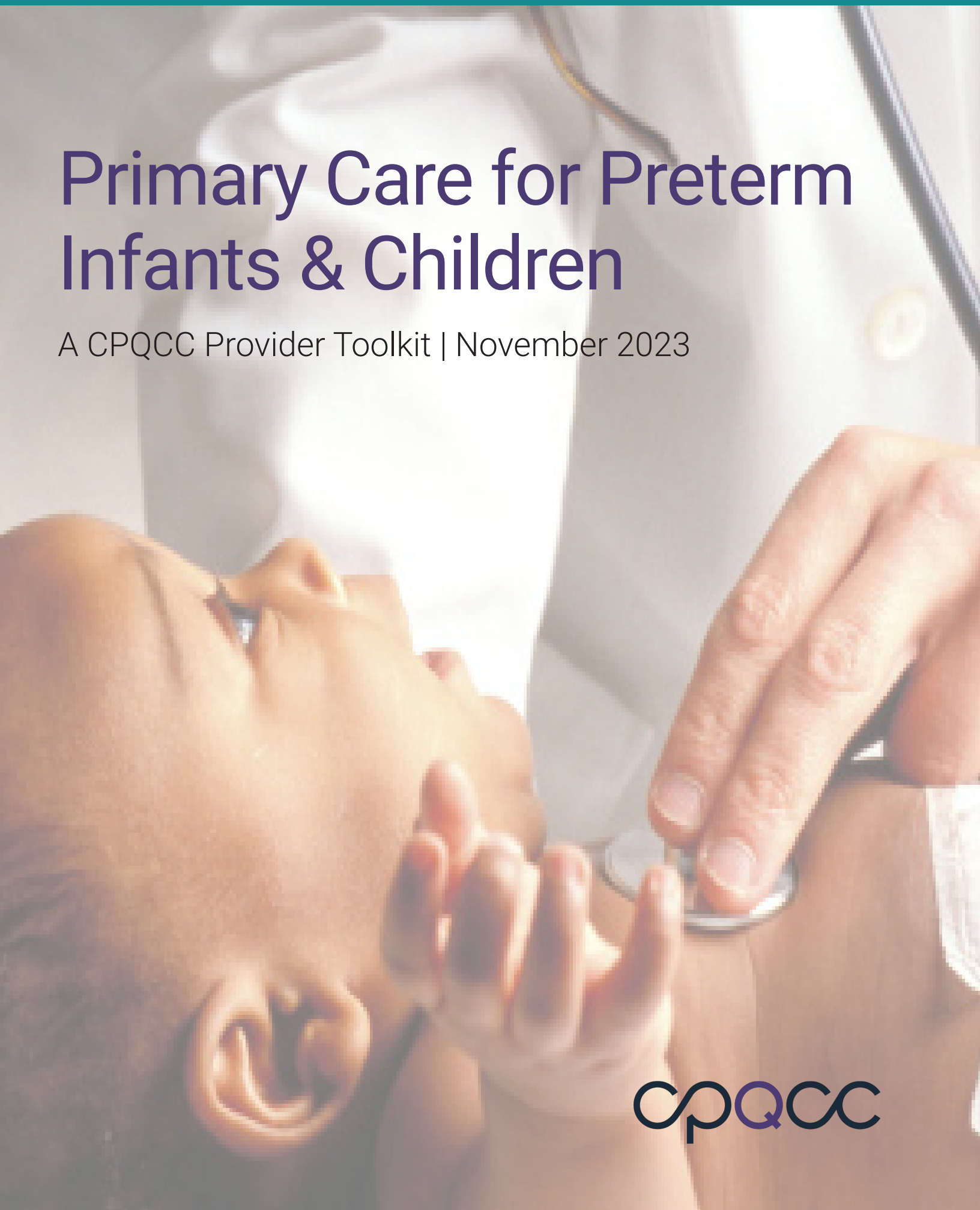
Primary Care for Preterm Infants & Children

A CPQCC Provider Toolkit | November 2023



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A CPQCC Provider Toolkit

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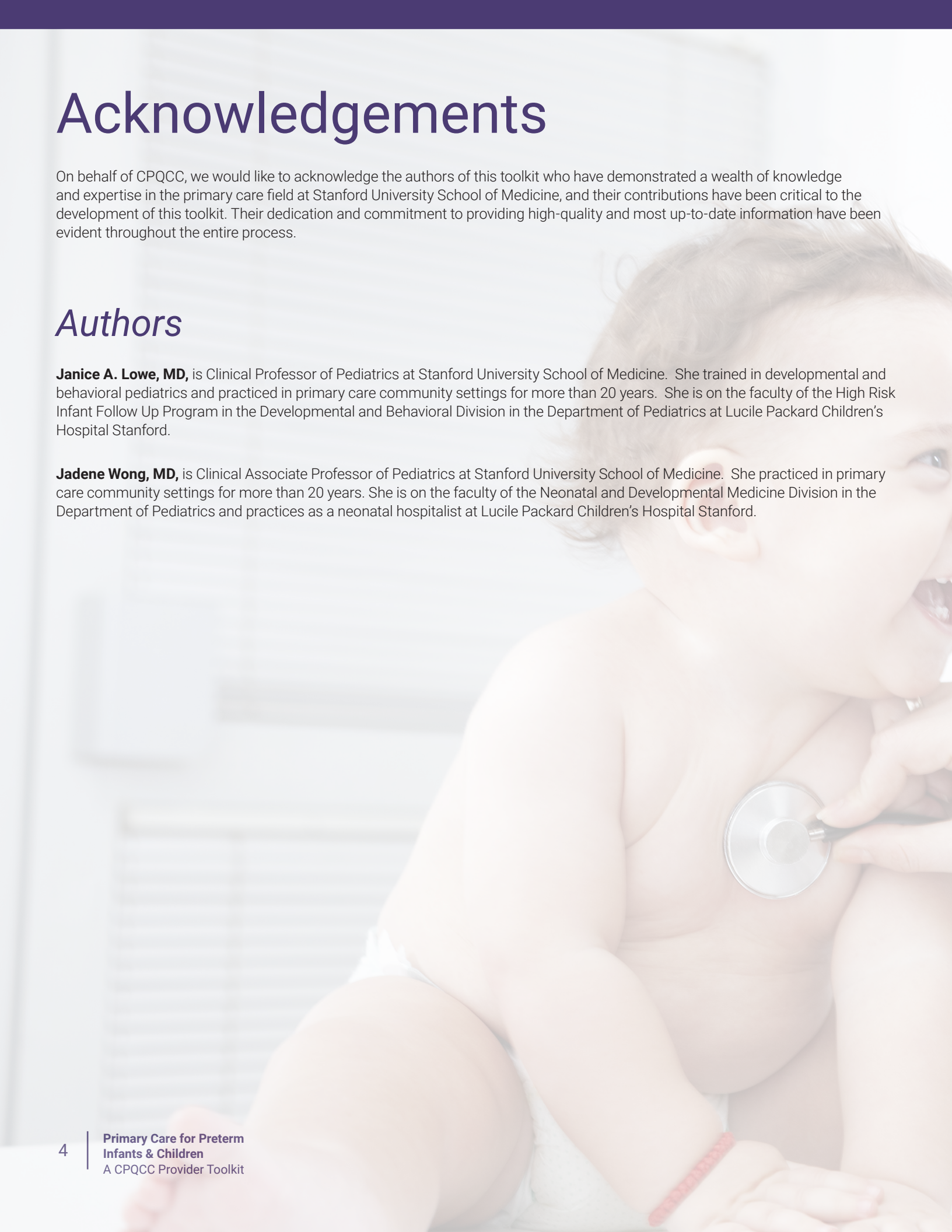

