In This Section

**Potentially Better Practices**

#1. Establish consistent, comprehensive, multidisciplinary nutrition care standards of practice based on evidence or expert opinion.  

#2. Establish standards of nutrition monitoring as an integral component of improving nutrition outcomes in the neonatal population.  

#3. Identify, diagnose, and monitor malnutrition.  

#4. Track nutritional continuous quality improvement (CQI) data, for the individual patient as well as the unit aggregate data, and use it to modify current practice.

**Tools**

#1. Common Growth Curves for VLBW Infants  

#2. Monitoring Schedule for VLBW Infants Receiving Parenteral or Enteral Nutrition Support  

#3. Diagnostic Criteria for Malnutrition  

#4. Example: Data Collection Forms  

#5. Example: CQI Data Charts  

**References**

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**General Principles for Supporting the Nutrition of Very Low Birth Weight (VLBW) Infants**

**Introduction**

Intensive care of the VLBW infant continues to advance and nutrition is a cornerstone of this care. Implementing evidence-based practice as the standard of care across NICUs will further enhance the daily clinical care that is provided. Various disciplines bring specialized expertise and can contribute to identifying potentially better practices (PBPs). Working together to create a cohesive approach will promote improved outcomes. Incorporating quality measures and learning where improvements can be made will assist all babies to reach their growth and neurodevelopmental potential.
Establish consistent, comprehensive, multidisciplinary nutrition care standards of practice based on evidence, or expert opinion if evidence is lacking.

**Background, Rationale, and Goals**

- Nutrition is essential for growth, metabolism, immunity, and optimizing neurodevelopmental outcomes.
- While there are some well-established evidence-based practices, practitioner variation may interfere with consistent application and implementation of evidence-based practice, depending on the infant’s medical course.
- Recent review articles have eloquently pulled together expert opinions and evidence as excellent resources.\(^1\)-\(^3\)
- Proper nutrition is the only way to promote growth; however, illness, infection, genetics, and gender influence growth.\(^6\),\(^13\),\(^14\)
- Poor growth, whether it occurs during antenatal or early postnatal life, is associated with increased risk to long-term health.\(^15\)-\(^17\)
- Rapid and/or excessive weight gain that follows a period of poor growth in utero or infancy increases development of chronic non-communicable diseases, such as type 2 diabetes mellitus, hypertension, overweight/obesity, and cardiovascular disease in adulthood.\(^18\)

**Recommendations, Guidelines and Algorithms**

- Create an interdisciplinary nutrition team/committee to review and implement evidence-based practice:
  - Potential members include clinical dietitians/nutritionists, physicians/nurse practitioners, physician assistants, lactation professionals, bedside nursing staff, pharmacy staff, developmental specialists, occupational and/or speech language therapists (who have expertise in oral feeding practices of neonates).
- Growth Standards:
  - Growth charts should be a part of every VLBW infant chart: Readily accessible (ideally electronic\(^4\)), appropriate growth curves, including weight, length, and head circumference.

See **TOOL #1** on page 10 for the Most Current and Common Growth Curves for VLBW Infants.\(^5\)-\(^9\)

- The American Academy of Pediatrics recommends growth at intrauterine growth rates.\(^10\)
- The ideal rate of catch-up growth is unknown, therefore catch-up growth is not prescribed.
- An emerging method of monitoring extraterine growth using a Growth Velocity Approach suggests that to parallel an ideal intrauterine growth of 17 g/kg/day, extraterine growth needs to be closer to 19-20 g/kg/day.\(^11\),\(^12\)
- Head circumference growth is used as a surrogate marker for brain growth and is highly correlated with neurodevelopmental outcomes.\(^19\) IQ in adolescents born preterm are best predicted by white matter volume.\(^17\)
- Studies indicate that linear growth indexes organ growth and may be a more accurate and earlier predictor of growth failure.\(^20\)-\(^22\)
- While at the present time it is not standard to monitor BMI, Weight for Length, or other measurement of body proportionality or
Nutritional Support of the Very Low Birth Weight Infant

• *“Ideal” Growth Goals.* 24,25
  • **Weight:** 19-20 g/kg/day (Measured daily, or as safe and able). Clinical judgment is important in determining weight gain goals considering the neonate’s medical condition, genetic growth potential, and nutrient intake.
  • **Length:** 0.8-1 cm/week (Measured weekly, ideally done with length board for accuracy).
  • **Head Circumference:** 0.8-1 cm/week (Measured weekly, unless otherwise needed more frequently).

