New Strategies to Improve the Nutritional Content of Enteral Feedings for VLBW Infants

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The speaker has signed a disclosure form and indicated she has no significant financial interest or relationship with the companies or the manufacturer(s) of any commercial product and/or service that will be discussed as part of this presentation.

Session Summary

As we learn more about the importance of the use of breast milk and the need for increased protein in enteral feedings, many new products become available for use in the NICU. This session will review new fortifiers and products, including literature supporting the use and best practice.

Session Objectives

Upon completion of this presentation, the participant will be able to:

- discuss the benefits of use of maternal breast milk and donor banked breast milk in the NICU;
- list at least three key nutrients VLBW infants need for optimal growth obtained from use of human milk fortifiers or use of preterm formulas;
- compare the differences between powder human milk fortifiers, liquid human milk fortifiers, and human milk based fortifiers.

References


**Session Outline**

See presentation handout on the following pages.
New Strategies to Improve the Nutritional Content of Enteral Feedings for VLBW Infants
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Background
• VLBW infants are born with minimal nutritional stores and develop deficits quickly.
• Adequate protein intake is essential to promote lean tissue mass accretion and prevent increased adiposity.
• Recent literature suggests that protein be the focus when feeding VLBW infants.
• Higher protein intakes are needed to support growth of lean tissue and organ development such as the brain.

Nutrition Related Problems
• Nutritional deficiencies
  protein, calcium, phosphorus, iron, zinc, water and fat soluble vitamins
  (Goday PS and Sentongo TS. Nutrient deficiencies in the premature infant. Clin N Am. 2009; 56: 1069-1083)
• Deficits in growth
• Feeding intolerance
• Necrotizing Enterocolitis (NEC).

Energy versus Protein
• Energy intakes = increased body fat mass.
• Higher protein intakes = growth of lean tissue and organ development such as the brain.

Extrauterine Growth Restriction (EUGR)

Protein Needs of the Premature Infant-Zeigler
Factorial Method
• Protein needs are 3.1-3.8 g/kg/day.

Empirical Method
• Protein needs are 3.4-4.3 g/kg/day with an energy intake of 120 kcals/kg/day.
  (Zeigler EE. Protein requirements of very low birth weight infants. JPGN. 2007; 45: S170-S164)
Protein to Energy Ratio

- A ratio of 3-3.3 g protein/100 kca.ls promotes lean tissue growth.
- Energy intake must be balanced with protein.

Nutritional deficits occur and can result in negative long term outcomes, including neurodevelopmental outcomes.

AAP Position on Breastfeeding

- The American Academy of Pediatrics (AAP) recommends breast feeding for all infants regardless of birth weight.
- Premature infants should receive either mother’s own milk or donor breast milk.

Benefits of Breast milk

- Improved neurodevelopmental outcomes.
- Decreased risk of NEC.

Use of donor milk

- Potential benefits:
  - protection against NEC
  - improved feeding tolerance
  - improved long term health outcomes
  - improved immune function


- 243 infants: 70 received mothers’ breast milk only while 81 received banked donor breast milk and 92 received preterm infant formula in addition to mothers’ breast milk.
- No advantage of using banked donor breast milk over preterm formulas when mothers’ own breast milk supply was not adequate.
- Poorer growth in those receiving banked donor breast milk.
Is Breast milk best?

- Unfortified human milk will not provide adequate amounts of protein, calcium and phosphorus for preterm infants without the use of human milk fortifiers.


- 171 infants with BW ≤1250 grams.
- 97% of infants received human milk, 51% received > 75% of all enteral intake as human milk.
- Those fed >75% human milk had a greater negative change in weight z-score from birth to discharge compared to infants receiving < 75% (-0.6 vs, -0.4, p = 0.03).
- In infants receiving > 75% human milk, there was no significant difference in change in weight z-score by milk type (mother’s own vs. donor).


- This group studied fortification of breast milk (mothers' own milk or donor milk). Protein content of the milk was assumed based on standard reference values while actual protein content of milk was analyzed.
- In a sample of 32 infants with birth weights between 600-1750 g, they found that actual protein intakes were typically 0.5-0.8 g/kg/day less than assumed protein intake.
- There was no difference between assumed and actual energy intakes.