Executive Summary

Approximately 10% of births are preterm, and while there are regional and demographic variations, the high rate assures that pediatric providers will see significant numbers of preterm infants and children in their practices. Primary care pediatric providers are facing increasing time pressures as they balance providing quality clinical care, connecting with families, documenting in the electronic health record, and managing a practice. These providers need updated information readily available to them as they manage primary care issues for preterm infants and children.

Recommendations and guidelines for providing care for preterm infants and children come from a variety of national organizations including the American Academy of Pediatrics (AAP), the Centers for Disease Control (CDC), and the Advisory Committee on Immunization Practices (ACIP). The Primary Care for Preterm Infants & Children Toolkit combines many of the key recommendations in one easily accessible reference and helps inform pediatric providers when there are a variety of approaches to clinical presentations. The goal of the Toolkit is to support primary care pediatric providers as they care for preterm infants and children.

How To Use This Toolkit

The Primary Care for Preterm Infants & Children Tookit serves as an easily accessible reference for primary care providers in a clinic setting. It can be viewed online or downloaded and printed. The Tip Sheet and Periodicity Chart summarize key information from the toolkit in two different two-page formats. A provider may choose to utilize either or both formats based on personal preference and practice needs.

We encourage NICUs to include guidance in their discharge summaries for primary care providers. The downloadable NICU Discharge Provider Template can be used by NICUs as a starting point for developing their own document to use as a customized dot phrase or addendum to their usual discharge summary.

Disclaimer

The recommendations in this publication do not indicate an exclusive course of treatment or serve as a standard of medical care.

Introduction

This toolkit prepares the primary care provider with the skills and knowledge to care for preterm infants and children who are at increased risk for morbidity, serious illness, and hospitalization.

Prevalence of Preterm Birth

An estimated 13.4 million children were born preterm (<37 weeks gestational age) in 2020, with the rates of preterm birth across countries ranging from 4-16% in 2020.[1] In 2021, the United States preterm birth rate was 10.5% and it has been gradually increasing. While this rate varies by geographic location and racial/ethnic groups, overall it assures that preterm children make up a significant portion of virtually every primary care practice that provides care for children.[2]

In 2021, the state with the lowest preterm birth rate was Vermont at 8.0%, and the highest was Mississippi at 15.0%. Other states with high rates included Louisiana 13.5%, Alabama 13.1%, and West Virginia 12.8%. Aggregate data from 2019-2021 reflect worsening racial/ethnic disparities in preterm birth. The lowest rate of prematurity is in the Asian/Pacific Islander population at 9.0%, followed by White 9.3%, Hispanic 10.0%, American Indian/Alaska Native 11.8%, and Black 14.4%. Increased awareness of geographic and racial/ethnic disparities can lead to advocacy for development of policies and programs to achieve improved health equity.[2]

Definition and Risks

Preterm infants and children are often medically complex and have been shown to require increased outpatient visits and hospitalizations.[3] The World Health Organization (WHO) defines preterm as babies born before 37 weeks gestation. Using their terminology, an extremely preterm infant is born less than 28 weeks gestation, very preterm 28 to less than 32 weeks, and moderate to late preterm 32 to 37 weeks.[1]

Common issues for these at-risk infants are poor weight gain, infections, respiratory issues, and neurologic abnormalities. Preterm infants who are small for gestational age (SGA), less than 28 weeks gestational age, or have bronchopulmonary dysplasia (BPD), intraventricular hemorrhage (IVH) grade 3 to 4, or necrotizing enterocolitis (NEC) have been shown to have higher rates of health care visits.[4] One study found that infants born at 23 to 32 weeks gestational age had a mean of 20 outpatient visits in the first year of life compared to 12 outpatient visits for term infants without morbidities, with most visits occurring in the primary care setting.[4] Preterm infants also have increased rates of rehospitalization during the first year of life with a 22% rehospitalization rate of infants <32 weeks GA in one study.[5] In addition, increased rehospitalization rates persist through childhood and adolescence.[6]

Primary care providers are responsible for health supervision and coordination of care for this high-risk population of preterm infants and children. This toolkit aims to assist primary care providers in the care of these infants and children by summarizing the current recommendations for many of the issues that are relevant in the primary care setting.

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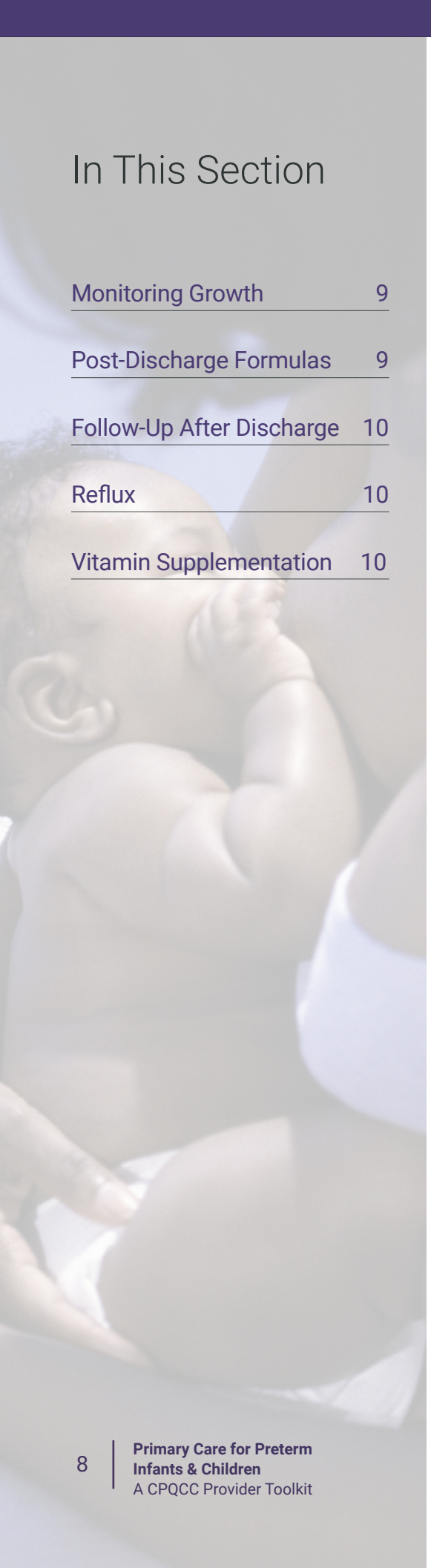

Nutrition

Monitor growth carefully, using the correct growth chart and adjusting for gestational age. Always support breastfeeding. If needed, supplement with post-discharge formulas specially formulated to meet the nutritional needs of preterm infants. Aim to maintain the growth trajectory achieved in the hospital, with proportional gain in weight and length. Do not overfeed infants who gain weight rapidly after discharge.