• **Calculating Growth Changes** 25-28:
  • Growth restriction, disproportionate fat mass vs. lean body mass in preterm infants when they reach term age vs term infants at birth suggest that current practices are not consistently promoting optimal growth and body composition in preterm infants. 25
  • **Z-Scores** are valuable to understand growth in relation to standard deviations above and below the mean.
  • Calculating weight changes from the infant’s nadir weight (lowest weight measured), or from the day they re-gain their birthweight, (which is typically anywhere between day of life 8-14) may be a more realistic approach than calculating weight changes starting with birthweight. 29
  • The amount of weight gain needed to maintain weight z score varies with age, weight z score, and sex, so weight goals should be adjusted weekly.
    • Can use PediTools Preterm calculator to individually assess growth goals

• **Nutrition Provision:** Use established, standardized monitoring protocols with defined nutritional goals
  • **TPN initiation, advancement, & duration**
  • **Nutrition discharge planning**

• **Laboratory Monitoring** 30
  • There are no absolute standards, only guidelines/recommendations
  • Influences on laboratory monitoring include:
    • Laboratory processing capabilities
    • Volume needed to obtain results
    • Cost to hospital and potential for reimbursement
    • Clinical status/stability, and goals of care for the patient
    • Parent preference or religious belief

Refer to **TOOL #2** on page 11 for a Monitoring Schedule for VLBW Infants Receiving Parenteral or Enteral Nutrition Support.

• Document assessments by registered dietitians who specialize in neonatal nutrition
  • Within 24 hours of admission
  • At regular intervals, every 3-5 days & no longer than 7 days apart

**Quality Improvement: Outcome/Process Measures**

• Are growth charts available in the hard copy or EMR?
• Are growth charts in the EMR auto-populated?
• Are perinatally-trained dietitians available in the NICU with standard orders for consultation?
• Are protocols available for monitoring growth laboratory measures?
Establish standards of nutrition monitoring as an integral component of improving nutrition outcomes in the neonatal population.\(^3\)

**Background, Rationale and Goals**

- There is no absolute approach to guarantee each and every baby will reach their growth and cognitive potential, yet we continue to strive to optimize those outcomes to the best of our ability.\(^{1,31,32}\)
- Lack of financial and personnel resources, may impact the ability to implement nutrition monitoring.
- Advances in nutrition care for VLBW infants enhance survival and can minimize or modify long-term morbidity outcomes.

**Outcome and Process Measures:**

- At a minimum, annual review of nutrition outcomes and compare to internal benchmarking &/or outside benchmarks (CPQCC, VON, etc.).

**Recommendations, Guidelines and Algorithms**

- Review current practice.
  - Often there may be a significant disconnect between assumed practice and reality.
  - Identify outdated practices and other areas for improvement.

**Quality and Process Improvement**

- If not already available in your unit, explore hiring a registered dietitian and lactation consultant.
- Create standardized flow-sheets or charting tools to support daily calculations, trends, and facilitate analyses.
- Identify changes in your nutrition outcomes, and measure change in clinical practice (as in Plan Do Study Act “PDSA” Cycles).
Identify, diagnose, and monitor malnutrition.

Background, Rationale and Goals

- The Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN) have recently established recommendations and criteria for the identification and documentation of malnutrition related to undernutrition for both adult and pediatric populations.
- Malnutrition can result in poor growth and may influence neurocognitive outcomes.
- VLBW infants are at very high risk for malnutrition and undernutrition due to:
  - Decreased nutrient stores at birth
  - Immature absorption and organ function
  - Delayed initiation and advancement of both parenteral and/or enteral nutrition
  - Complications due to NEC/SIP, CLD, infections, parenteral and enteral nutrition access, and/or cardiac anomalies, etc.
- Primary indicators used to diagnose malnutrition in neonates:
  - Individual data are compared to appropriate reference standards
  - To make the diagnosis of malnutrition, use the most accurate data points to determine the classification/degree of malnutrition (Mild, Moderate, Severe)

Refer to TOOL 3 on page 12 for diagnostic criteria.

- In some situations, diagnosing malnutrition may need to be deferred due to critical illness and patient instability, or it may become not necessary (such as end of life/comfort care).

Recommendations, Guidelines and Algorithms

- Accurate anthropometric data should be obtained routinely and compared to appropriate reference standards.
- Initial malnutrition assessment/diagnosis should be done within the first 2 weeks of life.
- Malnutrition assessment/diagnosis should be monitored and updated appropriately at least weekly during hospitalization.
- Tracking malnutrition diagnosis, and classifications (mild, moderate, severe) should be recorded and reviewed at least annually for trends.

