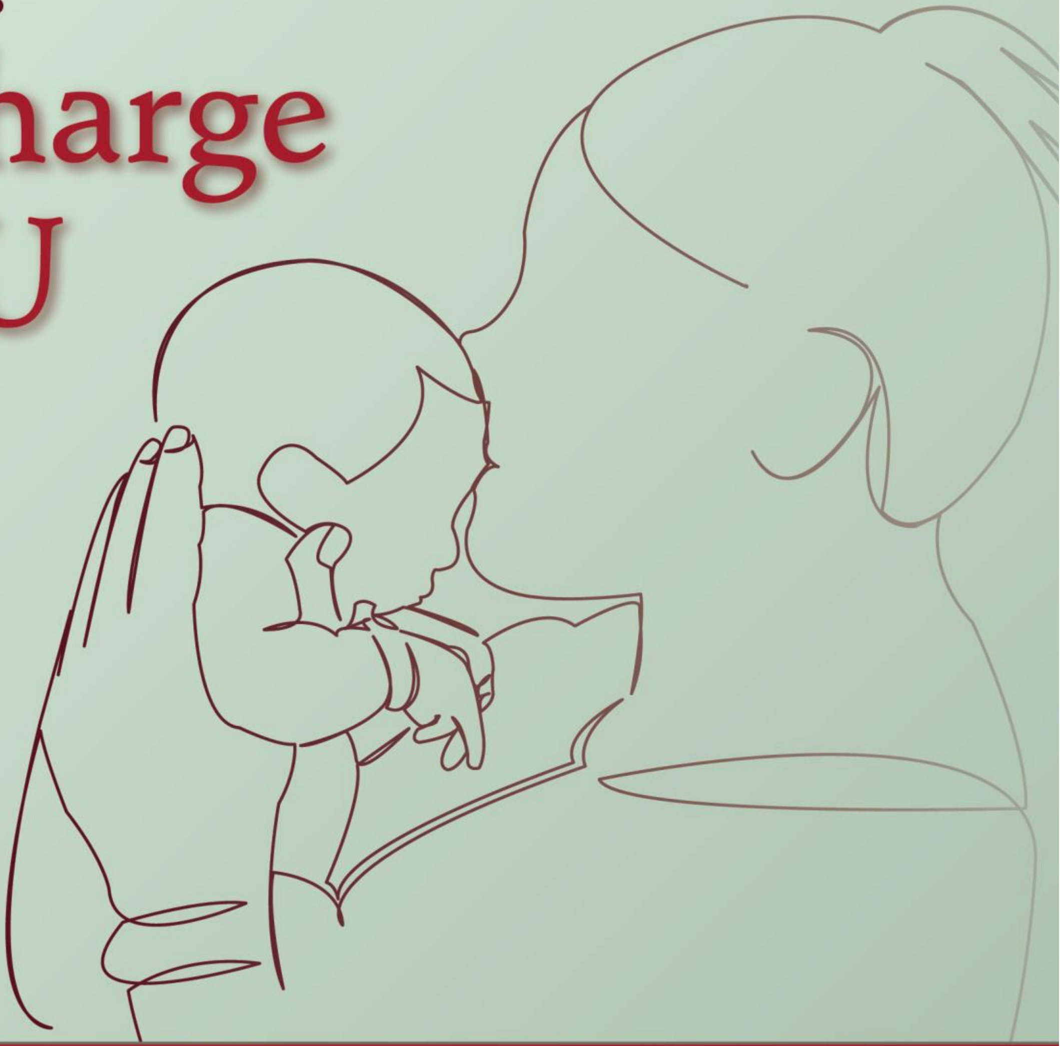
Tara K. Bastek, MD, MPH, and Ian J. Griffin, MB, ChB

Redesigning Postdischarge Nutrition in the NICU



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[Spouse Employment]	Pfizer (Gene Therapeutics)

Learning Objectives

- Link nutrient intake recommendations for growing preterm infants with expected growth
- Describe the latest evidence supporting preterm infant convalescent and discharge nutrition
- Review 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

Nutrient Intake Recommendations

"From the start of care, we implement recommendations from the experts."

–Tara K. Bastek, MD, MPH

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
- Trends from The International Network for Evaluating Outcomes of neonates[1]
  - Retrospective cohort study, N=154,233 neonates
  - In most of the 11 countries studied, mortality decreased; however, BPD increased in neonates born very preterm (<32 wks GA) or <1,500 g

BPD, bronchopulmonary dysplasia; GA, gestational age; NICU, neonatal intensive care unit.

1. Liu K, et al. *J Pediatr*. 2019;215:32-40.

Trends of Preterm Infants In the NICU *(continued)*

- Survival to discharge without comorbidities improving at 26–28 weeks
- Percentage of babies with comorbidities at 22–28 weeks GA is **not trending down**
- ROP remains flat
- Late-onset sepsis improving

Potential consequences of inadequate growth

Impaired neurodevelopment

Delayed cognitive development

Delayed growth

GA, gestational age; ROP, retinopathy of prematurity.