It is crucial to monitor growth parameters in preterm infants and children, particularly in the immediate post-discharge period but also longer term throughout childhood. Preterm infants are at high risk for growth failure and nutritional deficiencies because of multiple factors including difficulty with feeding, food tolerance, and food absorption. In addition, some infants have increased metabolic demands due to comorbidities including bronchopulmonary dysplasia (BPD), cardiac issues, and neurological issues.[7]

Many infants have inadequate nutrition during their hospitalization due to illness and medical issues.[8] However, there is evidence that weight gain in the post-discharge period is associated with obesity trends and may affect long term neurodevelopmental outcomes.[9, 10] The growth trajectory should be similar to growth achieved in the NICU. Weight and length should increase proportionally. Therefore, it is important to monitor for adequate growth and also to monitor for weight gain that is too rapid because of association with long term morbidities.[11]

Monitoring Growth

Use the Fenton growth chart for preterm infants to maximum 50 weeks postmenstrual age (gestational age + chronological age). Use the WHO growth chart from 0 to 2 years. Use the CDC growth chart from 2 to 20 years. Use corrected age to adjust for prematurity until at least two years of age.

The first step in monitoring growth requires using age-appropriate growth parameters and growth charts. The Fenton growth chart is most frequently used for preterm infants. It is based on 977 preterm infants in three North American cities and was subsequently revised and validated using data from 6 developed countries.[12] The Fenton growth chart does not require age adjustment as the chart shows gestational age, for which the provider uses postmenstrual age (gestational age + chronological age). The Fenton growth chart can be used until 50 weeks postmenstrual age.[13]

Both the American Academy of Pediatrics (AAP) and the Centers for Disease Control (CDC) recommend using the WHO growth chart for children 0 to 2 years of age and the CDC growth chart for children 2 to 20 years of age. Age should be corrected for prematurity until at least two years of age. The WHO growth standards are based on data collected 1997-2003 on 8440 children in 6 countries (Brazil, Ghana, India, Norway, Oman, and USA). These children were predominantly breastfed for the first 4 months of age and continued breastfeeding to one year. Selected children were healthy and living under conditions likely to favor achievement of full genetic growth potential.[14] The CDC growth charts are based on data from the National Health and Nutrition Examination Survey (NHANES) data of children in the United States.[15]

Post-Discharge Formulas

Consider using post-discharge formulas such as EnfaCare® and NeoSure® in infants <1800 grams birth weight and selected other high-risk infants. The usage of post-discharge formulas is controversial, and recommendations vary.

Post-discharge formulas may be used for supplementation or feeding of many preterm infants, especially those of very low birth weight (VLBW <1500 grams), when there is inadequate growth with breast milk alone. The post-discharge formulas that are most frequently used in the United States are EnfaCare® and NeoSure®, both 22 cal/oz. The contents of these formulas vary from the formulas for term infants in several areas including increased calories, protein, calcium, and phosphorus, which are known to be required in higher amounts for VLBW infants.[16]

The amount and length of usage of post-discharge formulas are controversial, and recommendations vary considerably among geographic regions and institutions. Some studies have shown improved growth and brain growth with the usage of post-discharge formulas compared with standard formulas, but studies have not shown consistent results.[17] In addition, there is growing evidence that breast milk provides similar growth and development to post-discharge formulas, and many do not currently recommend their usage if there is adequate growth with breast milk.[18, 19]

While all providers and families should be aware that specific recommendations vary and recommendations should be adjusted for each individual infant, some options for preterm infants at discharge include:

1. Substitute post-discharge formula for breast milk 2 to 3 feedings per day
2. Fortification of breast milk with post-discharge formula

powder to 22 or 24 calories for 2 to 3 feedings per day

3. Adjust post-discharge formula concentration (22 or 24 calories) and frequency based on growth trajectory[20]

In addition, the question arises as to how long to continue post-discharge formulas. Again, each individual infant should be followed, but here are some general guidelines:

- **BW>1800 grams:** May not be necessary
- **BW 1501-1800 grams:** Up to 3 months
- **BW 1001-1500 grams:** Up to 6 months
- **BW 751-1000 grams:** Up to 9 months
- **BW <750 grams:** Up to 12 months[20]

Follow-up After Discharge

See all infants within 48-72 hours of discharge from the NICU.

Preterm infants are at risk for growth failure after discharge, and most sources recommend a follow up appointment within 72 hours of discharge from the NICU. The nutrition goals after discharge are to promote breastfeeding, provide appropriate nutrients, achieve a normal rate of growth for corrected age, and avoid overfeeding.[18, 19]

Some general guidelines to monitor growth are:

1. Provide follow-up within 72 hours after discharge from the NICU
2. Recheck every two weeks initially until stable weight gain is established
3. Continue to follow closely if taking post-discharge formula to monitor for too rapid weight gain
4. Use clinical judgment

Reflux

Reflux occurs in almost all preterm infants. Treatment with positioning or pharmacologic agents is usually not indicated and may cause harm.

Gastroesophageal reflux (GER) is almost universal in preterm infants and usually occurs many times per day due to transient relaxation of the lower esophageal sphincter. Signs previously attributed to GER including desaturation, apnea, bradycardia, irritability, arching, perceived postprandial discomfort, feeding intolerance, or aversion have not been shown to be temporally related to the occurrence of GER. In addition, medications often used to treat reflux such as Histamine-2 (H2) receptor blockers (e.g., famotidine) and proton pump inhibitors (PPIs) (e.g., lansoprazole, omeprazole) have not been shown to be efficacious in reducing GER. H2 blockers may be associated with adverse effects including increased incidence of necrotizing enterocolitis and late-onset infections. PPI use may be associated with gastroenteritis, pneumonia, and increased risk for childhood fractures.[21, 22]

In most cases, treatment with positioning or pharmacological agents is not indicated and may cause harm. GER is considered a normal developmental occurrence that will resolve with time.[21] Infants with anatomic abnormalities, recurrent pneumonia, or difficulty with feeding may be at higher risk for pathology that requires intervention.[23]

Vitamin Supplementation

VITAMIN D: Supplement infants with 400 IU of Vitamin D per day.