Quality Improvement: Outcome/Process Measures

- At least annual review for the staff of proper techniques to obtain the most accurate data.
- Track influence of routine malnutrition diagnosis on short and long-term outcomes.
- Assessment of malnutrition status may affect payor reimbursement.
- Audit charts to review and assess for accuracy of malnutrition diagnosis.
  - Is the criteria appropriately being applied and accurately reflected in the degree of malnutrition diagnosed?
Track nutritional continuous quality improvement (CQI) data, for the individual patient as well as the unit aggregate data, and use it to modify current practice.

Background, Rationale and Goals

- Evidence-based quality improvement efforts continue to demonstrate the importance of measuring current practice to improve future practice.\(^{33,34}\)
- An individual database should facilitate the nutrition care of an individual patient.
- Collective analysis of nutritional processes and outcomes are needed for global NICU quality improvement and interventions.\(^{2,33,35}\)
- Implementation and ongoing quality improvement activities may be impeded by lack of data collection and analysis capability and resources.

Recommendations, Guidelines and Algorithms

- Individual patient data tracking of key measures
- Collective key measure information gathered from all patients admitted during a defined period (typically 1 calendar year)

Refer to TOOL 4 on page 14 for examples of measurement tools.

- Data updated and shared with staff regularly

Quality Improvement: Outcome/Process Measures

**INDIVIDUAL DATA**
- Are the patient’s nutrition goals being met?
  - Daily assessment and discussion on rounds
- Daily volume, caloric intake, including protein, dextrose, fat calories
- When appropriate, electrolyte, vitamin and trace element intake
- If not, why are they not being met? i.e. fluid restriction, tolerance, etc.
- Number of Days NPO
- Relative contribution of gavage vs. nipple vs. breastfeeding intake
- Consistent encouragement and appraisal of mother’s milk supply
  - Prenatal education and parental decision-making, especially regarding breastfeeding
  - Pumping log
  - Discussion on rounds
  - Availability of lactation professionals
  - Timing of skin-to-skin contact, non-nutritive breastfeeding
- Track the use of breastmilk as the preferred nutritional source.
  - Was breastmilk given as the first feed?
  - Did the infant receive banked breast milk (BBM)?
  - How much BBM vs. Mom’s own breastmilk (MBM)?
  - Fortification used and days on fortified feeds
  - Feeding any breastmilk at discharge
  - Breastfeeding at discharge
- Biochemical monitoring
  - Frequency of lab draws
  - Chemistries to monitor & trend

**AGGREGATE DATA**
- Develop a nutritional database
- Nutrition reports pulled automatically from
the electronic medical record (EMR)

- Trends over time (Monthly vs. Quarterly vs. Annually)
- Data may include, but is not limited to:
  - Average BW, GA
  - Amount of Amino Acids received in the first DOL
  - Average and range DOL feeding pathway starts
  - Average and range of DOL BW is regained
  - % of patients who received MBM as first feed
  - Average growth velocity
  - NEC rate
  - % of patients who are feeding breastmilk upon discharge
  - % of patients discharged with a feeding tube
- Comparison of center outcomes
  - % Exaggerate growth restriction (EUGR)
  - Weight at discharge decreased ≥ 1 SD from birthweight
  - % of infants AGA at birth who are SGA (<10th percentile) at discharge
  - CPQCC
  - VON
  - Children’s Hospital Association
  - Within healthcare system networks (eg. Kaiser, MedNax)
- Published data
- Available benchmarks
- Internally established metrics
### Current and Common Growth Curves for VLBW Infants

- Use hyperlinks to view each growth chart
- Source for access to most growth charts: PediTools Preterm

#### Fenton Growth Curve

|---------------------|--------------------------------------------------------------------------------------------------|
| Notes               | - International Data  
                        - Combine WHO Growth Curve data points, which is to be used once former preterm infants correct to post-term |

#### Growth Calculator

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes</td>
<td>Newer, more conceptual theory that needs further investigation, validation, and long-term understanding; however, is an approach focused on a more personalized expectation of growth</td>
</tr>
</tbody>
</table>

#### INTERGROWTH 21st

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes</td>
<td>Limitations: small sample size &lt;28 wk infants</td>
</tr>
</tbody>
</table>

