PRACTICE TOOL

Neonatal Nutrition Assessment

Adequate nutrition is vital for infant growth and development. Quality nutrition improves outcomes for preterm and high-risk neonates, including reduced risk of bronchopulmonary dysplasia, reduced risk of retinopathy of prematurity, and improved neurodevelopment. Nutrition assessment is crucial for detecting and managing nutrient deficiencies and malnutrition. This tool provides an overview of NICU nutrition assessment, including malnutrition indicators, the nutrition-focused physical exam (NFPE), and detailed growth anthropometrics.

Anthropometric Assessment

Accurate growth and malnutrition assessment requires systematic measurements and a collaborative, multimodal approach. Serial weight, length, and head circumference tracking is essential, though distinguishing pathological deviations from normal growth patterns can be challenging. Thus, growth assessment must be done with the patient's larger clinical context in mind. Selection of growth charts for growth assessment should consider the populations and data used to create each chart.

Anthropometric Measurement	Frequency of Measurement	Frequency of Assessment	Tool of Assessment	Notes
Key Measurements				
Weight	Daily, or 2–3 times weekly in less stable infants	Over minimum 7-day period	Preterm infant growth charts should be used until 40–50 weeks PMA, based on clinical judgement. Growth references[1,2] are commonly used, but growth standards[3,4] for preterm infants have been more recently published. For term infants, weight gain assessment should use the WHO 0–2-year growth charts.[5]	Weight gain velocities may be influenced by non-nutritive factors including: fluid status, exposure to postnatal steroids, hyponatremia, acidosis, hypoxia, anemia, temperature instability, increased work of breathing, and sepsis.
Length	Weekly	Over 1–2 week period		Requires measurement on a length board with two people. As length is not influenced by fluid status, poor linear growth is a better indicator of chronic growth problems resultant from insufficient nutrition administration, severity of illness, systemic steroid utilization, or genetic conditions.
Head circumference	Weekly, or more frequently for conditions requiring close assessment	Weekly or more frequently in certain disease states		May decrease by approximately 0.5 cm during the first postnatal week due to extracellular fluid space contraction. Birth head circumference may measure smaller due to molding during vaginal birth or may be influenced by cephalohematoma.
Enhanced Anthropometric Measurements				
Mid upper arm circumference	Weekly	Over 1–2 week period	Preterm infant mid upper arm circumference growth trends have been proposed, with 0.1–0.5 cm weekly growth for infants 27–55 weeks post menstrual age.[6] Sex-specific WHO data for age 3 months–5 years, 0.1–0.4 cm monthly growth for 3–12 month age range.[7]	Ensuring reliability of measurements requires clinical training. Utilization of tools that facilitate standardized tension in measurements may be beneficial for promoting accurate and reliable measures.
Body composition	As clinically feasible	As clinically available	Charts evaluating body composition trends from 30 1/7–41 6/7 weeks post menstrual age, and 1–27 weeks postnatal age have been published. These charts were creating using data collected via air displacement plethysmography.[8]	Incorporation of air displacement plethysmography into clinical practice is feasible but requires an investment in the technology and infrastructure to support standardized measurements. Infants must be free of respiratory and intravenous supports for evaluation via air displacement plethysmography.
Weight-for-length	Requires concurrent weight and length measurement	Over 1–4 week period	Olsen 2015 describes BMI patterns for preterm infants at 24 4/7–41 3/7 weeks post menstrual age.[9]	Body proportionality as assessed by BMI should be cautiously interpreted, as it is overly influenced by length measurements. Even when correctly measured, linear stunting takes much longer to rebound as compared to weight gain.

Continued on next page

Intake Assessment

Evaluating intake of preterm and term infants requires assessment of energy and all macro- and micronutrient intake. Intake recommendations for preterm infants are regularly evaluated, thus clinical practices must regularly evolve. The wide array of clinical presentations of critically-ill term infants necessitates individualized assessment of requirements based on disease state, using listed recommendations as a starting point for clinical evaluation.

