Tara K. Bastek, MD, MPH, and Karen M. Varga, RD, LDN, CNSC

Preterm Nutrition Through Discharge: A Case-Based Challenge

Pediatric Nutrition
CONTINUING EDUCATION FOR CLINICIANS
pnce.org

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Mead Johnson Nutrition.
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Raleigh, North Carolina
## Faculty Disclosures

<table>
<thead>
<tr>
<th><strong>Tara K. Bastek, MD, MPH</strong></th>
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<tbody>
<tr>
<td><strong>Speakers Bureau</strong></td>
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<td><strong>Consultant/Speaker</strong></td>
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<table>
<thead>
<tr>
<th><strong>Karen M. Varga, RD, LDN, CNSC</strong></th>
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<td><strong>Speakers Bureau</strong></td>
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Learning Objectives

- Link nutrient intake recommendations to the expected growth for preterm infants
- Apply the latest evidence supporting preterm infant convalescent and discharge nutrition
- Recommend novel approaches to convalescent and discharge feeds when a preterm infant is designated as at risk for growth failure or micronutrient deficiencies
- Customize nutritional interventions to help close the growth failure gap in the NICU and at discharge
Recommended for Foundational Knowledge

Tara K. BASTEK, MD, MPH
and

Ian J. GRIFFIN, MB, CHB
Director, Clinical and Translational Research
Mid-Atlantic Neonatal Associates
Biomedical Research Institute of New Jersey
Morristown, New Jersey
Trends of Preterm Infants In the NICU

- Preterm birth affects 1 of every 10 infants in the US
- 3,500–4,000 infants born at 22–27 weeks GA in US
- Rates decreased from 2007 to 2014; however, preterm birth rate rose for the fourth straight year in 2018
  - Retrospective cohort study, N=154,233 neonates
  - Survival to discharge without comorbidities improving at 25–28 weeks
  - Percentage of babies with comorbidities at 22–24 weeks GA is not trending down

GA, gestational age; NICU, neonatal intensive care unit.

Extrauterine Growth Restriction Is Common

Inadequate extrauterine growth results from

- Increased metabolic demand
- Poor early metabolic tolerance
- Poor feeding tolerance
- Infections
- Respiratory distress
- Pharmacologic effects
- Inadequate nutritional supply

Potential consequences of inadequate growth

- Impaired neurodevelopment
- Delayed cognitive development
- Delayed growth

Faster Growth Linked to Better Neurodevelopmental Outcomes

Neurodevelopmental impairment decreases when growth velocity increases

Neurodevelopmental impairment defined as the presence of any of the following: cerebral palsy, MDI < 70, PDI < 70, deaf/hearing loss requiring amplification in both ears or bilaterally blind.

MDI, mental development index; PDI, physical development index.

Evidence of the importance of growth in the NICU to help prevent growth restriction

<table>
<thead>
<tr>
<th></th>
<th>Q1 (n=124)</th>
<th>Q2 (n=122)</th>
<th>Q3 (n=123)</th>
<th>Q4 (n=121)</th>
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<tbody>
<tr>
<td>Weight gain mean (SD) g/kg/d</td>
<td>12.0 (2.1)</td>
<td>15.6 (0.8)</td>
<td>17.8 (0.8)</td>
<td>21.2 (2.0)</td>
<td></td>
</tr>
<tr>
<td>Normal neurologic exams</td>
<td>70</td>
<td>77</td>
<td>76</td>
<td>86</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Q1 vs Q4 equates 2.53x risk of NDI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP, %</td>
<td>21</td>
<td>13</td>
<td>13</td>
<td>6</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>MDI &lt;70,%</td>
<td>39</td>
<td>37</td>
<td>34</td>
<td>21</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>PDI &lt;70,%</td>
<td>35</td>
<td>32</td>
<td>18</td>
<td>14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Weight &lt;10 percentile, %</td>
<td>58</td>
<td>61</td>
<td>51</td>
<td>46</td>
<td>.03</td>
</tr>
<tr>
<td>Length &lt;10 percentile, %</td>
<td>47</td>
<td>43</td>
<td>29</td>
<td>28</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>HC &lt;10% percentile, %</td>
<td>31</td>
<td>18</td>
<td>18</td>
<td>22</td>
<td>.098</td>
</tr>
<tr>
<td>Rehospitalization, %</td>
<td>63</td>
<td>60</td>
<td>50</td>
<td>45</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

HC, head circumference; MDI, Mental Developmental Index; NDI, neurodevelopmental impairment; PDI, Psychomotor Developmental Index.

Cohort of over 400 extremely low birth weight (ELBW) infants looking at developmental outcome and growth at 18-22 months of age.

“Preterm Birth is a Nutritional Emergency.”
–Hay 2018

- NICUs must focus on nutrition because intake in the NICU affects growth and long-term health
- Easy to blame other diseases on a lack of growth, but poor nutrition is the driver of many morbidities
- Protocols are needed to guide nutrition
- Highly variable nutritional practices in busy NICUs can produce variable growth outcomes

Nutrient Intake Recommendations

“From the start of care, we implement recommendations from the experts.”
–Tara K. Bastek, MD, MPH
Optimal Macronutrients and Micronutrients

- Preterm infants have altered body composition (eg, less muscle mass, more fat mass) compared to term
- Protein and energy needs are greater
- **LC-PUFAs** (including DHA & ARA) support neurodevelopment and immune system development
- Preterm infants require increased intake of vitamins and minerals compared with their term counterparts
- Low iron stores—associated with poor neurodevelopment outcomes \(^1,^2\)

ARA, arachidonic acid; DHA, docosahexaenoic acid; LC-PUFA, long chain polyunsaturated fatty acids.

