PRIMARY CARE NEEDS OF PRETERM AND HIGH-RISK NEONATES
I have no financial disclosures
OBJECTIVES

- Identify high-risk infants requiring close follow-up in the outpatient setting
- Review outpatient medical problems commonly seen in preterm and high-risk infants
- Briefly describe the outpatient developmental care for high-risk infants
Many infants that are discharged from the Neonatal Intensive Care Unit (NICU) continue to require extensive outpatient care. May include medical treatments, care coordination in many specialties, use of medical devices, and/or neurodevelopmental evaluations and treatment.
Definitions:

- Preterm: infants born prior to 37 weeks gestation
- Chronologic age: age of infant since birth
- Corrected gestational age: age of infant corrected for weeks of prematurity (chronologic age minus the number of weeks born before 40 weeks)
- Postmenstrual age: age of infant in weeks from conception (gestational age plus chronologic age)
WHO IS AT RISK?

- All preterm infants
  - Very low birth weight premature infants (<1500 grams)
  - Late-preterm and early term infants

Davidoff et al, 2006
WHO IS AT RISK?

- Term infants with complicated post-natal course
  - Congenital abnormalities
  - Respiratory complications
  - Congenital heart disease
  - Hypoxic-ischemic encephalopathy
  - Neuromuscular disease
  - Neonatal abstinence syndrome
ROLE AS AN OUTPATIENT PROVIDER

- Communication with the family and inpatient NICU care team while infant is inpatient to facilitate information gathering and planning for follow-up needs
- Care for the infant upon discharge, using knowledge of underlying medical problems
- Anticipation of new medical problems that may arise
- Care coordination between subspecialists, such as cardiology, ophthalmology, and pulmonology
- Psychosocial support and evaluation of the family, using community resources
  - Substance use, parental physical and mental health status and parenting skills, finances and health insurance
MORE COMMON MEDICAL PROBLEMS

- Growth failure
- Infections
- Bronchopulmonary dysplasia (BPD) and respiratory complications
- Gastroesophageal reflux (GER)
- Hernias
- Anemia of prematurity
- Sudden Infant Death Syndrome (SIDS)
- Retinopathy of Prematurity
- Other vision problems
- Sensorineural hearing loss
- Neurodevelopmental delays and disabilities
GROWTH FAILURE

- Preterm and other high-risk infants are at risk for growth failure
  - Increased caloric usage
  - Poor feeding (swallowing or oral motor dysfunction, delayed feeding sillin development, behavioral issues)
  - Intestinal issues
  - Lack of transferred stores of key nutrients during 3\textsuperscript{rd} trimester
- May be discharged home on fortified feeds (22-26 kcal/oz)
  - Fortified breast milk or higher-calorie premature infant formula (Neosure or Enfacare)
  - Higher calcium and phosphorus delivery
- Most infants will be on vitamin supplementation
  - Vitamin D (all infants should be on whether on breast milk or formula); or multivitamin/multivitamin with iron
GROWTH FAILURE

- Growth should be monitored closely at each visit
  - Likely every 1-4 weeks shortly after discharge
  - Local Women, Infants and Children’s (WIC) office an important partner
- Optimal growth not clearly defined, but ideally growth will maintain percentile on growth curve
### GROWTH RATES OF PRETERM INFANTS THROUGH 18 MONTHS OF AGE

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Weight (g/day)</th>
<th>Length (cm/month)</th>
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<td>10-Apr</td>
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APPROPRIATE GROWTH
GROWTH FAILURE
Most infants need 140-180 mL/kg and 120-140 kcal/kg per day of formula/breast milk to maintain hydration and growth.

- Limit feedings to 30 minutes.
- Continue fortified breast milk or formula until corrected age of 12 months prior to change to whole milk.
- Ask about formula/breast milk mixing!
- Continue vitamin D supplementation until 1 year of age.
  - If on > 400 IU per day, check 25(OH)-vitamin D level monthly.
- Introduce complementary foods based on head control, interest in feedings, decreased tongue thrusting, and good baseline growth.
  - Typically introduce at corrected gestational age of 4-8 months.

PREVENTING GROWTH FAILURE
PREVENTING GROWTH FAILURE

- Consider consulting nutritionist and speech/feeding specialist if infant demonstrates poor growth
- Consider gastrostomy tube (G-tube) if prolonged poor growth noted
- As body growth goes, so goes the brain growth
- Abnormal feeding behaviors may continue into childhood
Bronchopulmonary dysplasia (BPD), also known as chronic lung disease (CLD), affects many preterm infants.

