication</th>
<th>Study Type</th>
<th>MOFE</th>
<th>SOFE</th>
<th>Significant Difference</th>
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<tbody>
<tr>
<td>Skouroliakou M, et al.</td>
<td>Randomized controlled trial</td>
<td>No change in Gal</td>
<td>Yes change in Gal</td>
<td>MOFE significantly reduced bilirubin levels</td>
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<tr>
<td>Skouroliakou M, et al.</td>
<td>Randomized controlled trial</td>
<td>No change in TAP</td>
<td>Yes change in TAP</td>
<td>MOFE significantly increased total antioxidant potential (TAP)</td>
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<tr>
<td>Skouroliakou M, et al.</td>
<td>Randomized controlled trial</td>
<td>No change in IL-6 and IL-8</td>
<td>Yes change in IL-6 and IL-8</td>
<td>MOFE significantly decreased IL-6 and IL-8 levels at end of treatment</td>
</tr>
</tbody>
</table>

Select MOFE studies – BPD

• In group of VLBW infants, lower incidence BPD in MOFE group vs. SOFE group (not statistically significant)
  - Logistic regression found both type of ILE and mechanical ventilation days significantly impacted likelihood of developing BPD
• Inflammation status improved with MOFE
  - Significantly increased total antioxidant potential (TAP) at 14 days in MOFE group compared to SOFE
  - Significantly decreased IL-6 and IL-8 levels at end of treatment in MOFE

Select MOFE studies – ROP

• One study of VLBW premature infants (birthweight <1500g) receiving PN with ILE dose up to 3 g/kg/day
• Rate of ROP significantly lower in MOFE group:
  - n = 2 in MOFE group (5%)
  - n = 13 in SOFE group (32.5%)
    - p = 0.004; OR = 9.1; CI 1.9-43.8
• Multivariate analysis done taking into account gestational age, respiratory distress syndrome, sepsis, necrotizing enterocolitis, number of hyperglycemic events, transfusions, duration of supplemental oxygen and ILE type
  - MOFE only factor associated with decreased risk of ROP
    - p = 0.018; p = 0.04
**MOFE study – ROP**

- One study of VLBW premature infants (birthweight <1500g) receiving PN with ILE dose up to 3 g/kg/day
- Rate of ROP significantly lower in MOFE group:
  - n = 2 in MOFE group (5%)
  - n = 13 in SOFE group (32.5%)
  - p = 0.004; OR = 9.1; CI 1.9-43.8
- Multivariate analysis done taking into account gestational age, respiratory distress syndrome, sepsis, necrotizing enterocolitis, number of hyperglycemic events, transfusions, duration of supplemental oxygen and ILE type
  - MOFE only factor associated with decreased risk of ROP
    - OR = 0.76, p = 0.04

**Adoption of MOFE for select patients in Akron Children’s NICU**

- Historically, have used lipid minimization strategies for long-term PN patients for treatment and prevention of IFALD
- However, despite maximizing glucose infusion rate (GIR) still not enough calories for ideal growth
- Decision made to use MOFE in January 2017 for these patients

**ACH NICU usage to date**

- Initiate at 2 g/kg/day and increase by 1 g/kg/day to goal of 3 g/kg/day
- Doses ≤ 2 g/kg/day infused over 12 hours; doses > 2 g/kg/day infused over 18 hours
- Patients with potential for long-term PN use, leave at 2 g/kg/day

**Practical challenges with MOFE**

- Separation from current SOFE process in ACH pharmacy
  - SOFE = pre-drawn syringes in 10 mL increments
  - MOFE = 100 mL intravenous bags
- Dose checks in Smart pump software
  - g/kg/day limits
  - Minimum infusion time limits
- Limited IV compatibility
  - Compatible with PN, furosemide, fentanyl, ranitidine and select concentrations of morphine, milatracin, abutanine, carfazidine, flocinazole, metamizadine, vancomycin, and tamoctidine
  - Have co-infused with dexmedetomidine, insulin and select concentrations of dopamine
  - Hold infusion for other medications
  - Potential for occlusion of 1.2 micron filter for ILE