# Recommended Intakes of Select Micronutrients

Global expert recommendations made by Koletzko et al 2014\(^1\) for select micronutrients.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Per kg body weight per day</th>
<th>Per 100 Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium, mg</td>
<td>120–200</td>
<td>109–182</td>
</tr>
<tr>
<td>Phosphate, mg</td>
<td>60–140</td>
<td>55–127</td>
</tr>
<tr>
<td>Sodium, mg</td>
<td>69–115</td>
<td>63–105</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>2–3</td>
<td>1.8–2.7</td>
</tr>
<tr>
<td>Zinc, mg</td>
<td>1.4–2.5</td>
<td>1.3–2.3</td>
</tr>
<tr>
<td>Vitamin D, IU</td>
<td>400–1,000 (^{[a]}) (per day)</td>
<td>100–350 (^{[b]})</td>
</tr>
</tbody>
</table>

- \(^{[a]}\) Total IU/day from milk and supplement
- \(^{[b]}\) From milk only

## Recommended Intakes

<table>
<thead>
<tr>
<th></th>
<th>Per kg body weight per day</th>
<th>Per 100 Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluids, mL</td>
<td>135–200</td>
<td></td>
</tr>
<tr>
<td>Energy, Cal</td>
<td>110–130</td>
<td></td>
</tr>
<tr>
<td>Protein, g</td>
<td>3.5–4.5</td>
<td>3.2–4.1</td>
</tr>
<tr>
<td>Lipids, g</td>
<td>4.8–6.6</td>
<td>4.4–6.0</td>
</tr>
<tr>
<td>DHA, mg</td>
<td>18–60</td>
<td>16.4–55</td>
</tr>
<tr>
<td>ARA, mg</td>
<td>18–45</td>
<td>16.4–41</td>
</tr>
<tr>
<td>Carbohydrate, g</td>
<td>11.6–13.2</td>
<td>10.5–12</td>
</tr>
</tbody>
</table>

ARA, arachidonic acid; DHA docosahexaenoic acid.

- Compared with Tsang et al 2005\(^1\) recommendations (3.0–3.6 g/kg/day), Koletzko et al 2014\(^2\) recommends increased protein intake at 3.5–4.5 g/kg/day
- DHA intake of 18–60 mg/kg/day compared with 12–30 mg/kg/day intake recommended by ESPGHAN 2010\(^3\)

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Feeding Methods in 3 Phases

- **Phase 1**: ACUTE
- **Phase 2**: CONVALESCENT
- **Phase 3**: DISCHARGE
Phase 1: Acute Feeding Phase

- **Acute** (parenteral nutrition) TPN IV nutritional feeds
  - Amino acid infusion mixtures important for parenteral nutrition

- Most **growth failure** occurs during transition phase to enteral feeds \(^1\)

- This phase determines how well the baby can use nutrition and micronutrients for growth vs survival \(^1\)

- TPN Protocols beneficial—safety, adherence, best practice \(^2\)

- Careful monitoring is key to optimize nutrition for individual patients

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TPN, total parenteral nutrition.
Phase 2: Convalescent Phase

- **Convalescent phase** defined as period during which preterm is feeding and growing
- “**Transition nursery**” and “**feeder grow**” stage
- Tempting to become complacent with infants in this stage
- Long periods of time
- Volume and composition is under provider’s control

**Improved growth in this phase can mitigate the effects of poorer growth earlier.**

Challenge Question #1
What is an appropriate growth velocity for a baby in the convalescent phase in the NICU (<36 weeks)?
Breastmilk Production Support

• Benefits of human milk
  - Immune protection
  - Influences preterm gut microbiota and intestinal maturation

• Breastmilk is optimal for all infants but requires supplementation to produce and sustain growth in preterm infants
  - Feeding methods include NG tube, breast, or bottle feed
  - Qualified and extended lactation support is required for mothers with frequent follow-up

NG, nasogastric.

Phase 3: Discharge—Post-NICU Recovery

• Healing period continues. Nutrition monitoring still vital!

• Nutritional volume is prescribed by provider in charge of composition

• Meeting nutritional goals while being mindful of important changes

If you don’t do well in the previous 2 phases, baby will fall behind in Phase 3.
Nutritional Evaluation Prior to Discharge

• Develop feeding plan prior to discharge, consider the following:
  ▪ Has the preterm infant had poor weight gain during NICU stay?
  ▪ Is the preterm infant’s discharge weight <10th percentile?
  ▪ Is the preterm infant at higher nutrition risk due to BW <1000 g or on prolonged PN during NICU course?

• Confirm appropriate growth is demonstrated based on discharge feeding regimen

• Important to ask:
  ▪ Can the preterm infant ingest the proper amount of human milk or formula for continued growth and development?
  ▪ Does human milk fortifier or formula include all key nutrients for continued growth and development?

• Discharge and higher calories
Individualized Fortification Flexibility

- Common approach of "standard" discharge feeds:
  - Baby needs 22 or 24 cal/feeding (fortified BM or straight mix formula)
  - Not very flexible for family needs; likely to fall short nutritionally

- "Individualized" fortification allows flexibility to get total calories needed in 24-hr period

- The additives/fortification/products used may be standard (or few in number/variety), but the feeding plan is individualized, logistically

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"Individualized" Fortification

| For some, this could mean 24 cal feeds 8/day |
| For others it might be 2 or 3 or 4 breastfeeds a day, and 24 or 27 cal/feeds for the rest |
| Others may include mom's milk for 5 to 6 feeds/day and 4-6oz of 30 cal/feeds for the other 2 feeds |
A Word About Growth Curves
Growth Charts vs Target Goals

• Growth charts preferred to show patterns over time; illustrates growth failure and/or recovery during NICU course and long-term growth trajectory for catch-up growth

• Targets goals—variable depending on parameters
  ▪ Change with corrected gestational age vs chronological age
  ▪ Change with different growth trajectories (eg, whether 90th or 10th centile)

• Important to use growth charts in combination as preterm infants transition from NICU to home and new growth goals are established
Challenge Question #2

When do you transition from using preterm growth charts to WHO growth charts?
## Growth Charts

High-quality neonatal growth charts that use advanced mathematical modeling. Although, we still don’t know what is “optimal.”

| Olsen (developed from NICU growth data) | Up to 36 weeks GA | • Assess for GA, SGA, LGA  
• Not recommended for growth monitoring for preterm >36 wks |
|----------------------------------------|-------------------|---------------------------------------------------------------------|
| Bertino (developed from ‘ideal’ growth data) | Between 23–50 weeks correct age (10 weeks post-term) | • Best growth chart to assess longitudinal growth in preterm infants over this period  
• Validated as a growth monitoring tool in preterm infants  
• Definitions of poor growth are strongly related to long-term outcomes |
| Fenton | Term birth to 24 months | • Separate male and female curves  
• Very large international sample size  
• Widely used |
| World Health Organization | Term birth to 24 months | • Separate male and female curves  
• Very large international sample size  
• Widely used |

SGA, small for gestational age; LGA, large for gestational age.

