A Pediatrician’s Guide to Caring for the Complex Neonatal Intensive Care Unit Graduate

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Abstract

Despite a decreasing trend in premature births, greater numbers of infants born at the limits of viability are surviving to discharge. Most of these infants have complex medical problems requiring multidisciplinary care. These infants are primarily cared for by the general pediatrician, but their needs are quite different from those of a full-term healthy newborn. The paucity of data regarding care for these infants complicates their management after hospital discharge. In this article, the authors present the most current evidence-based practices and provide a guide to the general pediatrician on caring for the complex neonatal intensive care unit graduate.

The rate of preterm births has gradually declined since its peak in 2006. With major advances in life-sustaining neonatal care, the population of preterm infants born near the limits of viability and surviving to discharge will continue to rise. Preterm infants have a plethora of health problems unique to them. Transitioning from months-long intensive care to the ambulatory environment can be daunting for most families. The general pediatrician plays an important role in continuing direct medical care and coordinating care with subspecialists following discharge from the neonatal intensive care unit (NICU). In this article, the authors touch upon the pertinent health problems and continuing care of the preterm infant during pediatric office visits. The focus will primarily be on very low birth weight (VLBW) infants (≤1,500 g).

GROWTH

A number of fetal-infant growth charts are available for assessing postnatal growth in preterm infants. The most commonly used in NICUs is the Fenton growth chart. The Fenton growth chart is based on a meta-analysis of large population-based studies. It uses weight, length, and head circumference parameters starting at 22 weeks of gestation up to 10 weeks post-term (ie, 50 weeks post-menstrual age). It thus provides an overlap between fetal and infant growth charts between 40 weeks (full term) and 50 weeks post-menstrual age. Most recently, the Fenton growth chart was revised to smooth the disjunction at this point of overlap and to provide sex-specific growth charts. Between 40 and 50 weeks post-menstrual age, the practitioner can use either the Fenton or the World Health Organization (WHO) 2006 growth charts. Beyond 50 weeks post-menstrual age, the practitioner must use the WHO 2006 growth chart for children younger than 2 years and the US Centers for Disease Control and Prevention (CDC) 2000 growth chart for ages 2 to 20 years. The corrected age is used when evaluating growth parameters with the WHO and CDC charts up to 3 years of chronological age. The corrected age is derived by subtracting the number of weeks/months the infant was born premature (using 40 weeks as full term) from the chronological age. Preterm infants demonstrate catch-up growth during the first 3 years of life. Catch-up growth is defined as accelerated growth velocity following a period of slow growth. Catch-up growth can continue into childhood and adolescence.

Soon after birth, preterm neonates lose weight, which is then regained within 2 to 3 weeks. To achieve adequate catch-up growth, an increment in weight, length, and head circumference of approximately 15 to 20 g/kg/day, 0.9 cm/week, and 0.9 cm/week, respectively, is required. Despite optimizing nutrition, most infants discharged from the NICU are below the 10th percentile for weight due to gut immaturity and other complicating medical conditions such as sepsis, necrotizing enterocolitis, and chronic lung disease. There are data that suggest too-rapid catch-up growth puts preterm infants at risk for obesity and metabolic syndrome. It is key to ensure that the preterm infant is gaining weight, length, and head circumference to catch up with their term counterparts by age 3 years. After discharge, these parameters should be monitored more frequently than is done...
for term infants to ensure that the preterm infant is not lagging behind.

**NUTRITION**

Energy requirements to sustain growth are higher in preterm infants compared with term infants. Greater caloric requirements are necessary to achieve growth in infants with comorbidities such as bronchopulmonary dysplasia secondary to increased energy expenditure. The energy requirement for most preterm infants to continue adequate intra-uterine growth (~15 g/kg/day) is 100 to 130 kcal/kg/day. Infants who are small for gestational age may require higher caloric intake than infants who are normal for gestational age. Preterm infants have a high need for protein, calcium, phosphorous, vitamin D, and iron that needs to be matched in their diet.