**Summary**

- ILEs are important source of calories and EFAs but concerns exist about their association with IFALD
- Until recently, US market with only SOFE products but other ILEs available in Europe and Canada composed of other oil sources and ratios
- Adjustments in ILE provision must be done carefully because not all ILEs or dosing strategies provide the same EFAs
- Use of MOFE may be beneficial in neonatal population, particularly for IFALD

**Questions?**
References

- Clinolipid (fat emulsion plant based) [prescribing information]. Deerfield, IL: Baxter Healthcare Corporation; July 2016.
- Intralipid 20% (IV fat emulsion) [prescribing information]. Deerfield, IL: Baxter Healthcare Corporation; May 2015.
- Omegaven (fish oil triglycerides) [PI]. Graz, Austria: Fresenius Kabi; July 2018.
Nutrition Focused Physical Examination: Applying Principles in Complex Situations

Disclosures
- “I have no commercial relationships to disclose”

Presentation Overview/Summary
- Nutrition focused physical exam is one of the domains of the nutrition assessment in the Nutrition Care Process. While the assessment of fat and muscle stores in pediatric patients has similarities with the adult NFPE, there are some unique differences inherent to the pediatric population. In younger patients, evaluation of fat and muscle stores may be more appropriate than evaluating fat and muscle loss. Documenting NFPE using consistent, descriptive terms is important when monitoring for changes.

Learning Objectives
At the conclusion of the presentation, the learner will be able to:
1. Describe the components of a nutrition focused physical exam
2. Evaluate subcutaneous fat stores in a pediatric patient
3. Evaluate muscle stores in a pediatric patient

Key Takeaways/Fast Facts
- Nutrition focused physical exam is an important part of the nutrition assessment of a pediatric patient.
- NFPE can help clarify nutrition status in patients with variable anthropometrics.

References
Some topics for consideration

PN shortages

• Sodium options
  o NS
  o 3% NaCL
  o 5% NaCL
  o Oral
    ▪ Table salt
    ▪ Salt substitutes

• Potassium options
  o 10 mEq/L bags
  o Oral products
    ▪ Cl vs Bicarb
    ▪ Salt substitutes

<table>
<thead>
<tr>
<th>Product</th>
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<th>mg per tsp</th>
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<tbody>
<tr>
<td>Table Salt</td>
<td>102 sodium</td>
<td>2360 sodium</td>
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<tr>
<td>Morton Lite Salt</td>
<td>50 sodium</td>
<td>1160 sodium</td>
</tr>
<tr>
<td></td>
<td>35 potassium</td>
<td>1400 potassium</td>
</tr>
<tr>
<td>Morton’s Salt Sub</td>
<td>62.5 potassium</td>
<td>2440 potassium</td>
</tr>
</tbody>
</table>

Use of Standardized Commercially Available PN Products in Pediatrics

• Electrolyte content
• Calcium/phos issue

Potential hazards of custom IV fluids during component shortages

Oclusions

• L-cysteine
• Bicarb
• Ethanol

PN and the Ketogenic Diet

• Appropriate ratio?
• 30% lipids

Patient with neurological deficit requiring less calories

Use of SMOFlipid in the pediatric patient—when not to use

Interpreting labs in an unstable patient

Amino acid choices—Inborn Errors of Metabolism
Learning Objectives

1. Discuss options for PN component replacement during drug shortages
2. Options for treatment of occluded central lines with regards to USP 797 Guidelines
3. Use of Standardized Commercially Available PN Products
4. PN and the Ketogenic Diet

Occlusion in the PN Line

• DD is a 6 mo 5.5 kg female with SBS, ileostomy who is receiving PN which is providing the patient with 93 kcal/kg, 3g/kg of protein, 1.5 g/kg of lipid and 120 mL/kg of fluid and Imina GIR of 13.3 mg/kg. In addition she is receiving replacement fluids for her high ileostomy output

• Her electrolytes intake incudes:
  - Na 6 mEq/kg
  - K 3 mEq/kg
  - Ca 2.8 mEq/kg
  - Phos 1.4 mmol/kg
  - Mag 0.5 mEq/kg
  - Zinc 0.8 mg/kg
  - Copper 20 mcg/kg
  - Standard Vitamins

• Her liver enzymes are rising however her alkaline phosphatase is dropping to below normal for her age and she is developing a skin rash suggesting that she developing a zinc deficiency. A measured serum zinc was low.