## What to Measure: Pros and Cons and Target Goals

<table>
<thead>
<tr>
<th></th>
<th>Pros</th>
<th>Cons</th>
<th>Target [1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>• Easy to do</td>
<td>• Affected by fluid status</td>
<td>• 23–36 weeks: 15–20 g/kg/d</td>
</tr>
<tr>
<td></td>
<td>• Done daily</td>
<td>• Diuretics</td>
<td>• &gt;36 weeks: 20–35 g/d (girls) 23–43 g/d (boys)</td>
</tr>
<tr>
<td></td>
<td>• Easy to see trends</td>
<td>• Only reflects short period of time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Clearly associated with short- and long-term outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>“Real” growth</td>
<td>• Hard to do</td>
<td>• ~1 cm/wk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Inaccurate</td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>• Strongly related to developmental outcome</td>
<td>• Confounded by change in head shape</td>
<td>• ~1 cm/wk</td>
</tr>
<tr>
<td>circumference</td>
<td>• Easy to do</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## WHO Growth Velocity Standards (in grams)

<table>
<thead>
<tr>
<th>Age</th>
<th>Boys</th>
<th></th>
<th></th>
<th>Girls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-month increments</td>
<td>Median change at 50th percentile</td>
<td>Daily Rate</td>
<td>Median change at 50th percentile</td>
<td>Daily Rate</td>
</tr>
<tr>
<td>0–4 wks</td>
<td>1023</td>
<td>34.1</td>
<td>879</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>4 wks–2 mo</td>
<td>1196</td>
<td>40</td>
<td>1011</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>2–3 mo</td>
<td>815</td>
<td>27</td>
<td>718</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>3–4 mo</td>
<td>617</td>
<td>21</td>
<td>585</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>4–5 mo</td>
<td>522</td>
<td>17</td>
<td>489</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>5–6 mo</td>
<td>422</td>
<td>14</td>
<td>401</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>6–7 mo</td>
<td>357</td>
<td>12</td>
<td>344</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>7–8 mo</td>
<td>316</td>
<td>11</td>
<td>311</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>8–9 mo</td>
<td>285</td>
<td>10</td>
<td>273</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>9–10 mo</td>
<td>259</td>
<td>9</td>
<td>245</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>10–11 mo</td>
<td>243</td>
<td>8</td>
<td>233</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>11–12 mo</td>
<td>239</td>
<td>8</td>
<td>232</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

WHO growth standards: https://www.who.int/tools/child-growth-standards/standards
Case Study “Ava”

Background

<table>
<thead>
<tr>
<th>Born at 30w5d</th>
<th>DOB 9/17/2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight</td>
<td>745 g</td>
</tr>
<tr>
<td>Birth length</td>
<td>34 cm</td>
</tr>
<tr>
<td>Birth HC</td>
<td>22.8 cm</td>
</tr>
</tbody>
</table>

Born to 21-yr old G1P1 via c/s due to recurrent decelerations in the setting of intermittent reverse and absent end diastolic flow on US

Pregnancy complicated by known IUGR, anxiety, tobacco dependence, palpitations, hx of chlamydia

Feeding plan per mother is breastfeeding

Mom signed consent for donor milk

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[a] Fenton premature growth chart

**Nutrition Progression: Phase 1 & 2**

**Phase 1:**
- Feeds began on DOL 1, per high-risk feeding protocol due to IUGR status
- Enteral feeds advanced per protocol and at goal on DOL 12
- IVF/TPN discontinued 9/30 with stable BG

**Phase 2:** DOL 12: Goal feeds MBM with liquid HMF 24 cal/oz at 150 mL/kg

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—MBM w/LHMF 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>121</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000</td>
<td>610 (w/ supplementation)</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3</td>
<td>3.3 (w/ supplementation)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200</td>
<td>177</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140</td>
<td>98</td>
</tr>
</tbody>
</table>

BG, blood glucose; DOL, day of life; HMF, human milk formula; IUGR, Intrauterine growth restriction; IVF, intravenous fluids; LHMF, liquid human-milk fortifier; MBM, maternal breast milk; TPN, total parenteral nutrition.
Nutrition Progression: Phase 2 continued

- DOL 14: Additional vitamin D and iron supplements started
- DOL 23: Feedings changed to HP fortifier, as infant receiving mix of DM and MBM (likely receiving less protein than estimated)
- DOL 25: Modular fat supplement added to provide additional 10 kcal/kg
- Feeds adjusted to provide ~131 kcal/kg and 4–4.5 g/kg protein (Based on DBM vs MBM)
- DOL 48: (37w3d) feeds changed to preterm HP RTF 24 cal formula @ 160 mL/kg as mom no longer providing MBM

| Average weight gain from DOL 10 to 36 weeks Gestational Age: 21.9 g/kg/d |
| Average weight gain from 36 weeks to discharge at 37w6d: 22 g/d |

DOL, day of life; DBM, donor breast milk; HP, high protein; MBM, maternal breast milk; HP RTF, high-protein, ready-to-feed, preterm formula.
Phase 3: Discharge Nutrition Assessment

Discharged 11/6/2020  Weight 1770 grams (0.07%, Z-score—3.18 based on Fenton chart) at 37w6d and DOL 51

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—PRTF HP 24 at 170mL/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>136</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000</td>
<td>722</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3</td>
<td>2.4</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200</td>
<td>224</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140</td>
<td>122</td>
</tr>
</tbody>
</table>

DM, donor milk; HP RTF, high-protein, ready-to-feed, preterm formula; MBM, maternal breast milk; SICC, Special Infant Care Clinic.

Case A—Combined

HP RTF, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.

Source: Fenton 2013 Preterm Growth Chart
Case A: Fenton Curve

Weight-for-age Percentiles (Premature girls, 22.5 to 50 weeks)

Source: Fenton 2013 Preterm Growth Chart
Case A: WHO Curve

Weight-for-age Percentiles (Girls, birth to 2 years)

Source: World Health Organization (WHO), 2006
Weight-for-age Percentiles (Premature girls, 22.5 to 50 weeks)

Fenton

Weight-for-age Percentiles (Girls, birth to 2 years)

WHO

Source: World Health Organization (WHO), 2006
Case A—Combined

Source: Fenton 2013 Preterm Growth Chart
Audience Poll – Case A

Do you use the Fenton Growth Calculator (available on PediTools website) to determine goal growth rates?
**Case A—Combined**

[SICC, Special Infant Care Clinic.](#)
Phase 3: 1st Clinic Follow-Up Visit

Date: 12/2/2020  PMA: 41w4d

Weight: 2.362 kg (0%, Z-score: -3.07 based on Fenton Growth chart)
Growth velocity: 23 g/d on average since discharge (Goal 21 g/d on per Fenton Calculator\[a\])

- Feeds changed to preterm discharge powder formula 24 cal/oz po ad lib (taking ~170 mL/kg)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—PDF 24 at 170 mL/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>136</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5 (2.8–3.2)^[b]</td>
<td>3.8</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000 (400)^[b]</td>
<td>441 (w/supplement)</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3 (2)^[b]</td>
<td>4.7 (w/supplement)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200 (70–140)^[b]</td>
<td>163</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140 (35–90)^[b]</td>
<td>90</td>
</tr>
</tbody>
</table>

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\[a\] Growth Calculator available on Peditools.org

\[b\] Estimated needs at discharge with no accumulated nutrient deficits

PDF, preterm discharge formula, PMA, postmenstrual age; SICC, Special Infant Care Clinic.

