The Iowa PERINATAL Letter

vol. XXXIII, no. 2 2014

Nutritional Needs of the Late Preterm Infant

Much attention has been focused on enhancing the nutritional support of the premature infant to improve mortality, morbidity and ultimately the quality of life. The majority of the research and publications in this area has been devoted to the very-low-birth-weight infant. More recently, there has been recognition that the late preterm infant is at increased risk for a number of complications associated with immaturity, including increased hospital readmissions, delayed oral feeding skills and failure to thrive[1, 2]. Most notably, studies suggest that the late preterm infant is at risk for neurodevelopmental and neurocognitive impairment compared to term infants[3, 4]. This is not surprising given the amount of brain growth that occurs between the 34th week of gestation and term, when brain weight and cortical volume increase approximately 50%[5-7]. Though specific risk factors for neurodevelopmental sequelae have not been thoroughly identified, it is probable that suboptimal nutrition during first few weeks of life impacts brain growth and development, ultimately contributing to neurocognitive risk.

It was only in 2005, following a workshop sponsored by the National Institutes of Health, that the term “late preterm” was adopted to better reflect the higher risk of complications in the population. The late preterm infant, those born between 34 0/7 and 36 6/7 weeks gestation, constitute over 70% of the preterm population born in the United States[8]. Over 300,000 late preterm infants are been in the United States annually, representing a significant impact on public health.

The late preterm infant presents unique nutritional challenges to health care providers, particularly those in smaller (Level I and Level II) centers. These infants may develop hypoglycemia, and have difficulty feeding, requiring gavage feedings, intravenous fluids, and even parenteral nutrition. Though the benefits of breastfeeding are clear, establishing breastfeeding in this population is often difficult due to decreased muscle tone and coordination[9, 10]. The weak suck in these infants can also result in reduced lactation in the nursing mother, making milk transfer even more difficult.

Weight gain of the late preterm infant during hospitalization often falls below that which occurs *in utero*. A survey of 15 NICUs revealed that while mean birthweight of moderate preterm infants was at the 44th percentile, the mean weight for adjusted age declined to the 19th percentile at discharge[11]. Only 2% of study subjects achieved weight gains comparable to intrauterine growth rates of 15 g/kg/d. The degree of growth deficit in the first postnatal week was associated with net growth velocity over the entire hospitalization, emphasizing the importance of adequate nutrition during the critical first week of life.

Developing a plan for feeding the late preterm requires an understanding of the nutritional needs of the population. Resting energy expenditure, expressed in kcal/kg/d, is actually slightly higher than in very-low-birth-weight infants[12]. *In utero*, the late preterm period is one of high fat accretion and energy storage as well as protein and mineral accretion. Estimated nutrient requirements for late preterm infants, relative to both younger and older counterparts, are outlined in Table 1. This table demonstrates that estimated energy needs, expressed per kg, are actually highest in the 32 – 33 week gestation infants and that estimated protein and mineral needs/kg remain increased until the infant reaches early term gestation (e.g., >37 wks). The increased nutrient requirements of the late preterm infant cannot be met by feeding unfortified or non-supplemented human milk or term formulas, though these are often used in this population.

Table 1. Estimated nutrient requirements preterm, late preterm and term infants

	28-31 wks	**32-33 wks**	**34-36 wks**	**37-38 wks**	**39-41 wks**
Fetal wt gain (g/kg/d)	17.5	15	13	11	10
Energy (kcal/kg/d)	125	130	127	115	110
Protein (g/kg/d)	3.9	3.5	3.1	2.5	2
Calcium (mg/kg/d)	120-140	120-140	120-140	70-120	70-120
Phosphorus (mg/kg/d)	60-90	60-90	60-90	35-75	35-75

Modified from Lapillonne et al. *J Pediatr* 2013:162:S90-100.