• It was decided to increase the zinc to 1 mg/kg and continue with the current intake of the other electrolytes
Disclosures

- After 2 days the PN line was sluggish then became totally occluded.
- What are your thoughts and what are you going to do?

Ketogenic Diet and PN

- The ketogenic diet is designed to establish and maintain ketosis in children with difficult to control epilepsy.
- The diet is very high in fat and low in carbohydrates and protein.
- Calories and fluid are strictly controlled and all food and fluids have to be precisely weighed and measured.

Sample Calculations of Daily Energy Requirements for the 3 : 1 Classic Ketogenic Diet for a 18 kg Patient

- Daily caloric requirement
  - (i) Total body weight × 68 cal/kg/day
  - (ii) 18 kg × 68 cal/kg/day = 1224 cal/day
- Daily number of dietary units
  - (i) For 3 : 1 (fat : protein/carbohydrate)
  - (a) 3 g fat/unit × 9 cal/g fat → 27 calories
  - (b) 1 g protein or CHO/unit × 4 cal/g protein or carbohydrate (CHO) = 4 calories
  - (c) 27 + 4 = 31 calories/unit
  - (ii) Daily caloric requirement - calories/unit = dietary units/day
  - (a) 1224 - 31 = 39 units/day

- Daily fat content
  - (i) Dietary units/day × g fat/unit = g fat/day
  - (ii) 39 units/day × 3 g fat/unit = 117 g fat/day
- Daily protein and CHO content (combined)
  - (i) Dietary units/day × g protein or CHO/unit = g protein or CHO/day
  - (ii) 39 units/day × 1 g protein or CHO/unit = 39 g protein and CHO/day
- Daily protein content = 1 g/kg/day
  - (i) 1 g/kg/day × 18 kg = 18 g/day
  - Daily carbohydrate content
  - (i) Combined protein and CHO content – daily protein content = daily carbohydrate content
  - (ii) 39 g protein and CHO/day – 18 g protein/day = 21 g CHO/day

Final Enteral Goals

- Protein 18 g
- Fat 117 g
- CHO 21 g
- Total calories = 1209

PN Order

- Fluid maintenance ~1400 mL/day
- Even if you desire to decrease the caloric intake parenterally to only 1000 kcal/day the amount of intravenous lipid would still be >100 g/day or 5.5 g/kg
- The glycerol content of 100 g of 20% intravenous fat emulsion (500 mL) would be ~25 g**

**Glycerol = 4.2 kcal/g
Any Options

• Changing the ratios from 4:1 or 3:1 to a lower ratio such as 2:1
• Advancing lipids to a total of 4 g/kg
• Short PN duration

Summary

• Pediatric PN management can be a difficult task
• Often solutions are not as simple as they seem
Disclosures

References


Parenteral Nutrition Order Writing in the Face of Clinical Challenges

Objective: Formulate nutrition care plans for neonates receiving parenteral nutrition in the face of challenging clinical scenarios.

1. Refeeding Syndrome:
   a. Early protein use may simulate a “refeeding-like” syndrome in the first days of life
      i. Due to disruption of placental feeding
      ii. Early TPN keeps cells in anabolic state & promotes uptake of PO4
      iii. PO4 need for ATP production & cell membrane maintenance
   b. Nutritional disturbances
      i. high PO4 consumption by cells causes decreases in serum PO4
      ii. Bone acts as reservoir & releases Ca & PO4
      iii. Hypophosphatemia
      iv. Hypercalcemia & hypercalciuria
         1. Hypercalcemia secondary to hypophosphatemia
   c. Refeeding syndrome characteristics