Case A—Combined

SICC, Special Infant Care Clinic.
Phase 3: 2nd Clinic Follow-Up Visit

Date: 1/13/21  
PMA: 47w4d

Weight: 3.788 kg (3%, Z-score -1.94 based on Fenton Growth Chart)  
Growth Velocity: 34 g/d (Goals: 23 g/d based on Fenton Calculator\textsuperscript{[a]})

- C/O frequent spit-ups. Omeprazole started and changed to extensively hydrolyzed protein (EHP) formula 24 cal/oz po ad lib goal of ~19 oz per day for 150 mL/kg

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—EHP formula 24 cal at 150 mL/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>120</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5 (2.8–3.2) \textsuperscript{[b]}</td>
<td>3.4</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000 (400) \textsuperscript{[b]}</td>
<td>427 (w/supplement)</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3 (2) \textsuperscript{[b]}</td>
<td>4.5 (w/supplement)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200 (70–140) \textsuperscript{[b]}</td>
<td>113</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140 (35–90) \textsuperscript{[b]}</td>
<td>52</td>
</tr>
</tbody>
</table>

\textsuperscript{[a]} Fenton Growth Calculator available on Peditools.org  
\textsuperscript{[b]} Estimated needs at discharge with no accumulated nutrient deficits  
EHP, extensively hydrolyzed protein; PMA, postmenstrual age.

Case A—Combined

SICC, Special Infant Care Clinic.

Source: Fenton 2013 Preterm Growth Chart
**Phase 3: 3rd Clinic Follow-Up Visit**

<table>
<thead>
<tr>
<th>Date: 3/17/21</th>
<th>CGA: 3 months 3 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight: 5.072 kg (0%, Z-score: -3.94 based on WHO 0–2 yrs Girls, chronological age)</td>
<td>Growth velocity: 20 g/d (Goal 21 g/d based on WHO goal at CGA of 3–4 months)</td>
</tr>
</tbody>
</table>

- Infant tolerating hydrolyzed protein formula well
- Reflux is improved
- Meeting growth goals for continued catch up growth
- Plan to continue current formula po ad lib. Discuss start of solids 4–6 months corrected age
## Nutrition Progression: Phase 3 Summary Table

<table>
<thead>
<tr>
<th>Dates</th>
<th>Gestational Age</th>
<th>Weights</th>
<th>Weight gain</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/27/2020–10/24/2020</td>
<td>32w1d (DOL 10)—36 weeks</td>
<td>810–1490 gram</td>
<td>21.9 g/kg/d on average</td>
<td>15–20 g/kg/d</td>
</tr>
<tr>
<td>10/24/2020–11/6/2020</td>
<td>36 weeks to discharge (37w6d)</td>
<td>1490–1770 gram</td>
<td>22 g/d</td>
<td>20–35 g/d 30.3 g/d per Fenton calculator</td>
</tr>
<tr>
<td>12/2/2020</td>
<td>Follow-up #1 (41w4d)</td>
<td>2.362 kg</td>
<td>23 g/d</td>
<td>20–35 g/d 21 g/d per Fenton calculator</td>
</tr>
<tr>
<td>1/13/2021</td>
<td>Follow-up #2 (47w4d)</td>
<td>3.788 kg</td>
<td>34 g/d</td>
<td>20–35 g/d 23 g/d per Fenton calculator</td>
</tr>
<tr>
<td>3/17/2021</td>
<td>Follow-up #3 (CGA 3 months 3 weeks)</td>
<td>5.072 kg</td>
<td>20 g/d</td>
<td>20 g/d based on WHO at CGA</td>
</tr>
</tbody>
</table>

CGA, corrected gestational age.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)
Case A—Combined

SICC, Special Infant Care Clinic.
Case A—WHO With Corrected Gestational Age

Weight-for-age Percentiles (Girls, birth to 2 years)

Source: World Health Organization (WHO), 2006
Case Study “Ava”: Managing Nutritional Deficits at Time of Discharge

**Key Takeaway** for baby who continued to have nutritional deficits at time of discharge:

- Use of more nutrient-dense formula for 4 weeks after discharge helped close nutrient gap.
- Maintained higher calorie formula (24 cal/oz) with PTDF and hydrolyzed protein formula to promote continued catch-up growth.

PTDF, preterm discharge powder formula.
## Background

<table>
<thead>
<tr>
<th>Born at 25w5d</th>
<th>DOB 6/29/2020</th>
</tr>
</thead>
</table>
| Birth weight  | 755 g         | (35%, Z-score -0.38) 
| Birth length  | 33 cm         | (44%, Z-score -0.15)  
| Birth HC      | 23 cm         | (37%, Z-score -0.33)  |

Born to 21-yr-old G1P0 via vaginal delivery due PTL, PPROM  
Mother with no PMH  
Feeding plan per mother is breastfeeding

---

[a] Fenton premature growth chart.  
PMH, past medical history; PTL, preterm labor; PPROM, preterm prelabor rupture of membranes.  
Nutrition Progression: Phase 1 & 2

**Phase 1:**
- Feeds started on DOL 1 per feeding protocol
- Enteral feeds advanced per protocol and at goal on DOL 12

**Phase 2:** Goal feeds—advanced to MBM with HMF 24 cal/oz at 150 mL/kg

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—MBM w/LHMF 24 at 150/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>122</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000</td>
<td>589 (w/ supplementation)</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3</td>
<td>3.3 (w/ supplementation)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200</td>
<td>177</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140</td>
<td>98</td>
</tr>
</tbody>
</table>

**DOL, day of life; HMF, human milk fortifier; LHMF, liquid human-milk fortifier; MBM, maternal breast milk.**
## Nutrition Progression: Phase 2 continued