The AAP recommends 400 IU of Vitamin D per day in infants under 1 year of age to optimize bone health and prevent rickets. Due to low levels of Vitamin D in breast milk, all breastfeeding infants should be supplemented with 400 IU per day. All formulas in the United States contain at least 400 IU of Vitamin D per liter. Infants who are partially breastfed or taking less than 1 liter of formula per day should also be supplemented.[24]

VITAMIN A: Vitamin A supplementation is not routinely recommended.

There has been controversy in the past as to whether preterm and low birth weight infants benefit from Vitamin A supplementation to prevent mortality and morbidity. A Cochrane study in 2016 did not find sufficient evidence to recommend routine supplementation, and there are no current recommendations for routine supplementation.[25]

IRON: Supplement all preterm infants with iron unless they have received blood transfusions.

Most preterm infants should be supplemented with iron 2-3 mg/kg per day for the first 6 to 12 months after birth, until the infant takes sufficient iron-fortified formula and complementary foods to provide sufficient iron.

Preterm infants are at high risk for iron deficiency anemia for several reasons including decreased iron stores at birth, the high rate of catch-up growth and its associated increase in blood volume, and iatrogenic depletion through blood testing during hospitalizations. Some studies have suggested that early iron deficiency in preterm infants may result in neurological abnormalities and effects on neurodevelopment.[26, 27]

All preterm infants should have an iron intake of at least 2 mg/kg per day through 12 months of age. Recommendations include treating with iron supplements 2-3 mg/kg/day through 6 months of age or until the infant begins eating complementary foods or takes sufficient iron-fortified formula that supplies 2 mg/kg of iron. An exception would be infants who have received an iron load from multiple transfusions of red blood cells. There is no universal recommendation for performing laboratory tests for anemia in preterm infants. Timing can be guided by inpatient laboratory values prior to discharge. Another approach would be to consider checking for anemia in higher risk patients 4-6 weeks after discharge and as needed thereafter.[28] Infants who are anemic should be treated with therapeutic doses of iron (4-6 mg/kg/day).[29]

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Immunizations

Follow general recommendations by chronological age except for special protocols for Hepatitis B Vaccine and Rotavirus Vaccine. Do not miss the opportunity to protect children from Respiratory Syncytial Virus infections.

Preterm infants and children should be immunized with the routine immunization schedule without adjustment for gestational age or birth weight except for Hepatitis B vaccine. Routine immunizations other than Hepatitis B vaccine have been shown to have adequate safety and antibody response.[30] It is important to follow immunization status carefully in this population, as a study from 2019 showed that preterm children had a lower rate of completed immunizations than full term children with over half who were under-immunized at 19 months and over one-third who were still under-immunized at 36 months.[31]

Hepatitis B Vaccine

Follow special recommendations for infants <2000 grams because of diminished antibody response.

Hepatitis B vaccine has been shown to produce a diminished antibody response in low birth weight infants.[32, 33, 34] Therefore the schedule and indications for infants <2000 grams have special considerations listed below.

BIRTHING PERSON IS HBsAg-NEGATIVE:

- 1 dose within 24 hours of birth for all medically stable infants ≥2000 grams.
- For infants <2000 grams, administer 1 dose at chronological age 1 month or hospital discharge.
- A dose received by an infant <2000 grams AND <1 month of age does not count towards the primary series.

BIRTHING PERSON IS HBsAg-POSITIVE:

- Administer Hepatitis B vaccine and 0.5 mL of Hepatitis B immune globulin (HBIG) (at separate anatomic sites) within 12 hours of birth, regardless of birth weight. For infants <2,000 grams, administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
- Test for HBsAg and anti-HBs at age 9–12 months. If Hepatitis B vaccine series is delayed, test 1–2 months after final dose.

BIRTHING PERSON'S HBsAg STATUS IS UNKNOWN:

- Administer Hepatitis B vaccine within 12 hours of birth, regardless of birth weight.
- For infants <2,000 grams, administer 0.5 mL of HBIG in addition to Hepatitis B vaccine within 12 hours of birth. Administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
- Determine birthing person's HBsAg status as soon as possible. If HBsAg is positive, administer 0.5 mL of HBIG to infants ≥2,000 grams as soon as possible but no later than 7 days of age.[35]

Rotavirus Vaccine

Follow the routine schedule, but do not miss opportunities to administer the vaccine because it is usually not given during hospitalization. The first dose must be given between 6 weeks and 14 weeks 6 days of age, and all doses must be completed before 8 months of age.

Rotavirus vaccine is the other immunization that requires special consideration for preterm infants and other infants hospitalized in the neonatal period. The recommendations for rotavirus vaccine for preterm infants follow the standard recommendations. However, because it is a live vaccine that can be shed by the recipient in the stool after administration, it is not routinely administered during NICU hospitalizations in the United States because of concerns regarding nosocomial infections. Some NICUs administer the vaccine at hospital discharge.

In addition, rotavirus vaccine is unique among the routine vaccines in that it must be administered by a minimum age. The first dose of rotavirus vaccine must be administered before 15 weeks chronological age. Some premature infants are still hospitalized at this age and therefore miss the opportunity to have this vaccine. Others are discharged close to the maximum age for the first dose of 14 weeks 6 days and have a small window of opportunity to receive the vaccine.[36] Administration of rotavirus vaccine should always be considered at the first outpatient visit after discharge. An infant can be given the first dose of rotavirus vaccine between the ages of 6 weeks and 14 weeks 6 days. All doses must be completed before the age of 8 months.[35]

RSV Immunization

Be alert for current guidelines regarding new immunization products and regional alterations in RSV season.

NIRSEVIMAB, A LONG-ACTING MONOCLONAL ANTIBODY, IS RECOMMENDED FOR ALL INFANTS UP TO 8 MONTHS AND SOME INFANTS AND CHILDREN AT HIGH RISK OF SEVERE RESPIRATORY DISEASE FROM 8 TO 19 MONTHS.

Since August 2023, nirsevimab is recommended for all infants less than 8 months of age who are born during or entering their first RSV season. Nirsevimab is also recommended for infants and children age 8-19 months who are at increased risk of severe RSV disease and entering their second RSV season. Increased risk is defined as those who have chronic lung disease of prematurity and required medical support (chronic corticosteroids, diuretics, supplemental oxygen) during the 6-month period before the start of the second RSV season, are severely immunocompromised, have cystic fibrosis with severe lung disease or weight-for-length < 10th percentile, or are American Indian or Alaska Native children.

Administration of nirsevimab may occur from October through March during a typical RSV season. Adjustments in the schedule may occur based on variable RSV activity, especially in tropical climates and Alaska, and may be determined by state, local, or territorial guidance.