Clark RH, et al. *J Perinatol.* 2003;23:337-344. Lapillonne A, et al. *J Pediatr.* 2013;162:S7-S16. Stoll BJ, et al. *JAMA*. 2015 8;314:1039-51.

Persistent Difficulty in Growth– Not New

- Postnatal growth failure affects most VLBW infants
- VLBW infants at 1 year of age:
  - 30% have weight <5%
  - 21% have a height <5%
- VLBW infants at 8 years of age:
  - Do not catch up to their full-term counterparts in any growth parameter

Note: This data is from 1990s [1],[2]

Today's outcomes show improvement, albeit slowly, based on improved process in the NICU.

VLBW, very low birth weight.

1. Hack M. *J Pediatr.* 1993:122:887.
2. Ernst, et al. *J Pediatr.* 1990; 117:S156-166.

Extrauterine Growth Restriction Is Common

Inadequate extrauterine growth results from

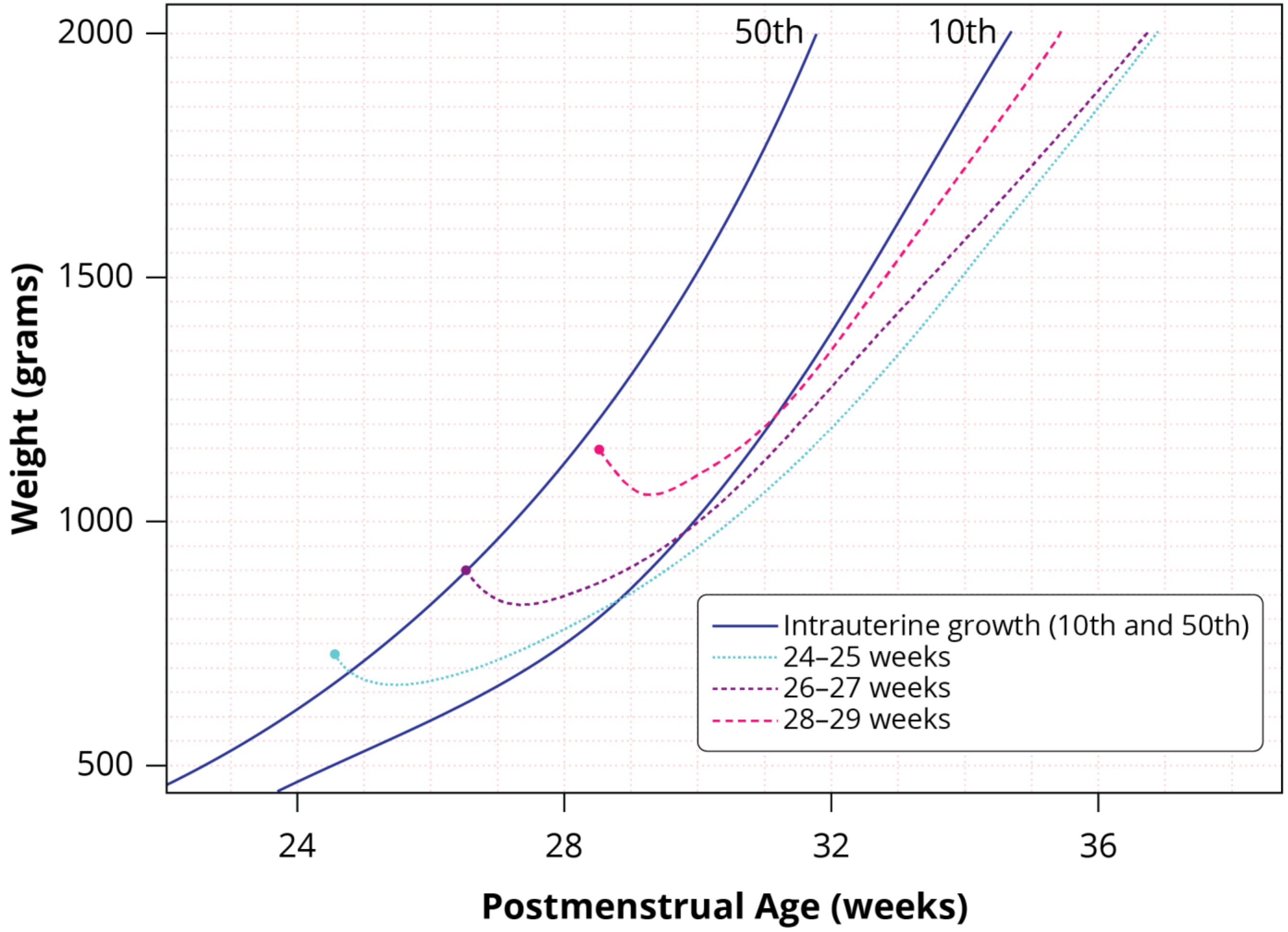
- Increased metabolic demand
- Poor early metabolic tolerance
- Poor feeding tolerance
- Infections
- Respiratory distress
- Pharmacologic effect
- Inadequate nutritional supply

Lapillonne A et al. *J Pediatr.* 2013;162:S7-S16.