		Preterm Infant		Term Infant
	Nutrient	**Initial**	**Goal**	**Goal**
Parenteral Nutrition	Energy (kcal/kg/d)[10-12]	40–60	90–120	85–110 Can consider Schofield's equations for calculating resting energy expenditure, multiplying by a factor of 1.3 to support growth. Males: 59.5 x (weight in kg) – 30 Females: 58.3 x (weight in kg) – 31
	Protein (g/kg/d)[12-14]	1.5–3	3–3.5	1.5–3
	Macronutrient ratios[12,14]	20–30 non-nitrogen energy per gram amino acid Non-nitrogen energy distributed as: 60–75% carbohydrate, 25–40% fat		
	Calcium (mmol/kg/d)[10,12,15,16]	0.8–1	1.6–2	0–6 months: 0.8–1.5 6–12 months: 0.5
	Phosphorus (mmol/kg/d)[10,12,15,16]	1	1.6–2	0–6 months: 0.7–1.3 6–12 months: 0.5
	Ca:P molar ratio	0.8–1 : 1		
	Zinc (mcg/kg/d)[17]	400–500		0–3 months: 250 3–12 months: 100
Enteral Nutrition	Energy (kcal/kg/d)	115–140 (-160)*		105–120
	Protein (g/kg/d)	3.5–4 (-4.5)**		0–6 months: 9.1 g/d 6–12 months: 11 g/d
	Calcium (mmol/kg/d)[18,19]	3–5		0–6 months: 200 mg/d 6–12 months: 260 mg/d
	Phosphorus (mmol/kg/d)[18,19]	2.2–3.7		0–6 months: 100 mg/d 6–12 months: 275 mg/d
	Zinc (mg/kg/d)[18,19]	2–3		0–6 months: 2 mg/d 6–12 months: 3 mg/d

* Energy intakes exceeding 140 kcal/kg/d may be necessary to support growth goals, but should not be provided until protein and other nutrient sufficiency has been ensured and should not exceed 160 kcal/kg/d.

** Enteral protein requirements may reach 4.5 g/kg/day where growth is slow, provided that protein quality is good concomitant energy and other micronutrients are optimal, and there are not other causes for suboptimal growth. Of note, unless analyzing breast milk clinically, calculated protein administered may not match actual protein administered.

Continued on next page

Nutrition Focused Physical Exam

Performance of the NFPE in the NICU setting is a growing practice. Evaluation of fat and fat-free mass is markedly different in the extremely premature (e.g., 22–24 weeks gestational age) and infant with history of severe intrauterine growth restriction. These populations' distinct body composition demonstrates their high nutritional risk at birth and may require substantial time to "normalize." Due to the medical fragility of preterm and high-risk newborns, the NFPE may need to be done in conjunction with other health professionals (e.g., nurses, physicians, APRNs) during required hands-on care.

Infant Nutrition Focused Physical Exam Checklist

Fat Mass

Site / Location	Normal / Well Nourished	Mild Malnutrition / Moderate Malnutrition	Severe Malnutrition
Face: eyes	Slightly bulging fat pads	Slight darkened circles, loose skin	Dark circles, hollow, depressions, sagging of skin
Cheeks / buccal	Full round cheeks	Flat, minimal bounce	Hollow, sunken
Chest	Full, round, ribs not visible	Ribs notable, depressions between ribs visible	Progressive prominence of ribs noted, with loss of intercostal tissue, Iliac crest very visible
Buttock	Full and round	Curved, less round / Slightly curved, not round	Skin very wrinkled, no fat mass noted
Legs	Full, round	Slight loose skin noted	Ample loose skin noted, fingers can separate skin from fat free mass

Fat-free Mass

Site / Location	Normal / Well Nourished	Mild Malnutrition / Moderate Malnutrition	Severe Malnutrition
Head	Temple/neck muscle well defined	Slight depression, thin appearance, poor tone–head control	Deep hollow, very poor tone, low muscle mass in neck and shoulders
Arms	Rounded, good tone	Bony prominence visible, low tone	Poor tone, bone noted, skin and bone
Abdomen	Good rebound to touch, soft, good bowel sounds	Firm, ribs noted, abdomen may be depressed	Maybe rounded and firm, edema may be present
Legs	Well rounds thigh and calf	Mild depression in thigh, kneecap may be visible	Kneecaps visible, thin calf, no muscle definition of thigh or calf noted

Hydration

Site / Location	Normal / Well Nourished	Mild Malnutrition / Moderate Malnutrition	Severe Malnutrition
Head	Moist mucous membranes, tears noted	+ 1–2 pitting edema	+ 3–4 pitting edema
Genitals	Normal appearance / 6-8 wet diapers per day	+ 1–2 pitting edema	+ 3–4 pitting edema
Extremities	Normal appearance	+ 1–2 pitting edema	+ 3–4 pitting edema