Timing of nirsevimab administration is in the first week of life or just prior to the start of RSV season. If birth hospitalization is prolonged due to prematurity or other causes, administration should occur shortly before or soon after discharge. If nirsevimab is administered, palivizumab is not indicated. If palivizumab has been initiated, nirsevimab may be given, and no further prophylaxis is needed. If nirsevimab is unavailable, palivizumab may be administered.[37]

PALIVIZUMAB, A MONOCLONAL ANTIBODY IN USE SINCE 1998, IS STILL INDICATED FOR INFANTS AND CHILDREN WHO ARE AT HIGH RISK OF SEVERE RESPIRATORY DISEASE AND UNABLE TO RECEIVE ANY OTHER FORM OF RSV PROPHYLAXIS.

The most common indication for palivizumab prophylaxis in the first year of life for children is for preterm infants born <29 weeks gestational age. It is also recommended for children born <32 weeks gestational age who required oxygen >21% for at least 28 days after birth. Other indications in the first year of life include hemodynamically significant heart disease and consideration for children with pulmonary abnormality or neuromuscular disease that impairs the ability to clear secretions.

For children younger than 24 months, palivizumab prophylaxis is recommended for children who required at least 28 days of supplemental oxygen after birth and who continue to require medical intervention within 6 months of the start of the second RSV season (supplemental oxygen, chronic corticosteroid, or diuretic therapy). It is also recommended for children who will be profoundly immunocompromised during the RSV season.

Palivizumab may be administered up to 5 monthly doses during the RSV season. Infants born during the RSV season may require fewer doses. In addition, there may be special considerations for Alaska Native infants and American Indian populations.[38] A complete list of recommendations is available at https://pediatrics.aappublications.org/content/pediatrics/134/2/415.full.pdf.

RSV VACCINE FOR PREGNANT PEOPLE PROTECTS NEWBORNS FROM SEVERE RSV DISEASE IF A PREGNANT PERSON RECEIVES THE VACCINE BETWEEN 32-36 WEEKS GESTATION AND AT LEAST 14 DAYS PRIOR TO BIRTH.

In September 2023, a recombinant bivalent RSV vaccine was approved for pregnant people to protect their newborns from severe RSV disease. The vaccine may be administered seasonally during 32-36 weeks gestation and will protect the newborn from severe RSV disease for up to 6 months of age if birth is at least 14 days after receipt of the vaccine. Most infants will not need nirsevimab if the birthing person received the RSV vaccine.[39]

NEW RSV IMMUNIZATION PRODUCTS AND GUIDELINES MAY CONTINUE TO BE RELEASED.

Refer to cdc.gov/rsv and aap.org/en/patient-care/respiratory-syncytial-virus-rsv-prevention/ websites for updated information. All primary care practices should develop a system by which they keep a record of infants and children who might qualify for RSV immunization throughout the year. Designating an office champion may facilitate appropriate systems in an individual practice.

Screening

Preterm infants and children need more frequent hearing and ophthalmologic screenings as well as careful monitoring for neurodevelopmental and psychosocial issues.

One of the most important roles of the primary care provider in the care of preterm children is continual monitoring and screening. It is well known that preterm children have increased risks in many domains, and it is important to establish and maintain an office structure that assures that routine and indicated screens are performed at appropriate intervals with timely referrals when needed.

Neurodevelopmental Screening

Follow Bright Futures guidelines for surveillance and screening. Provide additional visits for surveillance, screening, and early referrals as indicated.

Numerous studies have shown increased risks for neurodevelopmental impairment of preterm and low birth weight children. Preterm children are at especially high risk for significant impairments that can present early in life, such as cerebral palsy, intellectual disability (ID), autism spectrum disorder (ASD), visual impairment, and hearing loss. In addition, they are also at increased risk for conditions of lower severity that may present later in childhood, such as academic underachievement, language and speech disorders, attention deficit hyperactivity disorder, developmental coordination disorder, visual motor integration problems, ASD (without ID or language delay), and difficulties with social interactions and executive functioning. Factors that have been shown to increase the risks of neurodevelopmental impairment include lower gestational age, intraventricular hemorrhage and periventricular leukomalacia, hypoxic ischemic encephalopathy, bronchopulmonary dysplasia, retinopathy of prematurity, and necrotizing enterocolitis.[40]

The prevalence of cerebral palsy in the United States is approximately 3.1 per 1000 children.[41] Multiple studies have shown a marked increase of cerebral palsy in children born preterm, with increasing prevalence related to lower

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gestational age. In one study, the prevalence was approximately 50 times greater in children with birth weight <1000 grams.[42] A meta-analysis from 2021 suggested a rate of autism spectrum disorder 3.3 times the rate in the general population.[43] Another meta-analysis confirmed an increased prevalence of autism spectrum disorder (7% in this study) in preterm children including late preterm children that was well above the prevalence in the general population (0.76%).[44, 45] It has also been shown that preterm children have an increased risk of having attention deficit hyperactivity disorder (ADHD), with the risk of ADHD increasing by declining weeks of gestational age, including affecting late preterm children.[46, 47]

The AAP recommends developmental surveillance at each preventive care visit in the areas of social language and self-help, verbal language, gross motor skills, and fine motor skills. Developmental screening with evidence-based tools is recommended at 9, 18, and 30 months of age. Autism screening with an autism-specific tool is recommended at 18 months and 2 years.[48] It is important to follow developmental milestones carefully in all preterm children and examine for abnormalities of tone and movement at each visit. Schedule interim visits as indicated and have a low threshold for referrals for any concerns. It is always important to involve parents and other family members in shared decisions regarding appropriate referrals. Common referrals for additional diagnostic evaluation for preterm children may include orthopedics, neurology, developmental and behavioral pediatrics, and high risk infant follow-up programs (available in some states). Developmental intervention and support often come from physical therapy, occupational therapy, speech and language therapy, and early intervention programs.

Early intervention programs are federally mandated programs that are available in all states and territories to provide services and support for infants and toddlers with disabilities. These programs were enacted in 1986 under the Individuals with Disabilities Education Act and funded through grants to state governments from the federal government and other state funding sources. Services may be supported by private health insurance, are available free or at reduced cost for any eligible children, and may include speech therapy, physical therapy, and other types of services based on needs.[49]

Hearing Screening

Provide screening by 1 month of age, diagnostic evaluation for failed screens by 3 months of age, and intervention for hearing loss by 6 months of age.

All infants admitted to the NICU for >5 days should have ABR screening prior to discharge and, if normal, additional audiology assessment by 9 months of age.

Infants with high-risk conditions such as meningitis, culture positive sepsis, CMV infection, and ECMO requirement need more frequent screens. Always screen if there are concerns regarding hearing or language development.