Incidence of EUGR

- EUGR is very common
- Ehrenkranz et al 1999[1]
  - survey of NICHD units
  - 1994–1995
  - N=1,600 infants
  - birthweight 501–1,500 g
- Average weight <10th centile by discharge
- Worse with major morbidities
- Depending on hospital
  - 97–100% were <10th centile at discharge

Figure. **Longitudinal growth of hospitalized very low birth weight infants**



EUGR, *ex utero* growth restriction; NICHD, National Institute of Child Health and Human Development Neonatal Research Network.

1. Ehrenkranz RA, et al. *Pediatrics*. 1999;104:280-289.

Nutritional Impact on the Neonate

- Growth is most rapid around time of birth
- Growth is the most common measure of nutritional status
- Relationship of nutritional variable affects…
  - Growth
  - Brain volumes
  - Cognitive language
  - Motor development
- Cardiovascular and metabolic
- Neurological function

Power VA, et al. *J Pediatr*. 2019;215:50-55.e3.

Neonatal Nutrition and Long-Term Outcomes

- Power et al 2019[1] Australian study measured daily intakes:
  - Energy
  - Protein
  - Fat
  - Carbohydrate
- Only **higher protein intakes** in first 28 days of life were associated with **better weight growth** between birth and term-equivalent age in very preterm infants
  - n=149; born 2011–2014 at <30 weeks GA

1. Power VA, et al. *J Pediatr*. 2019;215:50-55.e3.

Protein Intake and Long-Term Outcomes

- Preterm infants have altered body composition compared to term
- Protein and energy needs are greater
- Growth outcomes of ELBW infants remain suboptimal, because they are not fed enough nutrients, especially protein[1]
- Ramel et al 2020[2] longitudinal study (n=103) showed

  Increased energy and protein intake early in hospitalization and across entire duration result in higher fat-free mass at point of discharge

1. Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21:234-247.
2. Ramel SE, et al. *Nutrients.* 2020;12:145.

Vitamin and Mineral Needs of Preterm Infants

- Preterm infants require increased intake of vitamins and minerals, including calcium, phosphorus, magnesium, sodium, potassium, copper, zinc, vitamins B_2, B_6, C, D, E, K, and folic acid compared with their term counterparts
- Poor accretion of calcium, phosphorus, and magnesium
- Low iron stores
- Poor accretion of trace minerals; levels decline in breastmilk

AAP, Kleinman RE, ed. Pediatric Nutrition Handbook. 6th ed. 2009:79-112.
Abrams SA, American Academy of Pediatrics Committee on Nutrition. *Pediatrics*. 2013;131:e1676-e1683.

Optimal Macronutrients and Micronutrients

Optimal intakes of macro- and micronutrients for preterm infants are essential[1],[2]

- **LC-PUFAs** (including DHA & ARA) supports neurodevelopment and immune system development
- Increased **vitamin D** supplementation support neuromuscular function and bone mineralization
- Low **iron** associated with poor neurodevelopment outcomes[3],[4]

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

1. Nzegwu NI, et al. *Clin Perinatol.* 2014;41(2):463-474.
2. Martin CR, et al. *J Pediatr.* 2011;159:743-749.
3. Young BE, et al. *Curr Pediatr Rep.* 2013;1:247-256.
4. Baker RD, et al. *Pediatrics.* 2010;126:1040-1050.

Recommended Intakes of Select Micronutrients

	Per kg body weight per day	Per 100 Cal
Calcium, mg	120–200	109–182
Phosphate, mg	60–140	55–127
Sodium, mg	69–115	63–105
Iron, mg	2–3	1.8–2.7
Zinc, mg	1.4–2.5	1.3–2.3
Vitamin D, IU	400–1,000[a] (per day)	100–350[b]

a. Total IU/day from milk and supplement
b. From milk only

Global expert recommendations made by Koletzko et al 2014[1] for select micronutrients.

1. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

Recommended Intakes

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

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

1. Tsang RC, et al. Digital Educational Publishing, Inc. 2005.
2. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

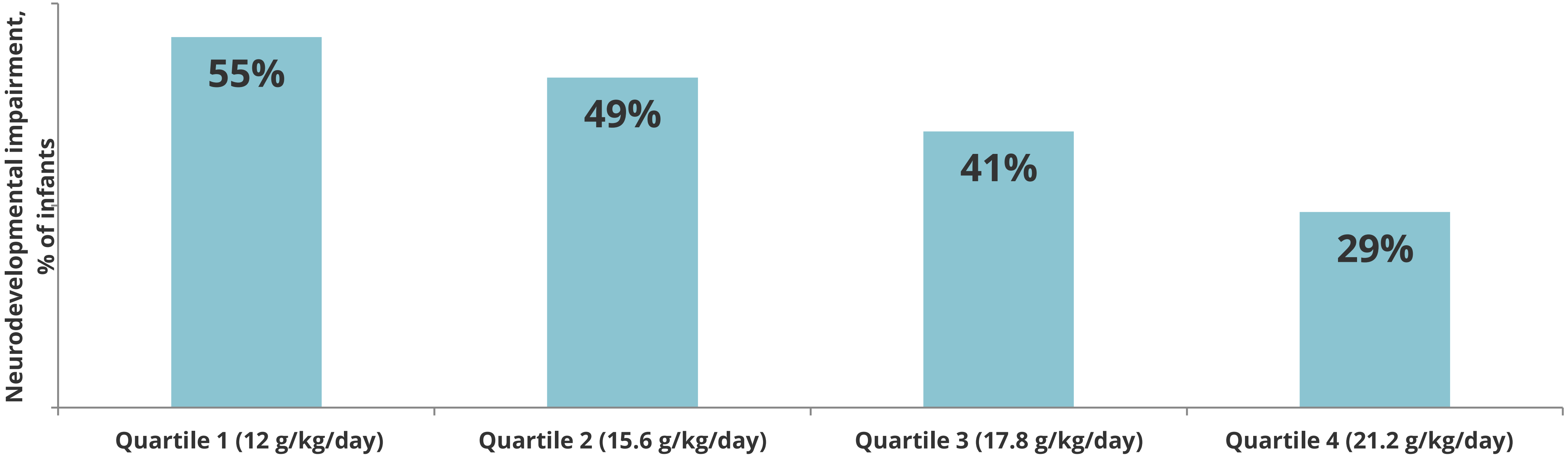
"Preterm Birth is a Nutritional Emergency"

–William W. Hay, Jr, MD, 2018

- **NICUs *must* focus on nutrition** because intake in the NICU affects growth and long-term health
- Protocols are needed to guide nutrition
- Highly variable nutritional practices in busy NICUs can produce variable growth outcomes

Faster Growth
Linked to Better Neurodevelopmental Outcomes

Figure. **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/hearingloss requiring amplification in both ears or bilaterally blind.

Ehrenkranz RA et al. *Pediatrics*. 2006;117(4):1253-1261.

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

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

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.

Ehrenkranz RA, *Pediatrics*. 2006;117(4):1253-1257.

Growth as a Measurement of Nutritional Status

- Growth is based on nutritional intake
- What does good growth look like in the hospital?
- What are the vulnerable periods (when baby may grow poorly)?

What to Measure: Pros and Cons and Target Goals

	Pros	Cons	Target
Weight	• Easy to do • Done daily • Easy to see trends • Cleary associated with short- and long-term outcomes	• Affected by fluid status • Diuretics • Not 'real' growth	~16–18 g/kg/d
Length	'Real' growth	• Hard to do • Inaccurate • Often not a better measure of lean mass • Often not better related to outcome	~1 cm/wk
Head circumference	• Strongly related to developmental outcome • Easy to do	Confounded by change in head shape	~1 cm/wk

Growth Charts over Target Goals

- Growth charts are preferred
- Targets can change with corrected gestational age
- And targets are dependent on whether one is in the 90th or 10th centile

Defining Optimal Growth vs Growth Curves

- "Ideal" growth would minimize short-term morbidities/mortality
  - NEC, ROP, IVH, etc
- Optimize long-term outcome
- Increase chance of good neurodevelopmental outcome
- Reduce the risk of adverse metabolic outcomes
  - T2DM, hypertension, insulin resistance, etc
- **We do not know what this is!**
- Aim to support growth that makes sense physiologically

IVH, intraventricular hemorrhage; NEC, necrotizing enterocolitis; ROP, retinopathy of prematurity; T2DM, type 2 diabetes.

Growth Charts

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

Olsen chart (developed from NICU growth data) Bertino chart (developed from 'ideal' growth data)	Up to 36 weeks GA	• Assess for GA, SGA, LGA • Not recommended for growth monitoring for preterm >36 wks
Fenton chart	Between 36–50 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
INTERGROWTH-21st	Between 24–33 weeks GA	• International fetal growth standards • Show how fetuses should grow rather than how they have grown