The nutritional deficits that may occur in the last preterm infant are easily illustrated using a case example: AJ was born at 34 2/7 weeks gestation after mother developed preterm labor. Apgar scores were 7 and 8 at one and five minutes, respectively, and birthweight was 2250 grams. Mild respiratory distress quickly resolved and AJ remained on room air throughout his hospitalization. He was initially started on breastfeeding ad lib, but the infant tired after a few minutes at breast. Hypoglycemia developed at 10 hours of age and intravenous fluids of D10 0.2%NS were started at 70 ml/kg. Nasogastric supplemental of breast milk was initiated on DOL #2 and the volume was increased daily until reaching caloric goal on DOL #9. Over the next week breastfeeding frequency and duration gradually increased. On DOL #14 (adjusted age 36 2/7 weeks), supplemental NG feeds were discontinued and infant transitioned to ad lib p.o. breastfeeding. Weight on DOL #14 was 2120 g (6%) below birthweight. This scenario is likely often repeated in hospitals around our state. Yet few recognize that during the first 10 days of life in this infant, a cumulative energy deficit of approximately 1000 calories occurred, with an associated protein deficit of 20 grams. The nutritional intake of the late preterm infant is significantly affected by the feeding practices followed by an institution. In a review of inter-hospital variations of nutritional practices in ten NICUs in California and Massachusetts involving over 500 infants, the percentage of infants receiving parenteral nutrition ranged from 5 to 66%, while 4 to72% of infants received caloric dense (>20 kcal/oz) feedings[13]. Institutions with the fastest growth rates of moderate and late preterm infants were found to provide higher enteral feeding volumes in the first week of life, use increased caloric density feedings, and have a higher incidence of breast milk feedings.

Recognizing optimal nutritional support of late preterm infants may improve quality of life and the fact that current nutritional practices likely provide transient undernutrition in late preterm infants, Lapillonne and colleagues recently published *Nutritional Recommendations for the Late-Preterm Infant and the Preterm Infant after Hospital Discharge*[12]. This is recommended reading for those caring for this population of infants. In brief, these authors promote, with sound evidence, breastfeeding and the provision of fortified human milk at least until the infant reaches 40 weeks postconceptional age. If formula-fed, a special discharge formula that contains more protein, minerals, trace elements and LCPUFA (n-3 long chain polyunsaturated fatty acids) than standard term formula should be provided. Information provided in Table 2 compares the nutritional needs of the late preterm infants to the nutrients provided in full caloric intakes of breast milk (with and without human milk fortifier), term formula and preterm discharge formula. At full caloric intake, unfortified human milk and term formula provide <60% of goals for protein and minerals.

Table 2. Comparison of Nutritional Requirements of the Late Preterm Infants and Nutritional Components of Human Milk and Formula

	Requirements		Human Milk		Formula	
	32-33 wks	34-36 wks	Breastmilk	Breastmilk + HMF	Term	Preterm Discharge
Energy (kcal/kg/d)	130	127	125	125	125	125
Protein (g/kg/d)	305	30.	1.9	3.5-4.1	2.7	3.5
Calcium (mg/kg/d)	120-140	120-140	51	180	98	150
Phosphorus (mg/kg/d)	60-90	60-90	26	98	54	83

Because of the paucity of specific nutritional and feeding recommendations for the late preterm infant, we have developed what we believe is a rationale and practical approach for this population based upon available data. The recommendations for the late preterm infant include:

1. Promotion of breastfeeding. The mother/infant dyad should attempt breastfeeds as the infant tolerates. Close attention should be given to the success of nursing attempts (latch, duration, presence of audible swallow). In order to encourage development of a good milk supply, mothers should also be encouraged to pump frequently, particularly if the infant has a weak suck or tires with nursing attempts. To increase protein and mineral intake, late preterm infants <2.5 kg will benefit from adding human milk fortifier or preterm formula powder (up to an estimated 24 kcal/ounce) to expressed breast milk 2 to 4 times per day. These supplemented feeds should be started in the hospital and continue post-discharge until the infant reaches term corrected age and term weight (~3.25 kg) and demonstrates appropriate weight gain (>25 grams/day). Vitamin D (400 IU/day) and iron (2-3 mg/kg/day elemental iron) should also be given.

2. Formula feeding when mothers' milk is not available. Use of a preterm transitional formula (22 kcal/ounce) is indicated while in the hospital and following discharge to home. Formula may be transitioned to term formula (20 kcal/ounce) when the infant reaches term corrected age and term weight.

3. Enteral nutritional support. Infants less than 35 weeks gestation, and even older frequently demonstrate poorly coordinated suck and swallow mechanisms and/or tire quickly with feeds. If these infants fail to demonstrate improvement in feeding volume or duration over the first 3 days of life, or measured intake is less than 100 ml/kg/day, use of supplemental gavage (nasogastric) feedings should be strongly considered. Infants developing hypoglycemia or low urine output on oral feedings should also receive gavage supplementation.