#### BMI Curves for Preterm Infants

<table>
<thead>
<tr>
<th>Where do I find it?</th>
<th><a href="http://pediatrics.aappublications.org/content/135/3/e572.figures-only">http://pediatrics.aappublications.org/content/135/3/e572.figures-only</a></th>
</tr>
</thead>
</table>
| Notes               | - To monitor proportionality of growth  
                        - Limitation is that it cannot delineate fat-free mass accumulation vs. fat mass |
**Monitoring Schedule for VLBW Infants Receiving Parenteral or Enteral Nutrition Support**

<table>
<thead>
<tr>
<th></th>
<th>Parenteral Nutrition</th>
<th>Enteral Nutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial Phase</td>
<td>Stable Phase</td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Daily</td>
<td>Daily</td>
</tr>
<tr>
<td>Length</td>
<td>Baseline</td>
<td>Weekly</td>
</tr>
<tr>
<td>Head Circumference</td>
<td>Baseline</td>
<td>Weekly</td>
</tr>
<tr>
<td><strong>Intake and Output</strong></td>
<td>Daily</td>
<td>Daily</td>
</tr>
<tr>
<td><strong>Glucose</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum</td>
<td>As indicated</td>
<td>As indicated</td>
</tr>
<tr>
<td>Urine</td>
<td>1-3 times/day</td>
<td>As indicated</td>
</tr>
<tr>
<td><strong>Electrolytes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium, magnesium,</td>
<td>2-3 times/week</td>
<td>Every 1-2 weeks</td>
</tr>
<tr>
<td>phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Triglycerides</strong></td>
<td>Daily during dose increase</td>
<td>Every 1-2 weeks</td>
</tr>
<tr>
<td><strong>BUN/creatinine</strong></td>
<td>2-3 times/week</td>
<td>Every 1-2 weeks</td>
</tr>
<tr>
<td><strong>Serum proteins</strong></td>
<td>Baseline</td>
<td>Every 2-3 weeks</td>
</tr>
<tr>
<td><strong>Liver enzymes</strong></td>
<td>Baseline</td>
<td>Every 2-3 weeks</td>
</tr>
<tr>
<td><strong>Alkaline phosphatase</strong></td>
<td>Baseline</td>
<td>Every 2-3 weeks</td>
</tr>
<tr>
<td><strong>Blood cell count</strong></td>
<td>Baseline</td>
<td>Every 2-3 weeks</td>
</tr>
<tr>
<td><strong>Vitamin and trace mineral status or other specific tests</strong></td>
<td>As indicated</td>
<td>As indicated</td>
</tr>
</tbody>
</table>

**Initial Phase:** Period in which PN solutions or enteral feedings are adjusted to meet the specific energy and nutrient needs of individual infants. This period generally lasts for < 1 week for parenteral nutrition support and 7-10 days for enteral nutrition support.

**Stable Phase:** Period in which the infant is in a metabolically stable state. For clinically stable infants receiving an adequate nutrient intake with desired growth, the interval between laboratory measurements may be increased beyond the above recommendations.

**Adapted from:** Moyer-Mileur LJ. *Anthropometric and laboratory assessment of very low birth weight infants: the most helpful measurements and why*. Semin Perinatol. 2007;31:96-103.
## Diagnostic Criteria for Malnutrition

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Mild malnutrition</th>
<th>Moderate malnutrition</th>
<th>Severe malnutrition</th>
<th>Use of indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary indicators requiring 1 indicator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decline in weight-for-age z score</td>
<td>Decline of 0.8-1.2 SD</td>
<td>Decline of &gt; 1.2-2 SD</td>
<td>Decline of &gt; 2 SD</td>
<td>Not appropriate for first 2 weeks of life</td>
</tr>
<tr>
<td>Weight gain velocity</td>
<td>&lt; 75% of expected rate of weight gain to maintain growth rate</td>
<td>&lt; 50% of expected rate of weight gain to maintain growth rate</td>
<td>&lt; 25% of expected rate of weight gain to maintain growth rate</td>
<td>Not appropriate for first 2 weeks of life</td>
</tr>
<tr>
<td>Nutrient intake</td>
<td>≥ 3-5 consecutive days of protein/energy intake</td>
<td>≥ 5-7 consecutive days of protein/energy intake</td>
<td>&gt; 7 consecutive days of protein/energy intake</td>
<td>Preferred indicator during the first 2 weeks of life</td>
</tr>
<tr>
<td></td>
<td>≤ 75% of estimated needs</td>
<td>≤ 75% of estimated needs</td>
<td>≤ 75% of estimated needs</td>
<td></td>
</tr>
<tr>
<td><strong>Primary indicators requiring 2 or more indicators</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days to regain birth weight</td>
<td>15-18</td>
<td>19-21</td>
<td>&gt; 21</td>
<td>Use in conjunction with nutrient intake</td>
</tr>
<tr>
<td>Linear growth velocity</td>
<td>&lt; 75% of expected rate of linear gain to maintain expected growth rate</td>
<td>&lt; 50% of expected rate of linear gain to maintain expected growth rate</td>
<td>&lt; 25% of expected rate of linear gain to maintain expected growth rate</td>
<td>Not appropriate for first 2 weeks of life.</td>
</tr>
<tr>
<td></td>
<td>May be deferred in critically ill, unstable infants.</td>
<td>Use in conjunction with another indicator when accurate length measurement available.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decline in length-for-age z score</td>
<td>Decline of 0.8 - 1.2 SD</td>
<td>Decline of &gt; 1.2-2 SD</td>
<td>Decline of &gt; 2 SD</td>
<td>Not appropriate for first 2 weeks of life.</td>
</tr>
<tr>
<td></td>
<td>May be deferred in critically ill, unstable infants.</td>
<td>Use in conjunction with another indicator when accurate length measurement available.</td>
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### TOOL #4