<table>
<thead>
<tr>
<th>Date</th>
<th>Nutrition Progression</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOL 25</td>
<td>NPO due to abdominal distention and pneumatosis on AXR, medical NEC tx started NPO x 7 days TPN/Lipids</td>
</tr>
<tr>
<td>DOL 32</td>
<td>Trophic feeds restarted, advanced slowly back to goal</td>
</tr>
<tr>
<td>DOL 40</td>
<td>Back on full feeds with MBM and HMF to 24 cal/oz at 150 mL/kg; + Vitamin D and Iron supplementation</td>
</tr>
<tr>
<td><strong>Nutrition labs</strong></td>
<td></td>
</tr>
<tr>
<td>DOL 49</td>
<td>Alk Phos 458, Phos 6.0, Vit D 56 <em>(Goals Alk Phos &lt;400, Phos &gt;6, Vit D &gt;30)</em></td>
</tr>
<tr>
<td><strong>Repeat labs</strong></td>
<td></td>
</tr>
<tr>
<td>DOL 85</td>
<td>Alk Phos 385, Phos 6.4, Vit D 93</td>
</tr>
<tr>
<td>DOL 101</td>
<td>Continued to work on both breast and bottle feeding. GT placed on 10/8/20 due to inability to take full feeds po.</td>
</tr>
</tbody>
</table>

Growth velocity from 7/31–9/9 (36 weeks) was 18 g/kg/d and from 36 weeks to discharge at 40 5/7 was 40 g/d on average

*AXR, abdominal X-ray; GT, gastrostomy tube; NEC, necrotizing enterocolitis; NPO, nothing by mouth; TPN, total parenteral nutrition.*
**Phase 3: Discharge Nutrition Assessment**

<table>
<thead>
<tr>
<th>Discharged 10/13/2020</th>
<th>Weight 3.72 kg (50%, Z-score—0.01 based on Fenton chart) at 40w6d and DOL 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge feedings</td>
<td>MBM with preterm discharge powder formula to 24 cal/oz at 160 mL/kg plus 1 mL infant multivitamin with iron. Infant taking bottle, breast and using GT if unable to finish goal volume</td>
</tr>
<tr>
<td>Nutrition labs prior to discharge WNL (Alk Phos 385, Phos 6.4, Vit D 93)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Provided—MBM with PDPF at 24 at 160mL/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>128</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>(2.8–3.2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000</td>
<td>477</td>
</tr>
<tr>
<td></td>
<td>(400)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>2–3</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>(2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>(70–140)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>60–140</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>(35–90)&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014<sup>[1]</sup>; Agostoni et al 2010<sup>[2]</sup>)

DM, donor milk; HP, high protein; MBM, maternal breast milk; PDPF, preterm discharge powder formula; SICC, Special Infant Care Clinic.

Case B—Combined

- NPO, nothing by mouth.
- Full feeds
- Change to preterm DC formula
- High Vit D levels
- Return to full feeds 24 cal
- NPO
- Full feeds
- Discharge

DC, discharge; NPO, nothing by mouth.
Case B—Fenton Curve

Weight-for-age Percentiles (Premature boys, 22.5 to 50 weeks)

Source: Fenton 2013 Preterm Growth Chart
Case B—WHO Curve

Weight-for-age Percentiles (Boys, birth to 2 years)

Source: World Health Organization (WHO), 2006
Case B—Combined

Source: Fenton 2014 (Ref.

WHO

Benet
Case B—Combined

Change to preterm DC formula
High Vit D levels

Discharge

SICC Follow-up #1

DC, discharge; SICC, Special Infant Care Clinic.
### Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up #1: 10/21/20</td>
<td>• Taking good po (140–170 mL/kg)</td>
<td>Weight 3.863 kg (16 g/d on average)</td>
</tr>
<tr>
<td></td>
<td>• Mom breastfeeding more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Not needing GT as much</td>
<td></td>
</tr>
<tr>
<td>Follow-up #2 11/11/20</td>
<td>• Continues to take all feeds by mouth</td>
<td>Weight 4.29 kg</td>
</tr>
<tr>
<td></td>
<td>• Mom estimates ~18 oz po with fortified MBM + 3–4 breast feedings per day</td>
<td>Weight gain since last visit: 20 g/d</td>
</tr>
<tr>
<td></td>
<td>• 1 mL infant multivitamin with iron</td>
<td>Labs checked: Alk Phos 605, Phos 5.5, Vit D 88</td>
</tr>
<tr>
<td>11/11/20</td>
<td>• Changed feeds to 8 oz/d RTF HP preterm formula 30 cal/oz+ ~16-oz plain MBM (BF or bottle)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Discontinue PVS with iron, and changed to 2 mg/kg iron supplement</td>
<td></td>
</tr>
</tbody>
</table>

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.
Case B—Combined

SICC, Special Infant Care Clinic.
<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
</table>
| Follow-up #1: 10/21/20 | • Taking good po (140–170 mL/kg)  
• Mom breastfeeding more  
• Not needing GT as much | Weight 3.863 kg (16 g/d on average) |
| Follow-up #2 11/11/20 | • Continues to take all feeds by mouth  
• Mom estimates ~18 oz po with fortified MBM + 3–4 breast feedings per day  
• 1 mL infant multivitamin with iron | Weight 4.29 kg  
Weight gain since last visit: 20 g/d  
Labs checked: Alk Phos 605, Phos 5.5, Vit D 88 |
| 11/11/20 | • Changed feeds to 8 oz/d RTF HP preterm formula 30 cal/oz+ ~16-oz plain MBM (BF or bottle)  
• Discontinue PVS with iron, and changed to 2 mg/kg iron supplement | BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic. |
### Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended Preterm/Recommended Discharge [a]</th>
<th>Estimated Intake at time of visit: (18-oz MBM w/PDF 24 cal + BF) (based on ~168 mL/kg)</th>
<th>New recommended feeds (based on 168 mL/kg) 8 oz RTF HP preterm formula 30 cal/oz + 16 oz plain MBM or BF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>129</td>
<td>131</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5 (2.8–3.2)</td>
<td>2.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000 (400)</td>
<td>473 (w/ supplementation)</td>
<td>729</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3 (2)</td>
<td>3.1 (w/ supplementation)</td>
<td>3.1 (w/ supplementation)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200 (70–140)</td>
<td>60</td>
<td>119</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140 (35–90)</td>
<td>35</td>
<td>68</td>
</tr>
</tbody>
</table>

[a] Estimated needs at discharge with no accumulated nutrient deficits

BF, breast feeding; PDF, preterm discharge powder formula; HP, high protein; RTF, ready-to-feed, preterm formula; MBM, maternal breast milk; PMA, postmenstrual age.