- Defined as oxygen requirement at 36 weeks
  - May be defined using more sophisticated measures in the NICU
- Infants with this diagnosis may need supplemental oxygen, medications such as diuretics, and extra calories in feeds
- BPD may be accompanied by pulmonary hypertension or systemic hypertension
  - Blood pressure should be obtained in clinic with an appropriately-sized blood pressure cuff
BRONCHOPULMONARY DYSPLASIA
Outpatient management goals:

- Optimize infant growth to encourage alveolar growth
- Minimize respiratory exacerbations
Oxygen will often be continued for several months or longer, depending on severity of disease
  - May be weaned in clinic depending on growth parameters, baseline oxygen saturations
  - Use of oxygen known to improve growth in preterm infants

Diuretics may be continued for several months
  - Infants on diuretics should have electrolytes checked regularly
  - May need adjustment of dose as the infant grows vs. allowing infant to outgrow dose
Morbidities:

- Acute respiratory exacerbations
  - Usually related to viral infections
  - May be associated with reactive airways disease, e.g. asthma and wheezing
  - Treatment may include increased oxygen, diuretics, steroids, and bronchodilators

- Pulmonary hypertension
  - May be seen clinically as acute decompensations when ill, or increasing oxygen requirement with time
  - Poor growth from high caloric needs and/or poor feeding

These morbidities, especially acute respiratory exacerbations, can lead to high hospital readmission rate during infancy and young childhood.
Preterm infants are at risk for acquiring infections, and becoming more ill due to their baseline poor immune systems from early birth.
Preterm infants have decreased placental antibody transfer

- Antibody transfer occurs during the third trimester
- Antibody levels at birth are proportional to gestational age
- Antibody levels are also influenced by birth weight, independent of gestational age
INFECTIONS

- Influenza is especially dangerous in high-risk infants that are more likely to develop complications
  - Influenza vaccination x2, starting at 6 months of age
  - Cocooning: vaccination of family members caring for infant
- Pertussis (whooping cough) can cause life-threatening infection and apnea
  - Vaccination at recommended chronologic ages
  - Cocooning
- Rotavirus infection causes vomiting/diarrhea and can lead to dehydration and need for hospitalization
  - Vaccine usually not given in the NICU as it is a live virus vaccine
  - Vaccination recommended at or immediately following hospital discharge if infant >6 weeks and <15 weeks; then vaccinate every 8 weeks for 2-3 total doses (depending upon which vaccine used)
Some immunizations may have been delayed in babies that have not been stable enough for administration

Important to identify immunization status at first visit and address frequently

Give immunizations at recommended times based upon chronologic age, not corrected age
- E.g. 2 month vaccines should be given at 2 months of age
Figure 1. Recommended immunization schedule for persons aged 0 through 18 years – 2013.

(FOR THOSE WHO FALL BEHIND OR START LATE, SEE THE CATCH-UP SCHEDULE [FIGURE 2]).

These recommendations must be read with the footnotes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars in Figure 1. To determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry and adolescent vaccine age groups are in bold.

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<th>9 mos</th>
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**Range of recommended ages for all children**

**Range of recommended ages for catch-up immunization**

**Range of recommended ages for certain high-risk groups**

Not routinely recommended
Respiratory syncytial virus (RSV) can cause significant morbidity and mortality preterm infants, especially those with respiratory problems.

Palivizumab, or Synagis, is a monoclonal antibody against RSV, and may prevent severe RSV in high-risk infants.

- Given monthly during respiratory season, usually November-March.

Limited to certain populations:

- Infants ≤ 28 weeks gestation until 1 year of age.
- Infants 29-32 weeks gestation until 6 months of age.
- Infants 32-35 weeks of age if they are in day care or have a sibling younger than 5 years of age until 3 months of age.
Gastroesophageal reflux (GER) is more common in premature infants, and often worsens until about 8-9 months of age prior to improving.

Also is more common in infants with congenital abnormalities requiring surgeries, such as esophageal atresia, diaphragmatic hernia, and congenital heart disease.