Approximately 1-2% of screened newborns in North America and Europe have hearing loss, and approximately 1 in 4 children with hearing loss has a birth weight < 2500 grams.[50, 51] Children who were admitted to the NICU have a 6.9 times higher rate of hearing loss compared with those children who did not need NICU care.[52] Hearing loss is primarily due to sensorineural hearing loss (SNHL) and auditory neuropathy (AN). Some additional risk factors associated with hearing loss are low birth weight, hyperbilirubinemia, hypoxia, ototoxic drugs (especially aminoglycosides), culture-positive sepsis, meningitis, and CMV infection.

The AAP's Early Hearing Detection and Intervention program (EHDI) 1-3-6 recommends hearing screening by 1 month,

diagnosis of hearing loss by 3 months, and enrollment in intervention by 6 months. Early detection and intervention have been shown to be highly effective, and they increase vocabulary and help all children regardless of their level of hearing loss or other determining factors.[53] Other studies have shown that amplification with hearing aids by 6 months of age was associated with better early language skills and that hearing loss detected prior to 9 months of age improved reading and communication skills and long-term reading comprehension skills through the teen years.[54]

Approximately 1 to 3 per 1000 children will become deaf or hard of hearing beyond the newborn period, and additional audiology evaluation is important for infants and children at highest risk.[55] In addition to universal newborn hearing screening, the 2023 AAP clinical report "Hearing Assessment in Infants, Children, and Adolescents: Recommendations Beyond Neonatal Screening" recommends that all children should have hearing screening consistent with the Bright Futures/AAP "Recommendations for Preventive Pediatric Health Care."[56] All children should also have a risk assessment for delayed-onset hearing changes with additional assessments based on their risk status. A partial list of risk factors is included below.

Diagnostic hearing follow up is recommended by 9 months for these children:

- Family history of childhood hearing loss
- Neonatal intensive care of >5 days
- Hyperbilirubinemia with exchange transfusion
- Aminoglycoside administration >5 days
- Asphyxia or hypoxic ischemic encephalopathy
- In utero infections such as herpes, rubella, syphilis, and toxoplasmosis
- Craniofacial malformations and other birth conditions

Diagnostic hearing follow up is recommended no later than 3 months for these children:

- Extracorporeal membrane oxygenation
- In utero infection with CMV
- Culture positive meningitis or encephalitis

All children should also have prompt, objective hearing screening if there are caregiver concerns or clinical concerns of possible hearing issues with a prompt referral to audiology for any positive screens. There should be rapid referral to Early Intervention and other medical specialties for children who are deaf or hard of hearing.[55]

It is crucial for providers to understand the types and limitations of hearing examinations to appropriately order hearing tests. Table 1 illustrates the types of tests that are used in children. Early referral to audiology is recommended for any child with concerns regarding hearing issues or speech and language delay.

TABLE 1. Types of Hearing Tests Used on Children

TYPE OF TEST	WHAT IT TESTS	APPROXIMATE TYPICAL AGES	LIMITATIONS	USED FOR NEWBORN SCREENING
Auditory Brainstem Response	Measures brainstem activity in response to sounds	All ages	Requires sleeping or quiet baby or calm older child. May require sedation in children older than 3 to 6 months who cannot cooperate.	Yes
Otoacoustic Emissions	Measures response of inner ear hair cells to sound. Measures middle and inner ear function.	All ages	Does not test neural pathways and can miss hearing loss due to neural conduction disorders.	Yes
Visual reinforcement audiometry	Child's behavioral responses to sounds	6 months to 2 years	Requires child's cooperation. Requires ability to respond motorically.	No
Conditioned play audiometry	Ability to voluntarily respond to sounds	2 to 5 years	Requires cooperation. Requires ability to respond motorically.	No
Pure-tone audiometry	Ability to hear sounds and respond	5 and up	Requires cooperation. Requires ability to respond motorically.	No

Ophthalmologic Screening

Infants ≤ 1500 grams or GA ≤ 30 weeks and other high-risk infants should be screened at 31 weeks postmenstrual age and followed for retinopathy of prematurity (ROP) until the retinae are mature. Repeat ophthalmologic exam is recommended 4 to 6 months after discharge from the NICU or ophthalmologic care. Continue to screen all preterm children, including those who never had ROP, in accordance with Bright Futures guidelines and additionally as indicated because of the high risk of other ocular abnormalities.

Children born preterm are at high risk for retinopathy of prematurity (ROP) and other ocular abnormalities. Very preterm children are more affected (<32 weeks gestational age). There are higher rates of strabismus (5-25% in preterm children), higher rates of refractive errors, particularly myopia (3-20%), lower stereoacuity, and loss of peripheral vision.[57] Therefore, while screening for retinopathy of prematurity is important in the newborn period, continued screening for ocular issues is also recommended for preterm children.

The American Academy of Pediatrics and the American Academy of Ophthalmology both recommend screening for ROP for all infants with a birth weight of ≤ 1500 grams or a gestational age of ≤ 30 weeks. Screening is also recommended for infants with birth weight between 1500-2000 grams or gestational age >30 weeks at high risk for ROP. Some high-risk factors include hypotension requiring inotropic support, oxygen supplementation for more than a few days, and infants who received oxygen without saturation monitoring. An experienced ophthalmologist should perform the screening, and the initial screen is usually scheduled based on postmenstrual age. Exams are recommended at 31 weeks postmenstrual age for infants who were born at or less than 27 weeks GA. They are recommended at 4 weeks chronological age for infants who were 27 weeks GA or more at birth. Follow up ophthalmologic visits are recommended every 1 to 3 weeks, depending on findings, until the retinae are mature. In addition, a repeat ophthalmologic examination is recommended 4 to 6 months after discharge from the NICU.[58]

Psychosocial Screening

Screen at all preventive care visits and other visits as indicated. Provide early referrals.

Mothers of all infants are at risk for postpartum depression, and parents of preterm infants often experience traumatic experiences in the hospital as well as the additional stressors from care required for preterm infants.[59] In addition, quality and quantity of parental sleep has been shown to be inadequate and may adversely affect psychosocial functioning.[60] One study showed increased post-traumatic stress symptoms in mothers of preterm infants compared to mothers of term infants. While symptoms diminished over time, they remained higher in mothers of preterm infants and children.[61] Another study showed higher rates of mental health issues in mothers of preterm children compared with mothers of term children.[62] Mothers of children born preterm had postpartum depression (PPD) rates up to 40% in one study, almost double the rate of mothers of term infants. Moreover, PPD has been shown to be prevalent in 5-13% of fathers of term infants and has been shown to be higher in fathers of preterm infants.[63] All families should receive maternal depression screening consistent with the Bright Futures/AAP Recommendations for Preventive Pediatric Health Care," and providers should consistently monitor families for stressors and make early referrals to provide support for families in their practices.[56, 64]

Additional Medical Risks

Children born preterm may be at higher risk for additional medical and mental health issues.