Continued on next page

Infant Nutrition Focused Physical Exam Checklist *(continued)*

Micronutrient by Body Site			
Oral cavity: Signs / Symptoms	**Deficits?**	**Potential nutrient deficiency / cause**	**Non-nutrition related causes**
Mouth lesions		Zinc, vitamin C	Trauma, irritation from medical equipment, graft vs. host disease, medication or food allergy
Dry mucous membranes		Dehydration, vitamin A, C, or D	Medication side effect, treatment side effect
Dental decay		Nursing bottle syndrome	Genetic anomaly
Pale mucosa		Iron, folate, B6, B12	Low flow state
Inflammation of tongue, lips, mucosa		B vitamins	Infection, GVHD
Skin: Signs / Symptoms	**Deficits?**	**Potential nutrient deficiency / cause**	**Non-nutrition related causes**
Dermatitis (swollen, red, raised, inflamed)		Zinc, essential fatty acid deficiency	Allergy, eczema, medication, diaper dermatitis
Flaky paint dermatitis		PMN	Environmental reaction
Pallor		Iron, folate, B6, B12	Low mean arterial pressure
Pellagrous dermatitis (areas of hyperpigmentation)		Niacin, tryptophan	Burns
Petechiae (small hemorrhagic papillae)		Vitamin C or K	GVHD
Poor wound healing		Zinc, vitamin C or A, protein, EFA	Dehydration, infection
Xerosis (dry, flaky, scaly)		Zinc, EFA, hydration	Allergy, atopic dermatitis, medication

Created by Patricia Becker, MS, RDN, CSP, FAND, FASPEN. Reprinted with permission.

Continued on next page

Malnutrition Indicators

Malnutrition indicators for the preterm infant and neonate were proposed in 2018. These malnutrition criteria have yet to be validated but mark an important starting point for bringing formalized malnutrition assessment and diagnosis to the NICU space.

Malnutrition Indicators in Preterm and Neonatal Populations[20]

Primary Indicators Requiring 1 Indicator

Indicator	Mild Malnutrition	Moderate Malnutrition	Severe Malnutrition	Use of Indicator
Decline in weight-for-age z score	Decline of 0.8–1.2 SD	Decline of >1.2-2 SD	Decline of >2 SD	Not appropriate for first 2 wks. of life
Weight gain velocity	<75% of expected rate of weight gain to maintain growth rate	<50% of expected rate of weight gain to maintain growth rate	<25% of expected rate of weight gain to maintain growth rate	Not appropriate for first 2 wks. of life
Nutrient intake	≥3–5 consecutive days of protein/energy intake ≤75% of estimated needs	≥5–7 consecutive days of protein/energy intake ≤75% of estimated needs	≥7 consecutive days of protein/energy intake ≤75% of estimated needs	Preferred indicator during first 2 weeks of life

Primary Indicators Requiring 2 or More Indicators

Indicator	Mild Malnutrition	Moderate Malnutrition	Severe Malnutrition	Use of Indicator
Days to regain birth weight	15–18	19–21	>21	Use in conjunction with nutrient intake
Linear growth velocity	<75% of expected rate of linear gain to maintain expected growth rate	<50% of expected rate of linear gain to maintain expected growth rate	<25% of expected rate of linear gain to maintain expected growth rate	Not appropriate for first 2 wks. of life May be deferred in critically ill, unstable infants Use in conjunction with another indicator when accurate length measurement available
Decline in length-for-age z score	Decline of 0.8–1.2 SD	Decline of >1.2–2 SD	Decline of >2 SD	Not appropriate for first 2 wks. of life May be deferred in critically ill, unstable infants Use in conjunction with another indicator when accurate length measurement available

SD = standard deviation. Expected weight gain velocity, expected linear growth velocity, and z scores can be determined using the online calculator PediTools (www.peditools.org).