Audience Poll – Case B

Do you routinely check nutrition labs for premature infants after NICU discharge?
Case B—Combined

SICC, Special Infant Care Clinic.
## Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up #3</td>
<td>• RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day.</td>
<td>Weight: 5.1 kg</td>
</tr>
<tr>
<td>12/10/20</td>
<td>• BF 5 times per day and taking additional plain MBM via bottle.</td>
<td>Weight gain improved since last visit: 28 g/d on average</td>
</tr>
<tr>
<td>Follow-up #4</td>
<td>• Mom recently ran out of HP RTF preterm formula and resumed adding preterm</td>
<td>Weight: 6.039 kg</td>
</tr>
<tr>
<td>1/28/21</td>
<td>discharge powder to MBM 24-cal/oz recipe from NICU</td>
<td>Weight gain velocity: 19 g/d on average&lt;br&gt;*Attempted to do lab check, however, unable to obtain sufficient sample size. Team decided to continue MBM fortified with preterm discharge powder formula</td>
</tr>
<tr>
<td>Follow-up #5</td>
<td>• Continues to take all po</td>
<td>Weight: 7.21 kg</td>
</tr>
<tr>
<td>4/14/21</td>
<td>• Mom with good supply</td>
<td>Weight-gain velocity: 15 g/d on average&lt;br&gt;• Mom advised to start solids &lt;br&gt;• GT removed</td>
</tr>
<tr>
<td></td>
<td>• Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds</td>
<td></td>
</tr>
</tbody>
</table>
Case B—Combined

SICC, Special Infant Care Clinic.

Source: Fenton 2013 Pred
### Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
</table>
| Follow-up #3      | • RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day.                 | Weight: 5.1 kg  
Weight gain improved since last visit: 28 g/d on average |
| 12/10/20          | • BF 5 times per day and taking additional plain MBM via bottle.            |                                                                          |
|                   |                                                                            |                                                                          |
| Follow-up #4      | • Mom recently ran out of HP RTF preterm formula and resumed adding preterm discharge powder powder to MBM 24-cal/oz recipe from NICU  | Weight: 6.039 kg  
Weight gain velocity: 19 g/d on average  
*Attempted to do lab check, however, unable to obtain sufficient sample size. Team decided to continue MBM fortified with preterm discharge powder formula* |
| 1/28/21           |                                                                            |                                                                          |
|                   |                                                                            |                                                                          |
| Follow-up #5      | • Continues to take all po  
• Mom with good supply  
• Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds | Weight: 7.21 kg  
Weight-gain velocity: 15 g/d on average  
• Mom advised to start solids  
• GT removed |
| 4/14/21           |                                                                            |                                                                          |

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; HP RTF, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.
Case B—Combined

SICC, Special Infant Care Clinic.

Source: Fenton 2013 Preterm Growth Charts

Source: World Health Organization (WHO)
## Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
</table>
| **Follow-up #3** 12/10/20 | • RTF HP preterm formula 30 cal/oz, 4 oz x 2 feeds per day.  
• BF 5 times per day and taking additional plain MBM via bottle. | Weight: 5.1 kg  
Weight gain improved since last visit:  
28 g/d on average |
| **Follow-up #4** 1/28/21 | • Mom recently ran out of HP RTF preterm formula and resumed adding preterm discharge powder powder to MBM 24-cal/oz recipe from NICU | Weight: 6.039 kg  
Weight gain velocity: 19 g/d on average  
*Attempted to do lab check, however, unable to obtain sufficient sample size.  
Team decided to continue MBM fortified with preterm discharge powder formula |
| **Follow-up #5** 4/14/21 | • Continues to take all po  
• Mom with good supply  
• Continues to BF and gives 24-cal/oz MBM with PDF when bottle feeds | Weight: 7.21 kg  
Weight-gain velocity: 15 g/d on average  
• Mom advised to start solids  
• GT removed |

BF, breast feed; GT, gastrostomy tube; MBM, maternal breast milk; RTF HP, high-protein, ready-to-feed, preterm formula; SICC, Special Infant Care Clinic.
### Nutrition Progression: Phase 3 Summary Table

<table>
<thead>
<tr>
<th>Dates</th>
<th>Gestational Age</th>
<th>Weights</th>
<th>Weight gain</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/8/2020–9/9/2020</td>
<td>31w3d to 36 weeks (From time back on full feeds after medical NEC tx)</td>
<td>1320–2388 grams</td>
<td>18 g/kg/d on average</td>
<td>15–20 g/kg/d</td>
</tr>
<tr>
<td></td>
<td>*Phase 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/9/202–10/12/2020</td>
<td>36 weeks to discharge (40w5d)</td>
<td>2388–3720 grams</td>
<td>40 g/d</td>
<td>23–43 g/d (boys)</td>
</tr>
<tr>
<td></td>
<td>*Phase 2</td>
<td></td>
<td></td>
<td>31 g/d per Fenton calculator</td>
</tr>
<tr>
<td>10/21/2020</td>
<td>First follow-up (40w5d) Phase 3</td>
<td>3.863 kg</td>
<td>16 g/d</td>
<td>23–43 g/d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33 g/d per Fenton calculator</td>
</tr>
<tr>
<td>11/11/2020</td>
<td>Second follow-up (42w0d) Phase 3</td>
<td>4.290 kg</td>
<td>20 g/d</td>
<td>23–43 g/d</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36 g/d per Fenton calculator</td>
</tr>
<tr>
<td>12/10/2020</td>
<td>Third follow-up (2 months CGA)</td>
<td>5.1 kg</td>
<td>28 g/d</td>
<td>27 g/d per WHO at corrected age</td>
</tr>
<tr>
<td>1/28/2021</td>
<td>Fourth follow-up (3 months 3 wks CGA)</td>
<td>6.039 kg</td>
<td>19 g/d</td>
<td>21 g/d per WHO at corrected age</td>
</tr>
<tr>
<td>4/14/2021</td>
<td>Fifth follow-up (6 months CGA)</td>
<td>7.21 kg</td>
<td>15 g/d</td>
<td>~12–17 g/d from 4–6 mo corrected age per WHO</td>
</tr>
</tbody>
</table>

CGA, corrected gestational age; NEC, necrotizing enterocolitis.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)

Case B—Combined

Fenton

Change to preterm DC formula
High Vit D levels

Return to full feeds 24 cal

NPO
Full feeds

Discharge

WHO

SICC Follow-up #1
SICC Follow-up #2
PT RTF 30

SICC Follow-up #3
SICC Follow-up #4
SICC Follow-up #5

DC, discharge; NPO, nothing by mouth; SICC, Special Infant Care Clinic.
Case B—WHO With CGA

Weight-for-age Percentiles (Boys, birth to 2 years)

Source: World Health Organization (WHO), 2006
Case Study “Benet”

Key Takeaway for baby who continued to have nutritional deficits at time of discharge:

- Growth was appropriate during NICU course and had good recovery growth during NICU stay. Nutrition labs WNL at time of discharge.