<table>
<thead>
<tr>
<th>Metabolic Sequelae</th>
<th>Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypophosphatemia</td>
<td>Cellular uptake of PO4 under influence of insulin for the synthesis of ATP,DNA,RNA, proteins &amp; phosphorylation of glucose</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Glucose introduction into a starved system adapted to fat metabolism</td>
</tr>
<tr>
<td>Hypomagnesemia</td>
<td>Cellular uptake after feeding (ATP)—mediator of hypocalcemia, &amp; hypokalemia</td>
</tr>
<tr>
<td>Hypokalemia</td>
<td>Induced by insulin produced in response to the nutritional load</td>
</tr>
<tr>
<td>Fluid Overload</td>
<td>Due to Na retention effects of hyperglycemia &amp; hyperinsulinemia</td>
</tr>
<tr>
<td>Vitamin Deficiency</td>
<td>Rapid depletion due to role in biochemical fxs. Thiamine depleted during starvation &amp; further depleted when glucose introduced</td>
</tr>
<tr>
<td>Trace Element Deficiency</td>
<td>Zn &amp; Se involved in DNA/RNA metabolism; oxidative-reduction processes (enzymatic activity during anabolic processes)</td>
</tr>
</tbody>
</table>

d. Monitoring
   i. Zinc deficiency – consider additional zinc when alk phos <200 units/ml
      1. Can precipitate calcium and phosphorous salts
         i. Zinc conc ≥ 16 mg/L trophamine/premasol
         ii. Zinc conc ≥ 12 mg/L travasol
   ii. Keep magnesium level upper level of normal range
   iii. Maintain a dosing weight until refeeding abnormalities resolve – increasing dosing weight can result in unintentional advancement in calories and resume metabolic abnormalities
      1. Advance calories at a rate that does not stimulate further refeeding metabolic changes
   iv. Consider thiamine supplementation when syndrome recognized

e. Patient populations at risk
   i. SGA/IUGR and Twin to twin transfusion
2. Chylothorax - Neonate
   a. Function of lymphatic system
      i. Transport lipids & lipid soluble vitamins
      ii. Collect & return excess fluid/extravasated proteins from interstitial space to circulation
      iii. Return lymphocytes to circulation
   b. Causes of chylothorax:
      i. Congenital, surgical/trauma – more common
         1. Trauma chylothorax – may take 2-10 days after injury for pleural effusion to become evident
      ii. Tumor associated, infectious – less common
   c. Chyle content – adapted from Pediatrics;2014;133:723
      |                | pH 7.4-7.8 | Total protein 2-6 gm/dl |
      |---------------|------------|-------------------------|
      | Absolute cell count | >1000 cells/L | albumin 1.2-4.1 g/dl    |
      | Lymphocytes    | 400-6800 /mm³ | Globulin 1.1-3.1 g/dl   |
      | Erythrocytes   | 50-600/mm³  | Glucose 2.7-11 mMol/L   |
      | Calorici       | 200 kcal/L  | Sodium 104-108 mMol/L   |
      | Total fat      | 0.4-0.6 gm/dl | Potassium 3.8-5 mMol/L   |
      | Cholesterol    | 65-220 mg/dl | Chloride 85-130 mMol/L   |
      | Triglyceride   | >110 mg/dl  | Calcium 3.4-6 mMol/L    |
      | Chylomicrons   | present     | Phosphate 0.8-4.2 mMol/L |
   d. Medical management
      i. Relieve respiratory symptoms → drainage of pleural fluid
      ii. Prevent reoccurrence → treat underlying cause
      iii. Prevent malnutrition while waiting for thoracic duct to heal
         1. Enteral feeds – breast milk or infant formula with medium chain fats
            i. Directly absorbed into portal venous system & bypass lymphatic drainage
            ii. May need essential fatty acid supplementation if on medium chain formula longer than 3 weeks
         2. If increased chyle output with breast milk or medium chain formula
            then will need some time period of bowel rest with addition of TPN/ILE
            i. Calories, electrolytes & volume of chyle output must be accounted for when determining caloric goals
            ii. Consider addition of replacement fluids when chyle output exceeds 15-20ml/kg/day
            iii. Consider addition of octreotide/somatostatin if enteral management fails
            iv. Resolution of chylothorax typically resolves in 1-3 weeks
3. **Bowel adaptation after resection** – (drives intestinal rehabilitation)
   a. location of ostomy/bowel length & location
      i. ileum – absorbs B₁₂, fluid, bile acids – if gone jejunum has limited ability to develop absorptive capacity of ileum
      ii. loss of jejunum leads to
         1. ↑'d gastric emptying time
         2. Gastric hypersecretion→fat malabsorption by inactivating pancreatic enzymes
            i. Acid peptic injury
            ii. Exacerbation of fluid/electrolyte losses
            iii. Damage mucosa
   b. presence of ICV – ICV acts as barrier to prevent bacterial translocation from colon
   c. best chance at good outcomes (proactive management)
      i. >15 cm with ICV
      ii. >40 cm without ICV
d. Phases of Adaptation
   i. Acute – first 2-3 wks post op, NPO, fluid electrolyte balance
      1. Consider use of replacement fluids to compensate for losses from various ostomy sites as well as gastrostomy tubes and the like.
         i. Consider 1:1 to 0.5:1 replacement of output
      2. Permissive undernutrition POD 0-2
   ii. Recovery – begin enteral feeds – goal to keep ostomy output <20-40 ml/kg
      1. Manganese – amounts delivered due to contamination of TPN solution appears to be adequate
      2. Copper requirements – can have extensive loses when ileostomy output high – no longer routinely eliminate from TPN in infants with cholestasis
   iii. Late – wean TPN, maximize enteral delivery, absorption, tolerance & prevent nutritional deficiencies