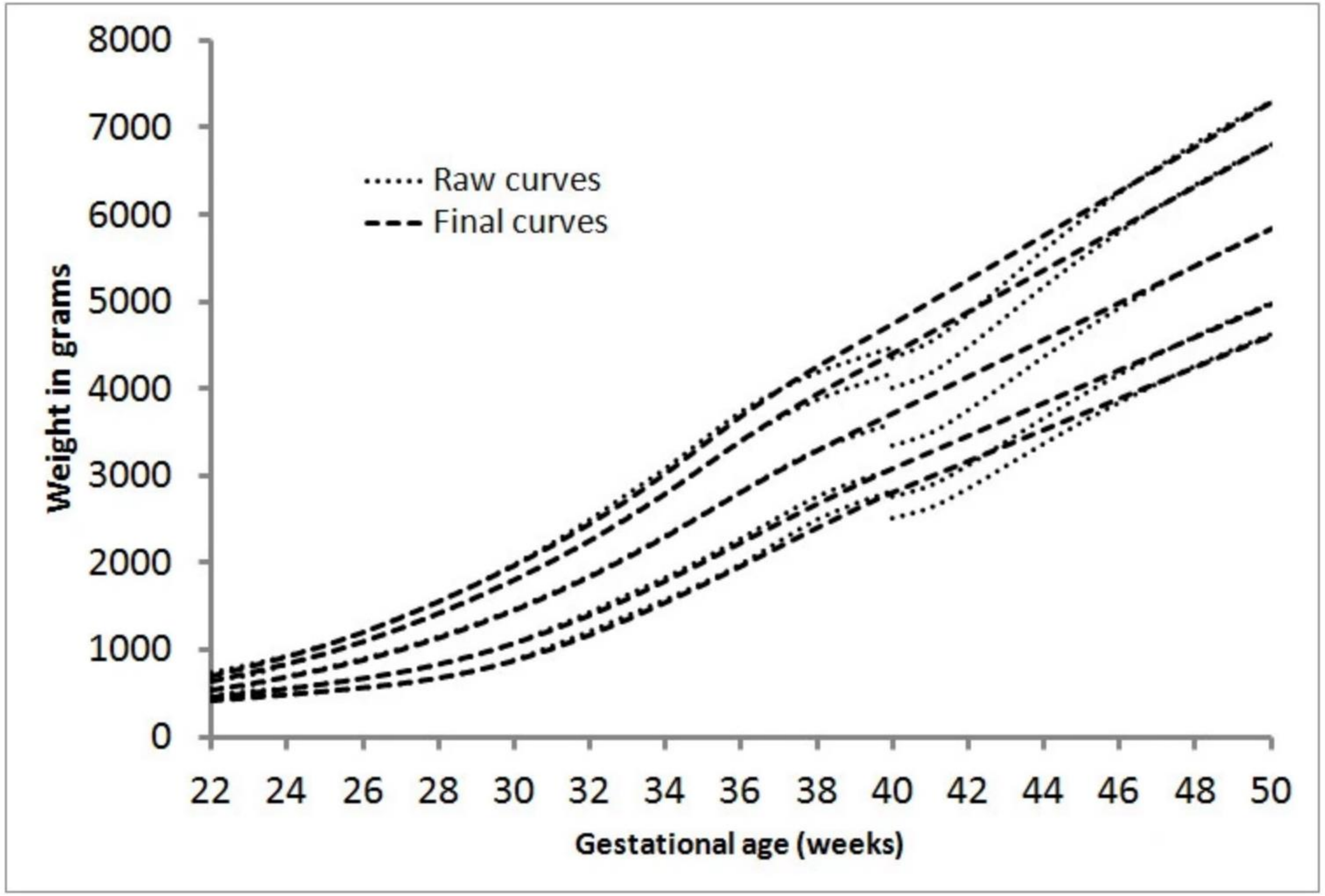
SGA, small for gestational age; LGA, large for gestational age.

Griffin IJ. Growth management in preterm infants. UpToDate.com. Last updated: Jun 17, 2020.

Fenton Curve–Weight

- Uses 2 references
- Before EDD
  - Compares to newborn “healthy” preterm infants
  - Haven’t undergone postnatal water loss
- After EDD
  - Compares to healthy term infants
  - Have undergone postnatal water loss
- Around EDD
  - Smooths from one to another

Figure. **Boys meta-analysis weight curves (dotted) with the final smoothed growth chart curves (dashed)**



EDD, expected date of delivery (EDD).

Feeding Methods in 3 Phases

Phase 1

ACUTE

Phase 2

CONVALESCENT

Phase 3

DISCHARGE

Phase 1: Acute Feeding Phase

Phase 1
ACUTE

- **Acute** (parenteral nutrition) transitioning to enteral feeds
  - Amino acid infusion mixtures important for parenteral nutrition
- Most growth failure occurs during this transition phase to enteral feeds
- This phase determines how well the baby can use nutrition and micronutrients for growth vs survival

Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21:234-247.

Parenteral Nutrition Support

- Amino acids and energy in appropriate amounts[1]
- Transition from parenteral to enteral poses challenges[1],[2]
- Improved practices for total parenteral nutrition protocols (TPN) in preterm neonates improve better survival and developmental outcomes[2]
  - Promotes safer administration
  - Aids in consistent adherence to guidelines
  - Improves overall best practices
- Careful monitoring is key to optimize nutrition for individual patients

TPN, total parenteral nutrition.