Gastroesophageal reflux disease (GERD) can cause poor weight gain, aspiration and choking, and apnea/bradycardia in these high-risk infants.
Strategies for improvement:
- Frequent, small-volume feeds
- Upright positioning 10-20 minutes after feeding
- Avoid semi-supine position (such as in bouncy seat) as this may worsen reflux

Medical treatment may be necessary to improve feeding refusal and growth
- Minimal evidence to show improvement in symptoms with H2 blockers or proton pump inhibitors
  - May be harm: increased risk of necrotizing enterocolitis, pneumonia,
  - Recommend trial of 2 weeks; if improvement seen, recommend use for 3-6 months
- Prokinetic agents have significant safety concerns and should not be routinely used

Surgical treatment may be necessary if aspiration present
Hernias are more common in preterm infants.

Prolonged mechanical ventilation and male sex increase the risk of hernias.
Umbilical hernias occur in up to 75% of preterm infants, especially very low birth weight infants < 1500 grams.

- Most resolve spontaneously by 1-2 years of age, but may require surgery if present later or become incarcerated.
- Provide parental reassurance.
Inguinal hernias occur in up to 40% of preterm infants, especially those with smaller birth weights.

- Do not resolve spontaneously and will require surgical correction (usually performed prior to hospital discharge).
ANEMIA OF PREMATURITY

- Preterm infants develop anemia at 4-8 weeks of age, earlier and more severe than term infants
  - Lower hematocrit at birth
  - Iron deficiency due to inadequate placental iron transfer (normally occurs during 3\textsuperscript{rd} trimester)
  - Inability to appropriately produce epopoeitin relative to level of anemia
  - Reduced red blood cell life span (45-50 days vs. 80-90 in term infants)
  - Iatrogenic due to frequent blood draws
Infants typically discharged on iron sulfate or a multivitamin containing iron

Iron supplementation of 2-4 mg/kg per day should be continued through 12 months of age, as recommended by the American Academy of Pediatrics
  - Transitional formulas and fortified breast milk provide about 2 mg/kg per day of iron

Consider periodically checking hematocrit as an outpatient if below 30%
Sudden infant death syndrome (SIDS) is the death of an infant under one year of age that is unexplained

- <1/1000 infants, but leading cause of infant mortality
- Preterm infants are at 3-4 fold greater risk of SIDS than term infants
  - Risk is not ameliorated by use of home apnea monitors
  - Peak risk at 50-52 weeks postmenstrual age
Sudden Infant Death Syndrome

Risk factors:
- Young maternal age
- Maternal smoking during pregnancy
- Post-natal exposure to smoking
- Late/no prenatal care
- Preterm birth
- Low birth weight
- Prone or side-lying sleep position
- Use of sleep positioners
- Bed sharing
- Sleeping with soft bedding
- Overheating
SUDDEN INFANT DEATH SYNDROME

- Risk reduction strategies:
  - Supine sleep position
  - Pacifier use
  - Breastfeeding
  - Room sharing for first 6 months (but not bed sharing)
  - Firm sleep surface without loose bedding
Retinopathy of prematurity (ROP) is a developmental vascular proliferative retinal disorder that may be seen in preterm infants, especially those less than 1500 grams at birth.

- Second most common cause of childhood blindness.
- Usually presents at 32 weeks postmenstrual age and peaks at 38-40 weeks.
- Infant will need a screening exam by a pediatric ophthalmologist if:
  - Birth weight is ≤ 1500 grams or gestational age < 30 weeks.
  - Birth weight is between 1500 grams and 200 grams or gestational age is >31 weeks if complicated clinical course.
  - <10% of those screened require intervention.
RETINOPATHY OF PREMATURITY

- Zone indicates location of the retinopathy
- Stage indicates severity of disease
- Stage 1 ROP: Flat line demarcates vascularized and non-vascularized retina
- Stage 5 ROP: total retinal detachment
Other Vision Problems

- Infants with birth weight below 1000 grams have a high rate of ophthalmologic abnormalities
  - Reduced visual acuity/refractive errors
  - Strabismus: misalignment of the eyes
  - Amblyopia: reduced vision caused by lack of use of one eye during visual development
  - Astigmatism
- Recommend examination by pediatric ophthalmologist at 9-12 months and 2-3 years of age
Infants that have been hospitalized in the NICU are at 10-20 times more likely to have bilateral sensorineural hearing loss.

- Risk factors: birth weight <1500 grams, mechanical ventilation >5 days, hyperbilirubinemia, low Apgar scores, or use of ototoxic medications.