<table>
<thead>
<tr>
<th>Electrolyte loses</th>
<th>Na (mEq/L)</th>
<th>K mEq/L</th>
<th>Cl mEq/L</th>
<th>HCO₃ mEq/L</th>
<th>Zn Mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastric</td>
<td>140</td>
<td>15</td>
<td>155</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ileostomy</td>
<td>80-140</td>
<td>15</td>
<td>115</td>
<td>40</td>
<td>12-17</td>
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<tr>
<td>Colostomy</td>
<td>50-80</td>
<td>10-30</td>
<td>40</td>
<td>20-25</td>
<td></td>
</tr>
<tr>
<td>Secretory</td>
<td>60-120</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td>30-40</td>
<td>10-80</td>
<td>10-110</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Normal stool</td>
<td>5</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Replacement fluid options – may add KCl 10-20mEq/L as needed

<table>
<thead>
<tr>
<th></th>
<th>Na (mEq/L)</th>
<th>K mEq/L</th>
<th>Cl mEq/L</th>
<th>HCO₃ mEq/L</th>
<th>Zn Mg/L</th>
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<tbody>
<tr>
<td>NS</td>
<td>154</td>
<td></td>
<td>154</td>
<td></td>
<td></td>
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<tr>
<td>0.45% NS</td>
<td>77</td>
<td></td>
<td>77</td>
<td></td>
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<tr>
<td>Lactated ringers</td>
<td>130</td>
<td>4</td>
<td>109</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

Pediatric Skills Lab: Parenteral Nutrition Order Writing in the Face of Clinical Challenges
3/26/19 12:30pm Teresa D. Puthoff, PharmD  Nationwide Children’s Hospital, Columbus, Oh
e. Poor growth
   i. evaluating Na requirements/loses
      1. more reflective of body stores – if <30 mEq/L consider supplementation in absence of use of diuretics or infants with advanced stage liver disease (hyperaldosteronism)
      2. can estimate Na loses from ostomy output to determine minimum needs – Basal Na need = 1.2 mEq/kg/day + 0.13 mEq/kg/day for each ml/kg/day of ileostomy output
   ii. evaluate Zinc requirements/loses (wound healing/ostomy output)
   iii. evaluate copper requirements/loses (ostomy output)

4. Dual lumen TPN – helpful when fluid restricted or when central access migrates

5. Patient Cases as requested

Selected References:


Embleton ND, Morgan C, King C. Balancing the risks and benefits of parenteral nutrition for preterm infants: can we define the optimal composition? Arch Dis Child Fetal Neonatal Ed 2015;100:f72-f75.