Nutritional Needs of VLBW Infants

- 110-130 kcals/kg
- 3.4-4.3 grams protein/kg
- 100-220 mg calcium/kg
- 60-140 mg phosphorus/kg

Strategies to Improve Nutritional Intake

- Powder Human Milk Fortifiers
- Liquid Human Milk Fortifiers
- Liquid Protein
- Exclusive Human Milk Fortifiers
- Premature Formulas

Powder HMF

<table>
<thead>
<tr>
<th>Abbott</th>
<th>Mead Johnson</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 grams protein/100 mL at 24 kcals/ounce</td>
<td>2 grams protein/100 mL at 24 kcals/ounce</td>
</tr>
<tr>
<td>Nonfat milk, corn syrups solids, MCT oil, whey</td>
<td>Whey protein hydrolysate, MCT oil, vegetable oil, corn syrup solids</td>
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<td>Contains Fe</td>
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</table>

- 150 preterm infants with BW <1250 grams randomized to get LHMF vs powder HMF (20% higher protein in LHMF).
- At 28 days, the LHMF had a significantly higher achieved weight, length, head circumference, and linear growth rate than the control HMF (P = .004, P = .003, P = .04, and P = .01, respectively).
- No difference in feeding tolerance or days to full feeds.
- Prealbumin, albumin, and blood urea nitrogen were higher in the LHMF group versus the control group (all P < .05).
- There was no difference in sepsis or NEC.

**Comparison of HMF products**

<table>
<thead>
<tr>
<th></th>
<th>BM 20</th>
<th>BM 22</th>
<th>BM 22</th>
<th>BM 22</th>
<th>BM 22</th>
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<tr>
<td>Kcals</td>
<td>67</td>
<td>73</td>
<td>73</td>
<td>73</td>
<td>80</td>
<td>79</td>
</tr>
<tr>
<td>PRO</td>
<td>1</td>
<td>1.5</td>
<td>1.5</td>
<td>1.4</td>
<td>1.9</td>
<td>2</td>
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<tr>
<td>Ca</td>
<td>23</td>
<td>80</td>
<td>85</td>
<td>74</td>
<td>140</td>
<td>110</td>
</tr>
<tr>
<td>Phos</td>
<td>13</td>
<td>47</td>
<td>37</td>
<td>48</td>
<td>81</td>
<td>61</td>
</tr>
<tr>
<td>Vit D</td>
<td>1</td>
<td>60</td>
<td>74</td>
<td>64</td>
<td>86</td>
<td>118</td>
</tr>
<tr>
<td>mOsm</td>
<td>290</td>
<td>343</td>
<td>338</td>
<td>308</td>
<td>385</td>
<td>380</td>
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</tbody>
</table>

**Liquid HMF**

- **Abbott**
  - 5 ml packet
  - Add to 25 ml Breast milk to make 24 kcals/ounce
  - 2 grams protein/100 mL
  - Nonfat milk, corn syrups solids MCT oil, whey
  - Acidified Liquid

- **Mead Johnson**
  - 5 ml vial
  - Add to 25 ml Breast milk to make 24 kcals/ounce
  - 2.7 grams protein/100 mL
  - Whey protein hydrolysate, MCT oil, vegetable oil

**Liquid Protein Fortifier**

- Calories: 4
- Protein, grams: 1
- Water, grams: 5
- Volume, ml: 6
- Ingredients: Water, and Casein Hydrolysate.
- Each mL increases osmolality by 12 mOsm/kg or 72 mOsm/kg when 6 mL added per 100 mL of Breast milk 24.

**Adjustable fortification**

- Researchers fortified breast milk using protein powder to keep blood urea nitrogen (BUN) levels between 9-14 mg/dL.
- BUN has been used as a marker for adequacy of protein intake in preterm infants.
- Their group found higher protein intake with statistically better weight gain and head circumference growth for infants with adjustable fortification of protein.


**Breast milk analyzer**

- The use of a breast milk analyzer has shown promise to more accurately determine the amount of protein in human milk.

Calais Breast milk Analyzer


- 53 infants with birth weight 500-1250 grams who's mothers did not intend to provide breast milk.
- Infants received Donor milk with Human milk based fortifier of bovine milk based preterm formula.
- Primary outcome was the number of TPN days and there was a statistical significance between the groups (36 vs 27 in BOV vs HUM P=.04)
- Incidence of NEC was 21% in BOV and 3% in HUM (P=.08) but no cases surgical NEC in HUM group (P=.04).
- Reduced linear growth in HUM group vs BOV.