Some studies have shown that children born preterm have a higher incidence of mental health issues, cardiovascular disease, hypertension, and metabolic syndrome.[65-67] Continue to monitor children based on Bright Futures/AAP Recommendations for Preventive Pediatric Health Care," with additional visits and evaluation as needed.

NICU Discharge Planning

Comprehensive discharge planning for infants in the NICU, and for all newborns with medical issues beyond routine care, eases the transition to the primary care provider. The discharging team should provide and arrange for all continuing care prior to discharge. Immunizations should be updated and documented. Specialty follow-up referrals and appointments should be arranged, including early intervention, ophthalmology, audiology, and occupational/physical therapy. The discharge summary should include primary care guidance and any information relevant to specific medical issues. A warm handoff to the primary care provider also ensures a smooth transition to outpatient care and provides an opportunity to address questions from the accepting provider.

Summary

The care of preterm infants and children can be complex and challenging. However, they are present in virtually all pediatric practices, and continued vigilance and organized systems of care are required to ensure that these infants and children receive the appropriate screening and special care necessary to optimize their health, development, and well-being.

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TIP SHEET

Primary Care for Preterm Infants & Children

Recommendations and guidelines for providing care for preterm infants and children come from a variety of national organizations including the American Academy of Pediatrics (AAP), the Centers for Disease Control (CDC), and the Advisory Committee on Immunization Practices (ACIP). The Primary Care for Preterm Infants and Children Tip Sheet summarizes key recommendations from the associated toolkit to support primary care pediatric providers as they care for preterm infants and children.

NUTRITION: Monitor growth carefully using adjusted age on appropriate growth charts. Always support breastfeeding. Supplement with post-discharge formulas when indicated to maintain growth trajectory. Do not overfeed.	
Monitoring growth	Use corrected age (adjusted for prematurity) until at least 2 years of age. Use corrected age (adjusted for prematurity) until at least 2 years of age. • WHO growth chart until 2 years • CDC growth chart for children 2-20 years
Breastfeeding	Always promote breastfeeding.
Post-discharge formulas	Length of use of post-discharge formula (usually EnfaCare® or NeoSure®) is controversial without standard recommendations and should not replace breast milk in an adequately growing infant. • BW >1800 grams – may not be necessary • BW 1501-1800 grams – up to 3 months • BW 1001-1500 grams - up to 6 months • BW 751-1000 grams - up to 9 months • BW <750 grams - up to 12 months. Caloric density and frequency of post-discharge formula will depend on growth history in the NICU and other medical issues. Monitor growth carefully and do not overfeed infants who are gaining weight very rapidly.
Reflux	Reflux is almost universal in preterm infants, and in most cases treatment with positioning or pharmacological agents is not indicated and may cause harm.
Vitamin supplementation	**VITAMIN D:** Almost all infants need Vitamin D supplementation. • 400 IU per day recommended <1 year old • Formulas in US contain at least 400 IU per liter • Supplement all breastfeeding infants taking less than 1 liter of formula per day **IRON:** Almost all preterm infants should receive iron supplementation. They are iron deficient unless they received blood transfusions. • Maintenance dose 2-3 mg/kg/day for 6 to 12 months (until dietary intake is sufficient) • Treatment dose 4-6 mg/kg/day if anemic

IMMUNIZATIONS: Follow standard recommendations by chronological age except for special recommendations for Hepatitis B Vaccine and Rotavirus Vaccine.	
Hepatitis B vaccine	Hepatitis B vaccine is the only routine childhood vaccine that has been shown to produce insufficient immunogenicity in preterm and low birth weight babies. A dose received by an infant <2000 grams AND <1 month of age does not count towards the primary series.
Rotavirus vaccine	Infants generally do not receive rotavirus vaccine in the NICU (though a few NICUs administer it at discharge). The first dose of Rotavirus Vaccine must be administered by age 14 weeks 6 days. If not previously given, consider administering at the first outpatient visit for infants 6 weeks to 14 weeks 6 days.
RSV Immunization	***Do not miss the opportunity to protect vulnerable children from Respiratory Syncytial Virus infections.*** Give nirsevimab for the following patients: • Infants < 8 months during RSV season if not given at birth hospitalization or if birthing person received RSV vaccine at least 14 days before birth • Infants 8-19 months at start of RSV season with chronic lung disease of prematurity, immunocompromised, cystic fibrosis with severe lung disease or weight-for-length < 10%ile, and American Indian and Alaska Native children • Complete recommendations: cdc.gov/rsv and aap.org/en/patient-care/respiratory-syncytial-virus-rsv-prevention/ If nirsevimab is unavailable, consider palizivumab for the following patients: • Infants < 12 months at start of RSV season if < 29 weeks GA at birth or < 32 week GA and O2 requirement for at least 28 days • Infants < 12 months with hemodynamically significant heart disease (may consult with cardiologist) or with pulmonary abnormality or neuromuscular disease that impairs the ability to clear secretions • Children < 24 months at the start of RSV season with chronic lung disease on medical therapy (oxygen, chronic corticosteroid, or diuretic therapy) within 6 months of start of RSV season • Complete recommendations: https://pediatrics.aappublications.org/content/134/2/415.full

SCREENING: Preterm infants and children need more frequent hearing and ophthalmologic screenings and careful monitoring for neurodevelopmental and psychosocial issues.	
Developmental Screening	• Surveillance at every WCC visit • Evidence based tools at 9, 18, 30 months • Autism spectrum disorder screening tool at 18 months and 2 years
Hearing screening	• ABR screening (such as ALGO) prior to discharge • If inpatient screen was not passed, repeat outpatient screening as quickly as possible and by one month of age. Identify any hearing deficit using ABR by 3 months of age. Begin intervention by 6 months of age • If inpatient screen was normal, repeat hearing screening by 9 months. Screen earlier for high-risk conditions, such as history of CMV infection, meningitis, and ECMO • Audiology referral advised at any time for concerns or language delays
Ophthalmologic screening	• Monitor for retinopathy of prematurity (ROP) until mature retinae for birthweight ≤1500 g or GA ≤30 weeks or selected infants either 1500-2000 g or GA >30 weeks • For all, follow up ophthalmologic exam 4-6 months after NICU discharge and yearly
Psychosocial screening	• At every WCC and other visits as feasible and indicated by risk status