- As patient transitioned to more BF and plain MBM at home, fortification strategy not enough to sustain adequate growth or bone mineralization. Alk phos found to be elevated, growth velocity slowed.

Use of nutrient-rich preterm formula paired with plain MBM can improve growth, and improve mineral provision.

BF, breastfeeding; MBM, maternal breast milk; WNL, within normal limits.
Case Study “Coygan”

Background

<table>
<thead>
<tr>
<th>Born at 33w3d</th>
<th>DOB 8/10/2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight</td>
<td>1190 g</td>
</tr>
<tr>
<td>(1%, Z-score -2.25) [a]</td>
<td></td>
</tr>
<tr>
<td>Birth length</td>
<td>38 cm</td>
</tr>
<tr>
<td>(44%, Z-score -0.15)</td>
<td></td>
</tr>
<tr>
<td>Birth HC</td>
<td>28 cm</td>
</tr>
<tr>
<td>(37%, Z-score -0.33)</td>
<td></td>
</tr>
</tbody>
</table>

Born to 36-yr old G3P1011 via C-section due to severe preeclampsia and decreased fetal movement

Mother with PMH of anxiety, depression, abnormal pap smear of cervix

Feeding plan per mother is breastfeeding

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[a] Fenton premature growth chart. PMH, past medical history.

Nutrition Progression: Phase 1

• TPN/Lipids while feeds advanced per high-risk feeding protocol

• Feeds reached goal on DOL 15, 35w4d

• MBM with HMF 24 cal/oz @ 150 mL/kg

• Working on bottle feeding and breastfeeding using cue-based feeding protocol

• PICC/Dextrose fluids discontinued on DOL 17, 35w6d

DOL, day of life; HMF, human milk formula; MBM, maternal breast milk; PICC, peripherally inserted central catheter; TPN, total parenteral nutrition.
Nutrition Progression: Phase 2

- DOL 17 feeds increased to MBM with HMF 26 cal/oz and patient attempting 1–2 breast feeds per day
- Continued above feeds while working on bottle and breast
- NGT discontinued/transitioned to po ad lib on DOL 33, 38w1d

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Estimated intake based on MBM w/LHMF 26x6 feeds, plain MBM via BF x 2 feeds @ ~150 mL/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>123</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5</td>
<td>4</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000</td>
<td>404</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3</td>
<td>2.6</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200</td>
<td>192</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>60–140</td>
<td>105</td>
</tr>
</tbody>
</table>

DOL, day of life; HMF, human milk fortifier; LHMF, liquid human-milk fortifier; MBM, maternal breast milk; NGT, nasogastric tube.
### Phase 3: Discharge Nutrition Assessment

**Discharged 9/13/2020**

| Weight | 1.921 kg (0.12%, Z-score -3.04 based on Fenton) at 38w2d and DOL 34 |

**Discharge feedings**
- Transitioned from liquid HMF to powder HMF for home
- 24 cal/oz po ad lib plus BF ad lib

- Growth velocity at time of discharge: 23.5 g/d on average
- Plan for follow up in SICC in one month to adjust feeding plan

---

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Estimated intake based on MBM w/powder HMF 24 cal/oz + BF 2 times/day (assuming ~160 mL/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>123</td>
</tr>
<tr>
<td>Protein, g/kg</td>
<td>3.5–4.5 (2.8–3.2) [a]</td>
<td>2.4</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000 (400) [a]</td>
<td>362</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3 (2) [a]</td>
<td>1.9</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200 (70–140) [a]</td>
<td>147</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140 (35–90) [a]</td>
<td>81</td>
</tr>
</tbody>
</table>

---

[a] Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014; Agostoni et al 2010)

BM, breast milk; HMF, human milk fortifier; MBM, maternal breast milk; SICC, Special Infant Care Clinic.

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Case C—Combined

Full feeds 24

Up to 26 cal for low glucose issues

Discharge

Source: Fenton 2013 Preterm Growth Chart
Case C—Fenton Curve

Weight-for-age Percentiles (Premature boys, 22.5 to 50 weeks)

Source: Fenton 2013 Preterm Growth Chart
Case C—WHO Curve

Weight-for-age Percentiles (Boys, birth to 2 years)
Case C—Combined

Source: Fenton 2013 Preterm Growth Chart
Challenge Question #3

For a preterm baby >36 weeks to 3 months with CGA (ie, 2–3 months), what is an appropriate growth velocity?
Case C—Combined

Follow-up #1

Discharge

Source: Fenton 2013 Preterm Growth Chart
Nutrition Progression: Phase 3 continued

Follow-up Dates Progression Weight +

Follow-up #1: 9/30/20, 40w5d

- Growth velocity—13.4 g/d on average
- HMF d/c due to constipation; changed to MBM with extensively hydrolyzed protein formula to 27 cal/oz + BF 1–2 times per day
- 0.5 mL multivitamin with iron supplementation recommended (0.5 mL until 2.5 kg, then 1 mL)

Weight: 2.162 kg (0.01%, Z-score: -3.69 based on Fenton)

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommended</th>
<th>Estimated intake based on MBM w/EHP formula 27 cal/oz + BF 2 times/day (assuming ~160 mL/kg)</th>
</tr>
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<tr>
<td>Energy, kcal/kg</td>
<td>110–130</td>
<td>134</td>
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<td>Protein, g/kg</td>
<td>3.5–4.5 (2.8–3.2)</td>
<td>2.4</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>400–1000 (400)</td>
<td>240 (w/ supplement)</td>
</tr>
<tr>
<td>Iron</td>
<td>2–3 (2)</td>
<td>3.1 (w/ supplement)</td>
</tr>
<tr>
<td>Calcium</td>
<td>120–200 (70–140)</td>
<td>64</td>
</tr>
<tr>
<td>Phos</td>
<td>60–140 (35–90)</td>
<td>39</td>
</tr>
</tbody>
</table>

a. Estimated needs at discharge with no accumulated nutrient deficits (Uauy et al 2014[1]; Agostoni et al 2010[2])

BM, breastfed; EHP, extensively hydrolyzed protein formula; HMF, human milk fortifier; MBM, maternal breast milk.