When available, human milk should be given priority for feeding preterm infants because it has been associated with improved long-term neurodevelopmental outcomes and fewer rehospitalizations. Unfortified human milk does not provide sufficient calories and nutrients for preterm infants. Breast milk fortified with liquid fortifiers and preterm formulas contain adequate quantities of nutrients such that the preterm infant has weight gain, body composition, and bone mineralization similar to full-term infants. Prior to discharge, infants are transitioned to unfortified human milk with or without supplementation with preterm transitional formulas (22 kcal/oz) or just preterm (24 to 30 kcal/oz) or term formula (20 kcal/oz) depending on corrected age, growth velocity, and maternal milk supply.

Controversy exists regarding the type and duration of diet in preterm infants post-discharge. A number of studies have shown better weight gain, lean mass body composition, and bone mineralization when preterm infants were fed preterm formulas up to 6 months to as long as 12 months of corrected age. No added benefit of this was noted on neurodevelopment.

Preterm infants may be transitioned off of highly enriched preterm formula and started on transitional formula at approximately 2,000 g if they are not fluid restricted. Preterm formulas may be used up to 3,000 g.

Iron (2 mg/kg/day) should be given as a supplement to preterm infants receiving unfortified human milk up until age 12 months, but supplementation with multivitamins is controversial. However, vitamin D supplementation (200 to 400 IU/day) is essential when unfortified human milk is the sole source of nutrition because mothers may be deficient in vitamin D. Vitamin D is important in addition to calcium and phosphorous supplementation to prevent osteopenia that often occurs in preterm infants. Alkaline phosphatase activity should be monitored for 2 to 4 weeks after discharge, and levels higher than 800 to 1,000 IU/L require close follow-up and additional nutrient supplementation.

**NEURODEVELOPMENTAL CARE**

Preterm infants are at risk for delayed development and long-term cognitive problems. The risk rises with decreasing gestational age. Routine surveillance to monitor gross and fine motor, language, problem-solving, and personal-social skills of the growing preterm infant is essential to detect delays and begin intervention. Statewide early intervention programs that are state and federally funded through the Individuals with Disabilities Education Act exist to provide evaluations and services for infants at risk for developmental delays. VLBW infants should be enrolled in the program based on the state qualifying criteria. Development should be assessed using the Ages and Stages Questionnaire (ASQ) or the Denver Developmental Screening Test and the corrected age of the preterm infant up to 2 years. It is prudent to remember that these diagnostic tools are not always effective in identifying developmental delays in preterm infants. Hence, it is important for all VLBW infants to be followed up in a specialized developmental
clinic where trained personnel can administer the Bayley Infant and Toddler Scales of Development.

PREVENTIVE CARE

Routine preventive care, as offered to full-term infants, should be provided to preterm infants with some additions. 29

Hearing Screening

All preterm infants are at risk for hearing deficiencies, especially those on assisted ventilation for prolonged periods and those receiving ototoxic medications such as gentamicin/tobramycin or loop diuretics. All preterm infants should have their hearing tested prior to discharge. Following discharge, infants should undergo periodic objective screening and assessment of risk factors for hearing loss. Objective screening could be either an oto-acoustic emissions test or an automated auditory brainstem response (ABR). Risk factors to be assessed are outlined in Table 1. If infants fail the hearing test, they should be referred to an audiologist for a more thorough evaluation that may include a sedated ABR. Infants with risk factors should have at least one audiology evaluation by age 24 to 30 months, even if the newborn hearing screen was normal. 30

Vision Screening

Retinopathy of prematurity is a disease of immature retina that leads to blindness in preterm infants. All preterm infants ≤ 30 weeks gestational age or ≤ 1,500 g are screened at 31 weeks postmenstrual age or 4 weeks chronological age, whichever comes later. Infants older than 30 weeks gestational age or with a birth weight between 1500 and 2000 g with an unstable course and requiring cardiorespiratory support should be screened at 4 weeks chronological age. Pediatricians should be aware that these infants may also develop other unrelated eye problems, such as strabismus or refractive errors, and that these need to be investigated if found on physical examination. 31