1. Roggero P, et al. *Nutrients*. 2020;12(6):1857.
2. Adamkin DH,et al. *J Neonatal Perinatal Med*. 2014;7(3):157-164.

Potential Mid-Growth Failure

- From 3–5 days to 1–2 weeks
- Period of transition from
  - Full parenteral nutrition to full enteral nutrition
- **Main challenge is use of low protein feeds**
  - Unfortified human milk or term formula
  - Not typically fortified until intake is 100 ml/kg/d
- Made worse if period of transition is long
  - Feeds advanced slowly
  - Feeds poorly tolerated

Resolving Mid-Growth Failure

- Fortify enteral feeds sooner (at 20–40 ml/kg/d)
- Advance feeds quicker (35 vs 20 ml/kg/d)
- There is good evidence this is safe and effective
  - Evidence is that there is no increase of NEC

NEC, necrotizing enterocolitis.

Phase 2: Convalescent Phase

Phase 2

CONVALESCENT

- **Convalescent phase** defined as period during which preterm is feeding and growing
- **“Transition nursery”** and **“feeder grow”** stage:
  - It is tempting to become complacent with infants in this stage because they are growing
  - They aren’t screaming for attention, and they are on full enteral nutrition

It is important not to become complacent when babies get to convalescent feeding.

Roggero P, et al. *Nutrients*. 2020;12:1857. Adamkin DH,et al. *J Neonatal Perinatal Med*. 2014;7:157-164.

Convalescent Phase

- Longest period of hospital stay
- Baby now on full enteral nutrition
- Volume and composition is under provider's control

Convalescent is a long period

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

Growth and Acute Morbidities

- Preterm babies tend to grow poorly due to comorbidities
- Poor growth can lead to acute morbidities
- Some reasons during neonatal care for not starting, slowly advancing, or stopping nutrition, IV, or enteral feeds:
  - Unsubstantiated concerns for metabolic toxicities
  - Feeding “intolerance”
  - Risk of NEC
  - Other common neonatal morbidities
- Result is under nutrition and less than optimal growth

NEC, necrotizing enterocolitis.

Ehrenkranz RA, et al. *Pediatrics*. 1999;104:280-289. Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:234-247.

Poor Nutrition Drives Morbidities

- Easy to blame other diseases on a lack of growth, **but poor nutrition** is the **driver of morbidities**.

- Saying "This is how we do it," falls short of micronutrient needs.

Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr.* 2018;21:234-247.

Breastmilk Production Support

- Benefits of human milk
  - Immune protection
  - Modulating microbiota
  - 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

ESPGHAN, The European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition (CoN); NG, nasogastric.

1. Lapillonne A et al. *J Pediatr Gastroenterol Nutr.* 2019;69:259-270.
2. Collado MC, et al. *Pediatr Res.* 2015;77:726-731.
3. Miller J, et al. *Nutrients*. 2018;10:707.

Enteral Nutrition Support

- Challenges using only human milk
  - Variable protein and calorie content
  - Low protein and calorie content (especially with DHM)
- Less problematic with better HM fortifiers
  - Higher protein content
- Proactive feeding regimen shown to reduce the length of hospital stay and risk of neonatal hypoglycemia
- Recommended intake for fully enterally fed VLBW
  - Ranges of adequate intakes

DHM, donor human milk; VLBW, very low birth weight.

Recommended Intakes of Select Micronutrients

	Per kg body weight per day	Per 100 Cal
Calcium, mg	120–200	109–182
Phosphate, mg	60–140	55–127
Sodium, mg	69–115	63–105
Iron, mg	2–3	1.8–2.7
Zinc, mg	1.4–2.5	1.3–2.3
Vitamin D, IU	400–1,000[a] (per day)	100–350[b]

a. Total IU/day from milk and supplement
b. From milk only

Global expert recommendations made by Koletzko et al 2014[1] for select micronutrients.

1. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

Recommended Intakes

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

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

1. Tsang RC, et al. Digital Educational Publishing, Inc. 2005.
2. Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

Human Milk With Supplementary Formula

- NICUs need to be knowledgeable about their feeding recipe combinations and how well these line up with recommendations
- When mother's milk is not available, pasteurized donor human milk (DHM) should be used (and in some circumstances, fortified formula is used)
- Human milk with supplementary formula feeds (post discharge)
  - Fortification of human milk is often needed in preterm infants
  - Breastmilk is optimal for all infants but requires supplementation to produce and sustain growth in preterm infants, post discharge
- Needs to guarantee nutrients required by each infant

DHM, donor human milk.

Morais J, et al. *Neonatology*. 2019;116(2):179-184.

Mother’s Milk and Donor Milk are NOT the Same

- Donor human milk has reduced protein concentrations and immune functions
- DHM protein is insufficient at normal enteral feeding rates (160–180 mL/kg/day) to support GA appropriate protein accretion and growth rates
- Estimation of caloric intakes is more difficult in DHM
  - Higher intakes or increased levels of fortification may be needed
- These distinctions need to be accounted for in fortification strategies

DHM, donor human milk; GA, gestational age.

Arslanoglu S, et al. *Front Pediatr*. 2019;7:76. Griffen IJ. UpToDate.com. Updated Jun 17, 2020. Hay WW Jr. *Pediatr Gastroenterol Hepatol Nutr*. 2018;21:234-247.