**EXAMPLE: Data Collection Forms**

<table>
<thead>
<tr>
<th>INDIVIDUAL DATA COLLECTION FORM</th>
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</thead>
<tbody>
<tr>
<td><strong>Name:</strong></td>
</tr>
<tr>
<td>DOB:</td>
</tr>
<tr>
<td>Admit Date:</td>
</tr>
<tr>
<td>Birth Wt: g</td>
</tr>
<tr>
<td>Birth Length: cm</td>
</tr>
<tr>
<td>Birth FOC: cm</td>
</tr>
<tr>
<td>Date BW regained:</td>
</tr>
<tr>
<td>Date of D/C:</td>
</tr>
<tr>
<td>D/C Weight: g</td>
</tr>
<tr>
<td>D/C Length: cm</td>
</tr>
<tr>
<td>D/C FOC: cm</td>
</tr>
<tr>
<td>AA started DOL:</td>
</tr>
<tr>
<td>Lipids started DOL:</td>
</tr>
<tr>
<td>90 kcal/kg on DOL:</td>
</tr>
<tr>
<td>120 kcal/kg on DOL:</td>
</tr>
<tr>
<td>130 kcal/kg on DOL:</td>
</tr>
<tr>
<td>3.5 g/kg on DOL:</td>
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<tr>
<td>HMF type:</td>
</tr>
<tr>
<td>HMF started DOL:</td>
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<tr>
<td>DOL started DHM:</td>
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<tr>
<td>Date started DHM:</td>
</tr>
<tr>
<td>Date ended DHM:</td>
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<tr>
<td># d total DHM:</td>
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<tr>
<td>DOL started Vits:</td>
</tr>
<tr>
<td>Date started Vits:</td>
</tr>
<tr>
<td>Date ended Vitamins:</td>
</tr>
<tr>
<td># d total Vitamins:</td>
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<tr>
<td>NEC Stage:</td>
</tr>
<tr>
<td>Date of NEC:</td>
</tr>
<tr>
<td>DOL of NEC:</td>
</tr>
<tr>
<td>Feeds at NEC:</td>
</tr>
</tbody>
</table>

Collection examples from: Kelli Hawthorne MS, RD, LD via personal communication with the authors of this toolkit.
<table>
<thead>
<tr>
<th>Name</th>
<th>MRN</th>
<th>DOB</th>
<th>Admit date</th>
<th>Birth GA</th>
<th>Admit PMA</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Birth Wt</th>
<th>Birth Length</th>
<th>Birth FOC</th>
<th>Date BW regained</th>
<th>%ile Wt at Birth</th>
<th>%tile Length at Birth</th>
<th>% FOC at Birth</th>
<th>DOL BW regained</th>
<th>% wt loss prior to regain</th>
<th>Date of D/C</th>
<th>D/C Weight</th>
<th>D/C Length</th>
<th>D/C FOC</th>
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</table>
EXAMPLE CQI Data Charts

SMBHW NICU- Timing of First Feeding (< 1500g): Average days post birth

Percentage Fed by DOL # 1, 2, 3

SMBHWN NICU- First Feeding (< 1500g): % MBM, PDHM, Formula

First PO Feeding: Breast Before Bottle

VON – ANY Breastmilk at Discharge

Breastmilk Use in Graduate NICU
24. Guidelines for Acute Care of the Neonate. Houston, TX: Section of Neonatology, Department of Pediatrics, Baylor College of Medicine; 2015-2016.