References

1. Olsen IE, Groveman SA, Lawson ML, et al. New intrauterine growth curves based on United States data. *Pediatrics.* 2010 Feb;125(2):e214-24.
2. Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. *BMC Pediatr.* 2013 Apr 20;13:59.
3. Fenton TR, Elmrayed S, Alshaikh BN. Fenton Third-generation growth charts of preterm infants without abnormal fetal growth: a systematic review and meta-analysis. *Paediatr Perinat Epidemiol.* 2025 Jun 19. doi: 10.1111/ppe.70035. Epub ahead of print.
4. Villar J, Giuliani F, Bhutta ZA, et al. Postnatal growth standards for preterm infants: the Preterm Postnatal Follow-up Study of the INTERGROWTH-21(st) Project. *Lancet Glob Health.* 2015 Nov;3(11):e681-91.
5. Centers for Disease Control. WHO growth standards for use in US infants and children birth to 2 years. 2024. https://www.cdc.gov/growthcharts/who-growth-charts.htm
6. Abdel-Rahman SM, Paul IM, Delmore P, et al. An anthropometric survey of US pre-term and full-term neonates. *Ann Hum Biol.* 2017 Dec;44(8):678-686.
7. World Health Organization. Arm circumference-for-age. https://www.who.int/tools/child-growth-standards/standards/arm-circumference-for-age
8. Norris T, Ramel SE, Catalano P, et al. New charts for the assessment of body composition, according to air-displacement plethysmography, at birth and across the first 6 mo of life. *Am J Clin Nutr.* 2019 May 1;109(5):1353-1360.
9. Olsen IE, Lawson ML, Ferguson AN, et al. BMI curves for preterm infants. *Pediatrics.* 2015 Mar;135(3):e572-81.
10. American Society for Parenteral and Enteral Nutrition. Appropriate Dosing for Parenteral Nutrition: ASPEN Recommendations. Parenteral Nutrition Resources. November 17, 2020. https://www.nutritioncare.org/pnresources/
11. Joosten K, Embleton N, Yan W, et al. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Energy. *Clin Nutr.* 2018 Dec;37(6 Pt B):2309-2314. doi: 10.1016/j.clnu.2018.06.944. Epub 2018 Jun 18. PMID: 30078715.
12. National Institute for Health and Care Excellence. Neonatal parenteral nutrition. February 26, 2020. https://www.nice.org.uk/guidance/ng154
13. Robinson DT, Calkins KL, Chen Y, et al. Guidelines for parenteral nutrition in preterm infants: The American Society for Parenteral and Enteral Nutrition. *JPEN J Parenter Enteral Nutr.* 2023 Sep;47(7):830-858.
14. van Goudoever JB, Carnielli V, Darmaun D, et al. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Amino acids. *Clin Nutr.* 2018 Dec;37(6 Pt B):2315-2323.
15. Boullata JI, Gilbert K, Sacks G, et al. A.S.P.E.N. clinical guidelines: parenteral nutrition ordering, order review, compounding, labeling, and dispensing. *JPEN J Parenter Enteral Nutr.* 2014 Mar-Apr;38(3):334-77.
16. Mihatsch W, Fewtrell M, Goulet O, et al. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Calcium, phosphorus and magnesium. *Clin Nutr.* 2018 Dec;37(6 Pt B):2360-2365.
17. Domellöf M, Szitanyi P, Simchowitz V, et al. ESPGHAN/ESPEN/ESPR/CSPEN guidelines on pediatric parenteral nutrition: Iron and trace minerals. *Clin Nutr.* 2018 Dec;37(6 Pt B):2354-2359.
18. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Committee to Review the Dietary Reference Intakes for Sodium and Potassium; Oria M, Harrison M, Stallings VA, editors. Dietary Reference Intakes for Sodium and Potassium. Washington (DC): National Academies Press (US); 2019 Mar 5. Appendix J, Dietary Reference Intakes Summary Tables. Available from: https://www.ncbi.nlm.nih.gov/books/NBK545442/
19. Embleton ND, Jennifer Moltu S, Lapillonne A, et al. Enteral Nutrition in Preterm Infants (2022): A Position Paper From the ESPGHAN Committee on Nutrition and Invited Experts. *J Pediatr Gastroenterol Nutr.* 2023 Feb 1;76(2):248-268.
20. Goldberg DL, Becker PJ, Brigham K, et al. Identifying malnutrition in preterm and neonatal populations: recommended indicators. *J Acad Nutr Diet.* 2018 Sep;118(9):1571-1582.

This practice tool is supported by Mead Johnson Nutrition