When Should Human Milk be Fortified?

- Approaches to low nutritional density of HM
  - Increase standard fortification
  - Use targeted fortification
- Targeted fortification:
  - Measure human milk nutrient content
  - Add required nutrients to meet expected needs
  - Increase nutrient intake and
  - Reduce variability in intake

HM, human milk.

Lapillonne A et al. *J Pediatr Gastroenterol Nutr.* 2019;69:259-270.

Increasing Fortification

- Increase standard fortification to a "nominal" 24 kcal/oz (80ml/100mL)
  - Give at 165 mls/kg/d (10% more than expected)
  - Add 0.5 g/kg/d additional protein

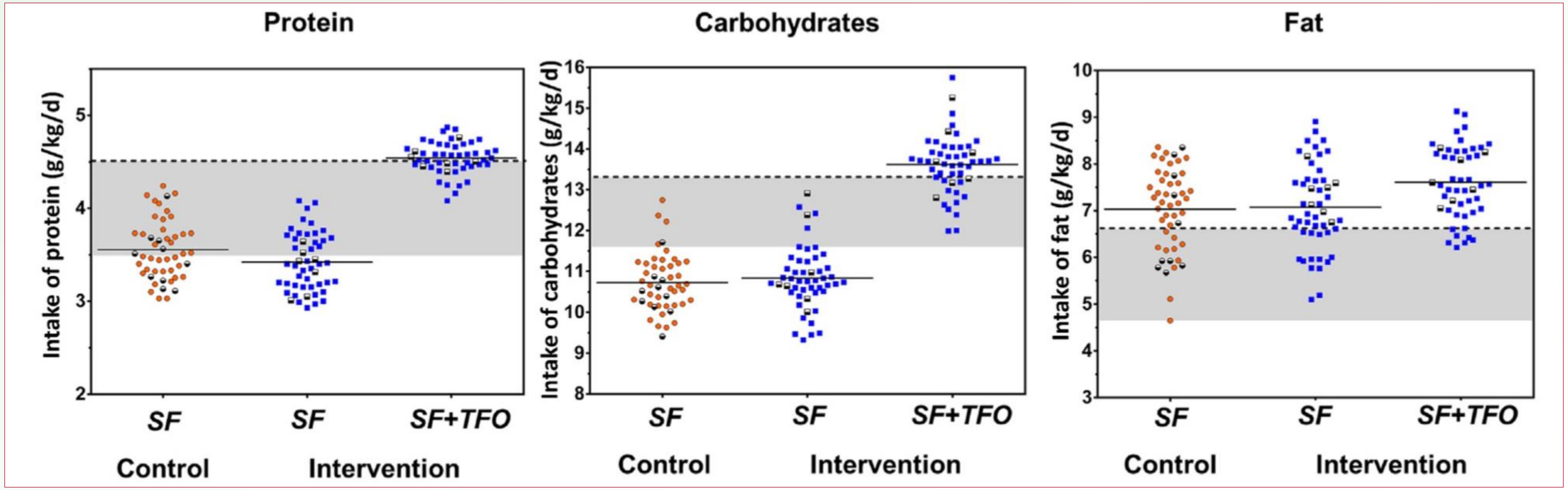
    You may not need to add additional protein with your fortifier. But be aware of the nominal intake of protein and energy your fortification recipe leads to.

- Targeted fortification—Rochow et al 2020[1] reports improved growth
  - 21.2 ±2.5 g/kg/d vs 19.3 ±2.4
  - 2,520 ±290 vs 2,290 ±330 at 36w
  - Difference was mostly in fat mass

1. Rochow N, et al. *Clin Nutr.* 2020:S0261-5614(20)30202-8.

Avoiding Growth Failure

TFO increases intakes but did not reduce variability



Could achieve the same by adding 1 g/kg/d protein and 3 g/kg/d carbohydrates to everyone’s feeds

TFO, targeted fortification.

Rochow N, et al. *Clin Nutr.* 2020:S0261-5614(20)30202-8.

Phase 2

CONVALESCENT

Don’t take your eyes off the ball!

Phase 3: Post-NICU Recovery

Phase 3

DISCHARGE

- Healing period continues. Nutrition monitoring still vital!
- Nutritional volume is prescribed by provider in charge of composition

If you don't do well in the previous 2 phases, baby will fall behind in Phase 3.

Novel Approaches to Convalescent and Discharge Feeds

Meeting nutrition goals
while being mindful of important changes

Nutrition Challenges During Transition from Convalescent to Discharge Ready

- Meeting nutritional goals during this transitional time
- Feeding difficulties can cause prolonged hospital stay
- Acknowledge all the changes and focus on meeting nutrition goals
  - Skill of oral feeding
  - Oromotor dysfunction
  - Avoidant feeding behavior

Physical Readiness Before and After Discharge

- Parental teaching and practice
  - Parental competency prior to discharge
  - Feeding tube or pump
  - Breast or bottle feeding
- Develop oral feeding skills
- Promote breastfeeding and monitor for fortification needs

Lapillonne A. *World Rev Nutr Diet.* 2014;110:264-277.