Case C—Combined

SICC Follow-up #1

SICC Follow-up #2

Fenton

WHO

Source: Fenton 2013 Preterm Growth Chart
# Nutrition Progression: Phase 3 continued

<table>
<thead>
<tr>
<th>Follow-up Dates</th>
<th>Progression</th>
<th>Weight +</th>
</tr>
</thead>
</table>
| **Follow-up #2:** 10/28/20 44w5d | • Taking 70–80 mL per feeding  
• Tolerating feeds better; constipation improved  
• Remains on MBM with extensively hydrolyzed protein formula to 27 cal/oz | Weight: 3.095 kg (0.12%, Z-score: -3.04 based on Fenton)  
Weight gain 33 g/d on average |
| **Follow-up #3:** 12/22/20 2 mo 3 wks CGA | • Mostly breast feeding  
• Takes 4 bottles (2 days per week) of MBM with extensively hydrolyzed protein formula to 27 cal/oz when mom is working  
• MD recommends same feeds, decrease to 24 cal/oz if more bottle feeds | Weight: 4.663 kg (0%, Z-score: -3.76 based on chronological age WHO 0–2 yrs Boys)  
Weight gain 28.5 g/d on average |
| **Follow-up #4:** 4/5/21 6 mo 1 wk CGA | • Continues to mostly breast feed.  
• Taking one bottle per day of MBM with extensively hydrolyzed protein formula to 27 cal/oz | Weight: 6.41 kg (1%, Z-score: -2.62 based on chronological age WHO 0–2 yrs Boys)  
Weight gain 17 g/d on average |

BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.
Case C—Combined

Fenton

SICC Follow-up #2

SICC Follow-up #3

WHO

Source: Fenton 2013 Preterm Growth Chart
## Nutrition Progression: Phase 3 continued

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BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.
Case C—Combined

Fenton

SICC Follow-up #3

SICC Follow-up #4

WHO

Source: Fenton 2013 Preterm Growth Chart
## Nutrition Progression: Phase 3 continued

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BF, breast feed; CGA, correct gestational age; MBM, maternal breast milk.

## Nutrition Progression: Phase 3 Summary Table

<table>
<thead>
<tr>
<th>Dates</th>
<th>Gestational Age</th>
<th>Weights</th>
<th>Weight gain</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/27/2020–9/12/2020 (Phase 2)</td>
<td>35w6d to 38w1d</td>
<td>1545–1921 grams</td>
<td>23.5 g/d on average</td>
<td>23–43 g/d 32g/d per Fenton calculator</td>
</tr>
<tr>
<td>9/30/2020 (Phase 3) Clinic follow-up #1</td>
<td>40w5d</td>
<td>2.162 kg</td>
<td>13.4 g/d since discharge</td>
<td>23–43 g/d 24 g/d per Fenton calculator</td>
</tr>
<tr>
<td>10/28/20 (Phase 3) Clinic follow-up #2</td>
<td>44w5d</td>
<td>3.095 kg</td>
<td>33 g/d</td>
<td>23–43 g/d 25 g/d per Fenton calculator</td>
</tr>
<tr>
<td>12/22/20 (Phase 3) Clinic follow-up #3</td>
<td>2 mo 3 wks CGA</td>
<td>4.663 kg</td>
<td>28.5 g/d</td>
<td>27 g/d based on WHO at corrected age</td>
</tr>
<tr>
<td>4/5/21 (Phase 3) Clinic follow-up #4</td>
<td>6 mo CGA</td>
<td>6.41 kg</td>
<td>17 g/d</td>
<td>~12–17 g/d based on WHO at corrected age (between 4–6 mo)</td>
</tr>
</tbody>
</table>

CGA, corrected gestational age.

Fenton calculator can be found on peditools.org (also in EPIC, most electronic medical records)
Case C—Combined

- Full feeds 24
- Up to 26 cal for low glucose issues
- Discharge

Source: Fenton 2013 Preterm Growth Chart
Case C—WHO with CGA

Weight-for-age Percentiles (Boys, birth to 2 years)

CGA, corrected gestational age.
Case Study “Coygan”

Key Takeaway:

• Nutrient-dense fortification is used in combination with BF to support nutrition needs at home.

• Transitioned to higher calorie supplementation for bottle feeds while mom increased BF throughout the day.

• No significant formula changes, allowed mom to incorporate more BF while catch-up growth supported with supplementation plan.

BF, breastfeeding.
Wrap-Up
Growth Curve Summary

• Remember what they tell you, along with the data provided
• Fenton: shows where you’ve been—are you staying on track
• WHO: shows where going—are they on track to achieve recovery growth
• Chart/compare growth velocities of different PediTools options
Transitioning Care to Community Providers

• Pediatric partners are essential

• Discharge summaries can be valuable
  ▪ Underscore why baby has specific feeding plan
  ▪ Highlight ongoing nutrient needs
  ▪ Reinforce that healing is still ongoing

• Specific feeding plan is in place to help support adequate growth
Individualized Feeding Plans

- Individualized feeding plans need to account for physical support
  - Immature feeding skills
  - Breastfeeding mechanics
  - Skills to manage O2 or G-tube
- Nutrient support needed in way of fortifiers
- Monitoring individual growth parameters
- “Standard Fortification” vs “Individualized Fortification”
  - Standard fortification falls short of supplying sufficient protein for some VLBW infants
  - Individualized fortification encourages providers and families to provide optimal nutrient intake


G-tube, gastrostomy tube; VLBW, very low birth weight.
Post-Discharge Growth Monitoring

• Having a structure is essential

• Using more “powerful” fortification strategies after NICU discharge can be powerful supports - But must be aware of risks of excessive micronutrient intake.

• Be mindful of risk mitigation.

• Have a process to follow up and actively monitor these infants to ensure excessive nutrient intake can be corrected if it occurs.

• Monitor infant’s growth, including weight, length, weight for length, and head circumference every 2–4 weeks after discharge.

• Monitor weekly to biweekly for first 4–6 weeks after hospital discharge.

• Once stable, monitor every month, then every 2 months.

Key Takeaways

Growth failure can occur during acute, convalescent, or later in post-NICU, recovery discharge phase.

Nutritional deficiency induces poor postnatal growth. Poor growth in preterm infants has long-term effects.

Nutrition evaluation prior to NICU discharge can help individualize fortification plan for home.

Postdischarge growth monitoring is essential to avoid loss of hard-won gains made in the hospital.