Immunizations

Preterm infants should be immunized according to their chronologic age, just like term infants, as long as the infants are clinically stable. 32 The immune response generated is not as robust in VLBW infants, but it is sufficient to prevent disease. Infants born weighing < 2,000 g should start their hepatitis B vaccine series at 1 month of chronologic age or at discharge if being discharged at younger than 1 month of age. Preterm infants with prolonged hospitalization should receive immunizations per their chronologic age except for live vaccines. Infants being discharged from the NICU between 6 weeks and 14 weeks and 6 days of life should receive the first dose of the rotavirus vaccine. After discharge, the vaccines should be administered in the pediatrician’s office per the recommended schedules for term infants. 32

Preterm infants, especially those with chronic lung disease, are susceptible to respiratory syncytial virus (RSV) infection. In this population, RSV infection can be fatal. To protect these infants, palivizumab, a humanized mouse monoclonal antibody, is administered monthly during the RSV season. Table 2 shows the most updated guidelines regarding vaccination with palivizumab. Pediatricians should ensure their patients’ compliance with this monthly vaccination and advise families on good hand hygiene practices. 34 In addition to RSV, influenza and pertussis are other causes of morbidity and mortality. Pediatricians should encourage family members, including mothers, to be vaccinated against influenza and pertussis to protect infants.

Abnormal Head Shapes

Preterm infants are at risk for developing abnormal head shapes such as dolicocephaly (elongated head along the sagittal suture), deformational plagiocephaly (oblique flattened head), or brachycephaly (flattened occiput). These occur as a result of compression of soft skull bones because of positional limitations, certain nursing care practices (such as side lying or supine or prone positioning), and medical management. Older infants with head deformities receive helmet therapy. A recent randomized, controlled trial showed no added benefit of helmet therapy. 35

### Table 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Note</th>
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<tbody>
<tr>
<td>Preterm infants with some additions</td>
<td>29</td>
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<tr>
<td>Risk factors for hearing loss</td>
<td>Table 1</td>
</tr>
<tr>
<td>Objective screening</td>
<td>Oto-acoustic emissions test or automated auditory brainstem response (ABR)</td>
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<td>Sedated ABR</td>
<td>If infants fail the hearing test</td>
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<tr>
<td>At least one audiology evaluation</td>
<td>Age 24 to 30 months</td>
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### Table 2

**Guidelines for Administration of Palivizumab**

<table>
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<tr>
<th>Infants eligible for palivizumab in the 1st year of life</th>
<th>All infants ≤ 29 weeks gestational age at birth</th>
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<tbody>
<tr>
<td>Infants &lt; 32 weeks gestational age with chronic lung disease of prematurity, defined as ≥ 21% oxygen for at least 28 days after birth</td>
<td>Infants with hemodynamically significant cardiac disease</td>
</tr>
</tbody>
</table>

| Infants eligible for palivizumab until 2nd year of life | Infants on supplemental oxygen for at least first 28 days of life and continuing to require medical intervention such as supplemental oxygen, steroid, and/or diuretic therapy |

| Infants in whom palivizumab should be considered | Infants with pulmonary abnormality |
|---------------------------------------------------| Infants with neuromuscular disability with inability to clear secretions in lower airways |
| Children < 2 years of age who will be severely immunocompromised during respiratory syncytial virus season | Infants not eligible for palivizumab |

| Infants ≥ 29 weeks and otherwise healthy | Any infant who experiences breakthrough respiratory syncytial virus infection despite vaccination |

Adapted from Lieberthal and Meissner. 33
MULTIDISCIPLINARY AND FAMILY CENTERED CARE

Preterm infants have multiple comorbidities, such as bronchopulmonary dysplasia, intraventricular hemorrhage, short gut from necrotizing enterocolitis, and retinopathy of prematurity, that require numerous types of subspecialty care. Pediatricians must identify these comorbidities and ensure that the infant is receiving the follow-up subspecialty care that is needed. It is not uncommon for families of preterm infants to get overwhelmed with the complexity of care for their preterm babies. Primary care physicians should be able to recognize this and provide support services when needed. Some parents can become overly protective of their infant, leading to family conflicts and neglecting of other children. It is the physician’s job to provide reassurance to the family and maintain a thorough follow-up with the infant.

SUMMARY

Pediatricians already care for a large number of preterm infants, and this number will continue to rise. Good growth and developmental surveillance and practice of preventive care can help families feel comfortable caring for their babies while preventing frequent rehospitalizations.

REFERENCES