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PERIODICITY CHART

Primary Care for Preterm Infants & Children

	Post-discharge visit	1 mo	2 mo	4 mo	6 mo	9 mo	12 mo	15 mo	18 mo	2 yr	2½ yr	3 yr	4 yr	5 yr
Nutrition: Monitor growth carefully using corrected age on appropriate growth charts. Always support breastfeeding. Supplement with post-discharge formula when indicated to achieve a normal rate of growth. Do not overfeed.														
Growth Charts	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC	GC
Post-discharge formulas	PF	PF	PF	PF	PF	PF	PF							
Iron supplement	IS	IS	IS	IS	IS	IS	IS							
Vitamin D	D	D	D	D	D	D	D							
Immunizations: Follow standard recommendations by chronological age except for special recommendations for Hepatitis B Vaccine and Rotavirus Vaccine. Do not miss the opportunity to protect vulnerable children from Respiratory Syncytial Virus infections.														
Rotavirus vaccine			R	R	R									
Hepatitis B vaccine	H	H	H	H	H	H								
RSV vaccine	RSV	RSV	RSV	RSV	RSV	RSV	RSV	RSV	RSV					
Screening: Preterm infants and children need more frequent hearing and ophthalmologic screenings and careful monitoring of neurodevelopmental and psychosocial issues.														
Developmental surveillance		DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS	DS
Developmental screening						DSc			DSc		DSc			
Autism screening									ASD	ASD				
Hearing screening	HS	HS	HS	HS	HS2	HS2	HS2	HS2	HS2	HS2	HS2	HS2	HS2	HS2
Ophthalmologic screening	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS	OS
Psychosocial screening	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS	PS

Nutrition

- **GC: *Monitoring growth/Growth charts -*** Use WHO growth chart until 2 years. Use corrected age until at least 2 years. Use CDC growth chart for children 2-20 years.
- **PF: *Post-discharge formula -*** Length of use of post-discharge formula (usually EnfaCare® or NeoSure®) is controversial without standard recommendations but should not replace breastfeeding in an adequately growing infant. These are some informal suggestions if using a post-discharge formula: BW >1800 grams – may not be necessary; BW 1501-1800 grams – up to 3 months; BW 1001-1500 grams - up to 6 months; BW 751-1000 grams - up to 9 months; BW <750 grams - up to 12 months. Caloric density and frequency of formula will depend on growth history in the NICU and other medical issues. Always support breastfeeding. Maintain growth trajectory. Do not overfeed.
- **D: *Vitamin D -*** Almost all infants need Vitamin D supplementation.400 IU per day recommended < 1 year old. Formulas in US contain at least 400 IU per liter. Supplement all breastfeeding infants and all infants taking less than 1 liter of formula per day.
- **IS: *Iron supplementation -*** Almost all preterm infants should receive iron supplementation. Supplement with 2-3 mg/kg/day for 6 to 12 months (until dietary intake is sufficient); 4-6 mg/kg/day if anemic. Almost all preterm infants are iron deficient unless they received blood transfusions.

Immunizations

- **H: *Hepatitis B vaccine -*** Hepatitis B vaccine is the only routine childhood vaccine that has been shown to produce insufficient immunogenicity in preterm and low birth weight infants. A dose received by an infant <2000 grams AND <1 month of age does not count towards the primary series. There are special considerations for infants <2000 grams.
  - **Birthing person is HBsAg-negative:** 1 dose within 24 hours of birth for all medically stable infants ≥2,000 grams. Infants <2,000 grams: administer 1 dose at chronological age 1 month or hospital discharge. A dose received by an infant <2,000 grams AND <1 month of age does not count towards the primary series.
  - **Birthing person is HBsAg-positive:**
    - Administer Hepatitis B vaccine and 0.5 mL of Hepatitis B immune globulin (HBIG) within 12 hours of birth, regardless of birth weight. For infants <2,000 grams, administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
    - Test for HBsAg and anti-HBs at age 9-12 months. If Hepatitis B vaccine series is delayed, test 1–2 months after final dose.
  - **Birthing person's HBsAg status is unknown:**
    - Administer Hepatitis B vaccine within 12 hours of birth, regardless of birth weight.
    - For infants <2,000 grams, administer 0.5 mL of HBIG in addition to Hepatitis B vaccine within 12 hours of birth. Administer 3 additional doses of vaccine (total of 4 doses) beginning at age 1 month.
    - Determine HBsAg status as soon as possible. If HBsAg is positive, administer HBIG to infants ≥2,000 grams as soon as possible, but no later than 7 days of age.
- **R: *Rotavirus vaccine -*** Infants usually do not receive rotavirus vaccine in the NICU. The first dose of rotavirus must be administered by age 14 weeks 6 days. Consider administering at the first outpatient visit for infants age 6 weeks to 14 weeks 6 days. All doses must be completed before the age of 8 months.

  For complete recommendations: https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html

- **RSV: *RSV immunization***
  - **Give nirsevimab for the following patients:**
    - Infants < 8 months during RSV season if not given at birth hospitalization or if birthing person received RSV vaccine at least 14 days before birth
    - Infants 8-19 months at start of RSV season with chronic lung disease of prematurity, immunocompromised, cystic fibrosis with severe lung disease or weight-for-length < 10%ile, and American Indian and Alaska Native children

    For complete recommendations: cdc.gov/rsv and aap.org/en/patient-care/respiratory-syncytial-virus-rsv-prevention/

  - **If nirsevimab is unavailable, consider palizivumab for the following patients:**
    - Infants < 12 months at start of RSV season if < 29 weeks GA at birth or < 32 weeks GA and O2 requirement for at least 28 days. Also consider for children with hemodynamically significant heart disease or with pulmonary abnormality or neuromuscular disease that impairs the ability to clear secretions
    - Children < 24 months at the start of RSV season with chronic lung disease on medical therapy (oxygen, chronic corticosteroid, or diuretic therapy) within 6 months of start of RSV season

    For complete recommendations: https://pediatrics.aappublications.org/content/134/2/415.full

Screening

- **DS: *Developmental surveillance -*** Perform at every well child check (WCC) health maintenance visit and at other visits as indicated by risk status and concerns.
- **DSc: *Developmental screening -*** Perform with an evidence-based tool at 9, 18, and 30 month WCC visits.
- **ASD: *Autism Screening:*** Use autism spectrum disorder screening tool at 18 months and 2 years.
- **HS: *Hearing screening -*** ABR screening (such as ALGO) is performed prior to discharge. If initial screen was not passed, repeat outpatient screening is indicated as quickly as possible and by one month of age. Identify any hearing deficit using ABR by 3 months of age. Begin intervention by 6 months of age.
- **HS2: *Hearing screening after newborn period -*** If newborn hearing screen normal, repeat hearing screen for children hospitalized in NICU > 5 days by 9 months of age. Screen earlier for high-risk conditions such as history of CMV infection, meningitis, and ECMO. Refer at any time for concerns or language delays. In addition, follow Bright Futures guidelines.
- **OS: *Ophthalmologic screening -*** Monitor for ROP until mature retinae for GA<30 weeks or <1500 g or selected infants 1500-2000 g or GA >30weeks. For all, follow up at 4-6 months after ophthalmological care discharge and yearly.
- **PS: *Psychosocial screening -*** Perform at every WCC and at other visits as feasible and indicated by risk status.

DISCLAIMER: The recommendations in this publication do not indicate an exclusive course of treatment or serve as a standard of medical care.

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