Nutritional Content of Prolact +4

<table>
<thead>
<tr>
<th>Per 100 mL</th>
<th>Kcals</th>
<th>PRO</th>
<th>Ca</th>
<th>Phos</th>
<th>Vitamin D</th>
<th>mOsm/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>82</td>
<td>1.9</td>
<td>123</td>
<td>64</td>
<td>27.6</td>
<td></td>
</tr>
</tbody>
</table>

Human Milk Based Fortifier

- Formulated to fortify breast milk to a minimum of 24 Cal/11 oz. (82 kcal/100mL)
- Fortifies breast milk to a target of 1.9 grams of protein per 100mL.
- Human milk with minerals added.

Other Prolacta Products

- Prolact+6 (26 kcals/ounce and 2.4 grams protein/100 mL)
- Prolact+8 (28 kcals/ounce and 2.8 grams protein/100 mL)
- Prolact+10 (30 kcals/ounce and 3.3 grams/100 mL)
Other Prolacta Products

- Neo20 (donor milk)
- PreemieLact (donor milk in small volume bottles designed to minimize waste)

Non Human Milk Strategies

- High Protein formulas are designed to meet the nutritional needs of premature infants.
- All 3 formula companies make a 30 kcals/ounce premature formula that some institutions dilute 1:1 with breast milk as a fortifier.

Comparison of Preterm Formulas

<table>
<thead>
<tr>
<th>Per 100 mL</th>
<th>Special Care 24 HP</th>
<th>Enfamil 24 HP</th>
<th>Gerber Good Start 24 HP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>81</td>
<td>81</td>
<td>80</td>
</tr>
<tr>
<td>Protein</td>
<td>2.7</td>
<td>2.8</td>
<td>2.9</td>
</tr>
<tr>
<td>Calcium</td>
<td>146</td>
<td>134</td>
<td>131</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>81</td>
<td>67</td>
<td>68</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>122</td>
<td>192</td>
<td>144</td>
</tr>
<tr>
<td>Osmolality</td>
<td>280</td>
<td>300</td>
<td>299</td>
</tr>
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</table>

All Lactose reduced and partial MCT.
Gerber: 100% partially hydrolyzed whey vs. casein and whey.

So What Meets the Nutritional Needs at 150 mL/kg?

<table>
<thead>
<tr>
<th></th>
<th>110-130 kcals/kg</th>
<th>4 grams PRO/kg</th>
<th>100-220 mg Calcium/kg</th>
<th>60-140 mg Phos/kg</th>
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<tbody>
<tr>
<td>Breast milk</td>
<td>100 kcals/kg</td>
<td>1.5</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Dil with powder</td>
<td>120 kcals/kg</td>
<td>3</td>
<td>165+</td>
<td>98</td>
</tr>
<tr>
<td>HPF 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dil with Similac</td>
<td>140 kcals/kg</td>
<td>3</td>
<td>194</td>
<td>117</td>
</tr>
<tr>
<td>HPF 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dil with Enfamil</td>
<td>120 kcals/kg</td>
<td>4</td>
<td>177</td>
<td>98</td>
</tr>
<tr>
<td>HPF 24</td>
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</tr>
<tr>
<td>Dil with Enfamil</td>
<td>120 kcals/kg</td>
<td>4</td>
<td>100</td>
<td>115</td>
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<tr>
<td>HPF 24 + LP</td>
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<tr>
<td>Dil with Prolact</td>
<td>120 kcals/kg</td>
<td>2.9</td>
<td>185</td>
<td>96</td>
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<tr>
<td>Preterm 24 HP</td>
<td>120 kcals/kg</td>
<td>4</td>
<td>195+</td>
<td>100+</td>
</tr>
</tbody>
</table>

Summary

- Early, adequate nutrition has positive outcomes.
- Breast milk is best but protein content is suboptimal.
- The use of donor milk is beneficial but growth is a concern.
- Human milk must be fortified to meet the increased needs due to prematurity.
- Adjusted fortification can help improve growth measurements and may be the wave of the future.

Questions?