4. Use of parenteral nutrition support. Infants less than 33 weeks gestation or ~2 kg often display immature gastrointestinal motility, evidenced by emesis and/or gastric residuals with enteral feeding. Current recommendations for such infants include the advancement of enteral feeding volumes by no more than 20 ml/kg/day; thus goal nutrient intakes will not be met by this route alone until the infant is greater than a week of age. Often, even this rate cannot be achieved. Because these infants, or older infants with feeding intolerance, are at the highest risk for nutritional deficit, consideration of parenteral nutrition, including lipids, is strongly recommended during the first week on life. Ideally, this intervention is started early in the hospital course to prevent a large protein and/or caloric deficit. Parenteral nutrition may be discontinued once the patient tolerates >100-120 ml/kg/day of enteral/oral feeds.

Because every infant is different, individualized planning and approaches are necessary to provide optimal nutritional management of the late preterm infant. Such approaches include close monitoring of nutrient intake, feeding tolerance and growth during hospitalization and growth after hospital discharge. Parents should be educated regarding warning signs of poor feeding / inadequate intake before discharge and early and frequent follow-up in an outpatient clinic should be scheduled until the infant demonstrates consistent, appropriate weight gains in the home environment. The guidelines and information presented in this text may be used to help develop these individualized plans. Any nutritional strategy implemented should recognize that late preterm infants are a vulnerable population, at risk for short and long term sequelae and that poor nutrition during the period of rapid brain growth (34-40 weeks gestation) may contribute to long-term neurodevelopmental problems.

In summary, the nutritional requirements early in life for these infants are underappreciated and the nutritional needs are often not met. Selection of a gestational age appropriate feeding choice (fortified human milk, preterm discharge formula) may improve the protein and mineral intakes of these infants. In addition, more aggressive nutritional support, including the use of gavage and parenteral nutrition, which improves growth, is often needed.

1. McLaurin KK, Hall CB, Jackson EA, Owens OV, Mahadevia PJ. Persistence of morbidity and cost differences between late-preterm and term infants during the first year of life. *Pediatrics*. 2009;123(2):653-659.
2. McGowan JE, Alderdice FA, Holmes VA, Johnston L. Early childhood development of late-preterm infants: a systematic review. *Pediatrics*. 2011;127(6):1111-1124.
3. Chan E, Quigley MA. School performance at age 7 years in late preterm and early term birth: a cohort study. *Archives of Disease in Children: Fetal and Neonatal Edition*. 2014.
4. Vohr B. Long-term outcomes of moderately preterm, late preterm, and early term infants. *Clinics in Perinatology*. 2013;40(4):739-751.
5. Guihard-Costa AM, Larroche JC. Differential growth between the fetal brain and its infratentorial part. *Early Human Development*. 1990;23(1):27-40.
6. Kapellou O, Counsell SJ, Kennea N, Dyet L, Saeed N, Stark J, et al. Abnormal cortical development after premature birth shown by altered allometric scaling of brain growth. *PLoS medicine*. 2006;3(8):e265.
7. Kinney HC. The near-term (late preterm) human brain and risk for periventricular leukomalacia: a review. *Seminars in Perinatology*. 2006;30(2):81-88.
8. Martin JA, Hamilton BE, Osterman MJK, Curtin SC, Mathews TJ. Births: Final data for 2012. *National vital statistics reports : from the Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System*. 2013;62(9):1-87.
9. Meier P, Patel AL, Wright K, Engstrom JL. Management of breastfeeding during and after the maternity hospitalization for late preterm infants. *Clinics in Perinatology*. 2013;40(4):689-705.
10. Nagulesapillai T, McDonald SW, Fenton TR, Mercader HF, Tough SC. Breastfeeding difficulties and exclusivity among late preterm and term infants: results from the all our babies study. *Canadian Journal of Public Health*. 2013;104(4):e351-356.
11. Blackwell MT, Eichenwald EC, McAlmon K, Petit K, Linton PT, McCormick MC, et al. Interneonatal intensive care unit variation in growth rates and feeding practices in healthy moderately premature infants. *Journal of perinatology : official journal of the California Perinatal Association*. 2005;25(7):478-485.
12. Lapillonne A, O'Connor DL, Wang D, Rigo J. Nutritional recommendations for the late-preterm infant and the preterm infant after hospital discharge. *The Journal of pediatrics*. 2013;162(3 Suppl):S90-100.
13. McCormick MC, Escobar GJ, Zheng Z, Richardson DK. Place of birth and variations in management of late preterm ("near-term") infants. *Seminars in perinatology*. 2006;30(1):44-47.

SUSAN K CARLSON, MMSc, RD, LD
Neonatal Dietician, Department of Food and Nutrition
University of Iowa Children’s Hospital

JEFFREY L SEGAR, MD
Professor, Department of Pediatrics
Director, Division of Neonatology
University of Iowa Children’s Hospital
Director, Statewide Perinatal Care Program