- Hearing screen should be performed in the NICU or after discharge.

- Recommend rescreening:
  - At 12 months of age if birth weight < 1500 grams.
  - At 24-30 months of age if NICU stay > 5 days and has undergone mechanical ventilation, extra-corporeal membrane oxygenation (ECMO), ototoxic medications (aminoglycosides or loop diuretics), or had hyperbilirubinemia requiring exchange transfusion.
Preterm and high-risk infants are more likely to have developmental abnormalities

- Cerebral palsy
- Fine or gross motor delays
- Learning delays
- Language delays
- Sensory processing disorders
- Autism and autism spectrum disorders
- Psychiatric disorders in childhood/adulthood

Risk increases with significant medical complications of term infants, or decreasing birth weight/gestational age in preterm infants

Preterm infants generally will demonstrate motor development equivalent to term peers by 2-3 years of age
NEURODEVELOPMENTAL DELAYS

- Infants should be screened at every visit with early referral to early intervention services.
- In Colorado, infants with any hospital weight <1200 grams qualify automatically for Early Intervention services.
<table>
<thead>
<tr>
<th>Area of Assessment</th>
<th>3–4 and 6–8 mo CA</th>
<th>12–14 mo CA</th>
<th>18 mo CA</th>
<th>3–5 y</th>
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<td>CBCL; Conners CPT; Conners RS</td>
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TIMELINE OF CHILD OUTCOMES

- Cognition
- Executive function
- Motor control
- Temperament, Self-Regulation
- Relationship to parent
- Behavior Problems
- Relationship to peers
- Psychopathology
- Antisocial behavior
- School failure

1-3 yr.  4-7 yr.  8+ yr.

Families of infants that have been hospitalized in the NICU often undergo psychosocial and post-traumatic changes.

Vulnerable Child Syndrome consists of overprotective parents that results in overindulgence of the infant, long-term behavioral issues, sleep problems, and poor peer relationships.

Increased risk of child abuse.
OUTPATIENT MANAGEMENT

- Initial visit:
  - Review NICU course, current medications, oxygen or other equipment needs, growth parameters, nutrition/feeding, immunization history, and neonatal screening exams
  - Ensure psychosocial aspects addressed: access to care, phone contacts, medications, transportation
  - Need for specialty appointments
    - Ophthalmology
    - Audiology
    - Pulmonology
    - Cardiology
- Subsequent visits (every 1-4 weeks):
  - Monitor growth, nutrition/feeding, follow-up with specialists
  - Evaluation of neurodevelopment and access to in-home therapies

| Provide Support to Family | Understand stress of early delivery and NICU hospitalization  
|                          | Be aware of individual family dynamics  
|                          | Acknowledge fear of being “home alone” |
| Establish Relationship    | Visit NICU to meet infant and family  
|                          | Talk with neonatal caregivers  
|                          | Review discharge summary  
|                          | Schedule office visit 1 week after discharge |
| Monitor Growth           | Measure weight, length, and head circumference at every visit  
|                          | Plot on premature chart or adjust for prematurity on standard chart |
| Order Immunizations      | Check immunizations given in NICU  
|                          | Administer according to American Academy of Pediatrics schedule at chronological age  
|                          | Consider Synagis and flu vaccine |
| Assess Nutrition         | Do 24-hr intake and calorie assessment  
|                          | Assess feeding skills |
| Examine and Analyze      | Monitor vital signs adjusting for prematurity  
| Medical Condition        | Review monitor downloads and alarms  
|                          | Check saturations if on oxygen  
|                          | Evaluate respiratory status at every visit  
|                          | Observe for signs of gastroesophageal reflux  
|                          | Order laboratory tests as indicated (CBC, drug levels, etc.) |
| Screen Vision and Hearing| Review NICU evaluations of sensory function  
|                          | Encourage outpatient ophthalmology, audiology follow-up  
|                          | Discuss parental concerns  
|                          | Observe sensory responses in office |
| Evaluate Development     | Administer standardized assessment at specific intervals  
|                          | Adjust development for prematurity for 2 yrs |
| Offer Anticipatory Guidance| Discuss common behavioral/developmental responses of premature  
|                          | Review need to adjust for prematurity in regard to growth and development |
| Refer for Services       | Consider early intervention, WIC, social services, specific support groups |
SELECTED REFERENCES