Tutor JD. Chylothorax in Infants and Children. Pediatrics 2014;133:722-733


Pediatric Skills Lab: Parenteral Nutrition Order Writing in the Face of Clinical Challenges
3/26/19 12:30pm Teresa D. Puthoff, PharmD  Nationwide Children’s Hospital, Columbus, Oh
Pediatric Enteral Formulas
Elizabeth Bobo, MS, RD, LD/N, CNSC

There are no commercial relationships to disclose.

Outline:

I. Formula classifications and descriptions
II. Indications and Contraindications
III. Case discussion
# Pediatric Enteral Formulas

<table>
<thead>
<tr>
<th>Formula Classification</th>
<th>kcals/ml</th>
<th>Protein (g)/mL</th>
<th>Fiber containing option y/n</th>
<th>Gluten free y/n</th>
<th>Suitable for lactose intolerance</th>
<th>May be used as sole source of nutrition</th>
<th>Indications</th>
</tr>
</thead>
</table>
| Elemental (amino acid based formula) | 0.8-1 | 0.02-0.03 | N | Y | Y | Y/N | • Soy and cow milk allergy  
  • Severe food allergies  
  • Short bowel syndrome  
  • Eosinophilic GI disorders  
  • Other GI disorders |
| Peptide-based | 1.0 | 0.03 | Y (prebiotics) | Y | Y | Y | • Short bowel syndrome  
  • Cystic fibrosis  
  • Malabsorption  
  • Delayed gastric emptying  
  • Impaired GI function |
| Calorically dense peptide-based | 1.2-1.5 | 0.05-0.07 | Y | Y | Y | Y | • Short bowel syndrome  
  • Cystic fibrosis  
  • Malabsorption  
  • Delayed gastric emptying  
  • Impaired GI function |
<table>
<thead>
<tr>
<th>Type</th>
<th>Calories</th>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Fat</th>
<th>Vitamin</th>
<th>Minerals</th>
<th>Carbohydrate Restriction</th>
<th>Fat Restriction</th>
<th>Protein Restriction</th>
<th>Fat and Protein Restriction</th>
<th>Qualities</th>
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<tbody>
<tr>
<td>Polymeric</td>
<td>1.0</td>
<td>0.03-0.06</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Increased calorie needs</td>
</tr>
<tr>
<td>Polymeric (soy based)</td>
<td>1.0</td>
<td>0.3</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Increased calorie needs</td>
</tr>
<tr>
<td>Calorically dense polymeric</td>
<td>1.2-1.5</td>
<td>0.04-0.06</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Increased calorie needs</td>
</tr>
<tr>
<td>Calorically restricted polymeric</td>
<td>0.63</td>
<td>0.03</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Reduced calorie tube feedings/oral intake, but nutritionally complete</td>
</tr>
<tr>
<td>Partial food containing polymeric</td>
<td>0.6-1.0</td>
<td>0.03-0.04</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>Food containing blend</td>
<td>0.9-1.4</td>
<td>0.04-0.07</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y/N</td>
<td>Y</td>
<td>Malnutrition, Insufficient dietary intake, Tube only</td>
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<tr>
<td>Juice based polymeric</td>
<td>0.6-1.06</td>
<td>0.03-0.04</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Clear liquid diet, Fat restricted diet, Increased calorie needs, Insufficient dietary intake</td>
</tr>
<tr>
<td>Renal</td>
<td>1.0</td>
<td>0.02</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>• Renal failure</td>
<td></td>
<td></td>
<td></td>
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<td>-------</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
| Lymphatic Disorders | 1.0 | 0.03-0.04 | N | Y | Y | N | • Chylothorax  
• Hyperlipoproteinemia type I  
• Intestinal lymphangiectasia  
• Long chain fatty acid oxidation disorders |

Note: Formulas may be suitable for lactose intolerance, but not appropriate for those with galactosemia.