Nutritional Readiness in Preterm Infants

- If formula-feeding, formulas need to provide high amounts of protein, micronutrients, and DHA should be used until 52 weeks GCA
  - Monitor for excessive intake of certain nutrients, particularly vitamin D, also iron, and excessive growth velocity
  - Promotes better weight gain, linear growth, and bone mineral content
- **Follow recommendations feeding preterm after hospital discharge**
- **Maintain consistent pattern of appropriate weight gain**
- Goal is to **nourish preterm infants** after discharge
  - Promote human milk feeding
  - Minimize nutrient deficits
  - Promptly address identified deficits
  - Avoid over-nourishing or promoting postnatal growth acceleration once nutrient deficits have been corrected

GCA, gestationally corrected age.

Lapillonne A. *World Rev Nutr Diet.* 2014;110:264-277. Smith VC. UpToDate.com. Updated Jun 24, 2020.

Feeding Preterm Infants After Hospital Discharge

A commentary by ESPGHAN CoN:

- Formula-fed preterm infants should receive special postdischarge formula with high contents of protein, minerals, and trace elements, as well as LC-PUFAs, until at least post-conceptional age of 40 wks or until 52 wks.
- Continued growth monitoring is required to adapt feeding choices to individual infants.

ESPGHAN, European Society for Paediatric Gastroenterology, Hepatology and Nutrition; CoN, Committee on Nutrition (CoN); LC-PUFAs, long-chain polyunsaturated fatty acids

ESPGHAN Committee on Nutrition, Aggett PJ, et al. *J Pediatr Gastroenterol Nutr.* 2006;42:596-603.

Out of the Hospital Discharge Planning and Monitoring Nutrition for Optimal Growth

If things don't go well once the baby is home, then all the gains in the hospital will be lost.

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.

Arslanoglu S, et al. *Front Pediatr.* 2019;7:76.

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*

"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

Nutritional Evaluation Prior to Discharge

- Develop feeding plan prior to discharge
- 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

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Nutritional Recommendations for the Late-Preterm Infant and the Preterm Infant after Hospital Discharge

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- Ideal—Pre-/Postdischarge nutrition goals are coupled
- Often fail when…
  - Discharge earlier, younger, smaller
  - Care is transferred to HCP not involved in inpatient care
  - High-Risk Infant Follow-Up Clinics focus on neurodevelopment, not nutrition

Lapillonne A, et al. *J Pediatr*. 2013;162:S90-100.

Role of Enhanced Nutritional Support Post Discharge

- Preterm infants have unique nutritional needs that may not be met with breast milk alone[1],[2]
- Importance of human-milk fortifier
- Enriched formula
  - DHA & ARA in formulas for preterm infants, help catch-up in weight[3]
  - Higher protein formula/fortifiers have the most pronounced effect[4]
- Additional supplements to minimize nutrient deficits

DHA docosahexaenoic acid; ARA, arachidonic acid.

1. Lapillonne A,, et al. *J Pediatr Gastroenterol Nutr.* 2019;69(2):259-270.
2. Arslanoglu S,, et al. *Front Pediatr.* 2019;7:76.
3. Clandinin MT, et al. *J Pediatr.* 2005;146(4):461-468.
4. Mayberry L, et al. *FASEB J.* 2014;28(suppl1):LB318.

Postdischarge Growth Monitoring

- Having a structure is essential.
- Note: providing the "typical" 110–127 kcal/kg and 1.5–3.1 g/kg protein may not account for deficits incurred during hospitalization.
- Using more "powerful" fortification strategies after NICU discharge can risk 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.

Smith VC, , et al. UpToDate.com. Updated Jun 24, 2020.; Griffin IJ. UpToDate.com. Updated Jun 17, 2020; Lapillonne A, et al. *J Pediatr Gastroenterol Nutr.* 2019;69(2):259-270; Koletzko B, et al. *World Rev Nutr Diet.* 2014;110:297-299.

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

Transition Home Challenges

- Parents turn to pediatricians for help with "typical" baby issues
  - Sleep cycle regulation
  - Spitting/gassiness
  - Fussiness/arching with feeds
  - Straining while stooling
- Community providers may change feeding plan from prescribed “richer feeding strategies” to help parents, but *it is* a short-term win
- Change in feeding may have negative impact of long-term recovery and outcomes

Support For the Family

- Importance of individualized care
- Schedule earlier visits in developmental follow-up programs
  - 2–4 weeks after discharge
  - Focus on growth and nutritional intake review
  - Review/investigate infant behaviors typical for former preemie at corrected gestational age
- Visit can provide support for parents and monitor growth and nutrition status

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.**
- **The better job done early in the NICU, the less work is needed during the convalescent stage.**
- **If things do not go well once the baby is home (eg, if the feeding regime is not followed), then risk losing the hard-won gains made in the hospital.**