



CARING FOR OUR SMALLEST GRADUATES: A PASSPORT TO HEALTH



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Disclosures

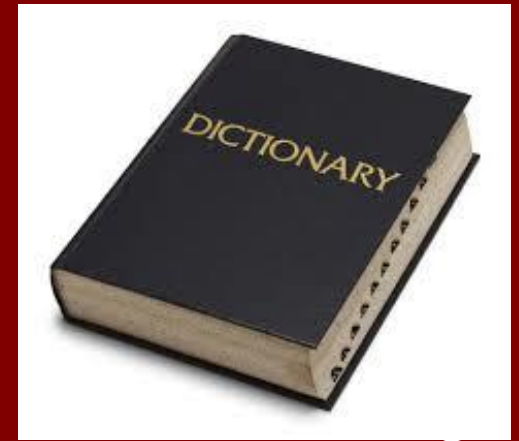
- No relevant disclosures

Objectives

- Note importance of correcting for “adjusted gestational age”
- Discuss nutritional requirements of premature infants
- Discuss screening needs for bone health, anemia, vision, hearing, development

Definitions

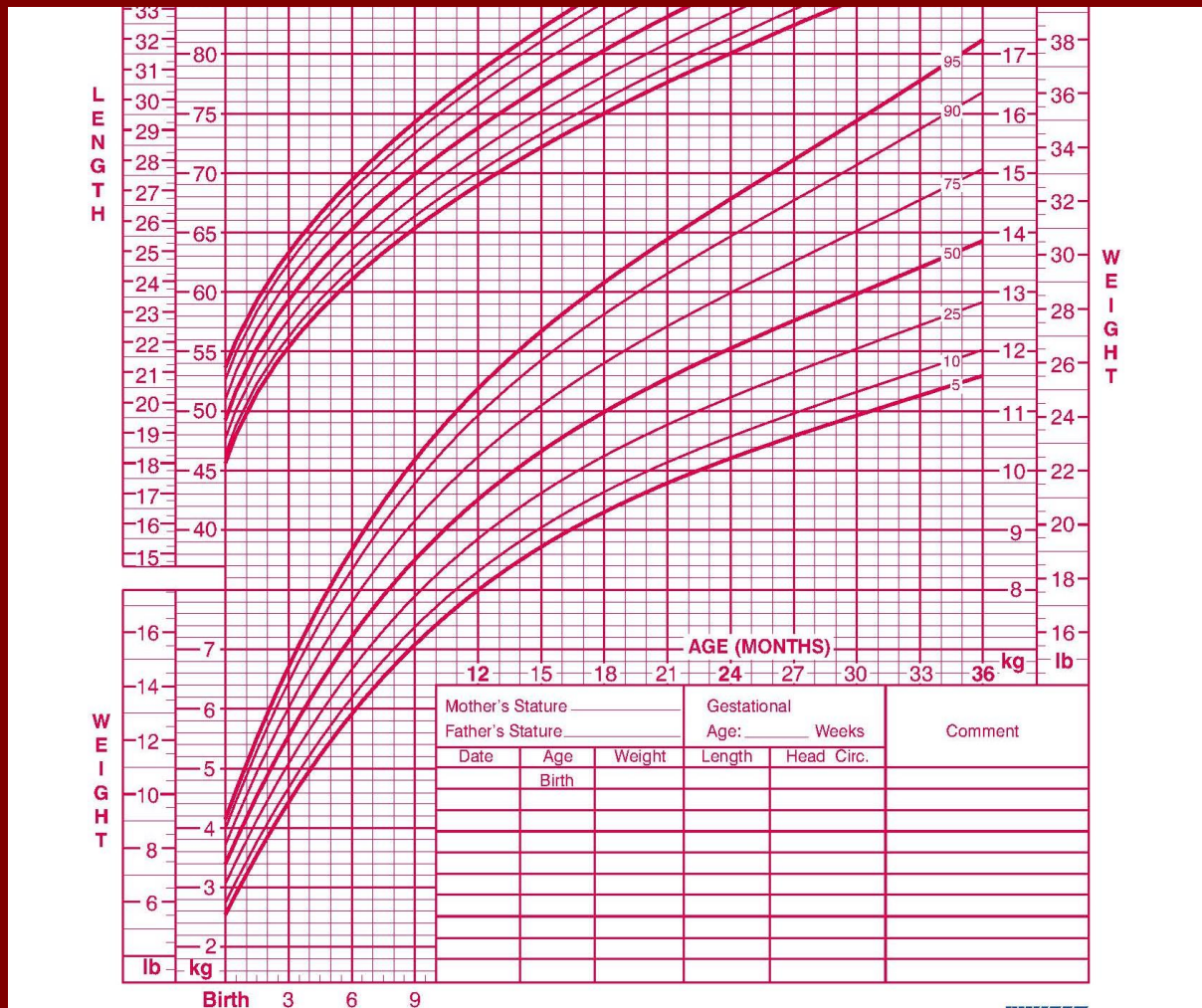
- Preterm: < 37 weeks gestation
- Low Birth Weight (LBW):
- Very Low Birth Weight (VLBW): < 1500g
- Extremely Low Birth Weight (ELBW): < 1000g
- Post-Menstrual Age (PMA):
 - Gestational age at birth, dated by mother's last LMP
- Corrected Gestational Age (CGA):
 - The PMA plus weeks after birth (e.g. 27 week infant at 4 weeks of age is 31 weeks CGA)

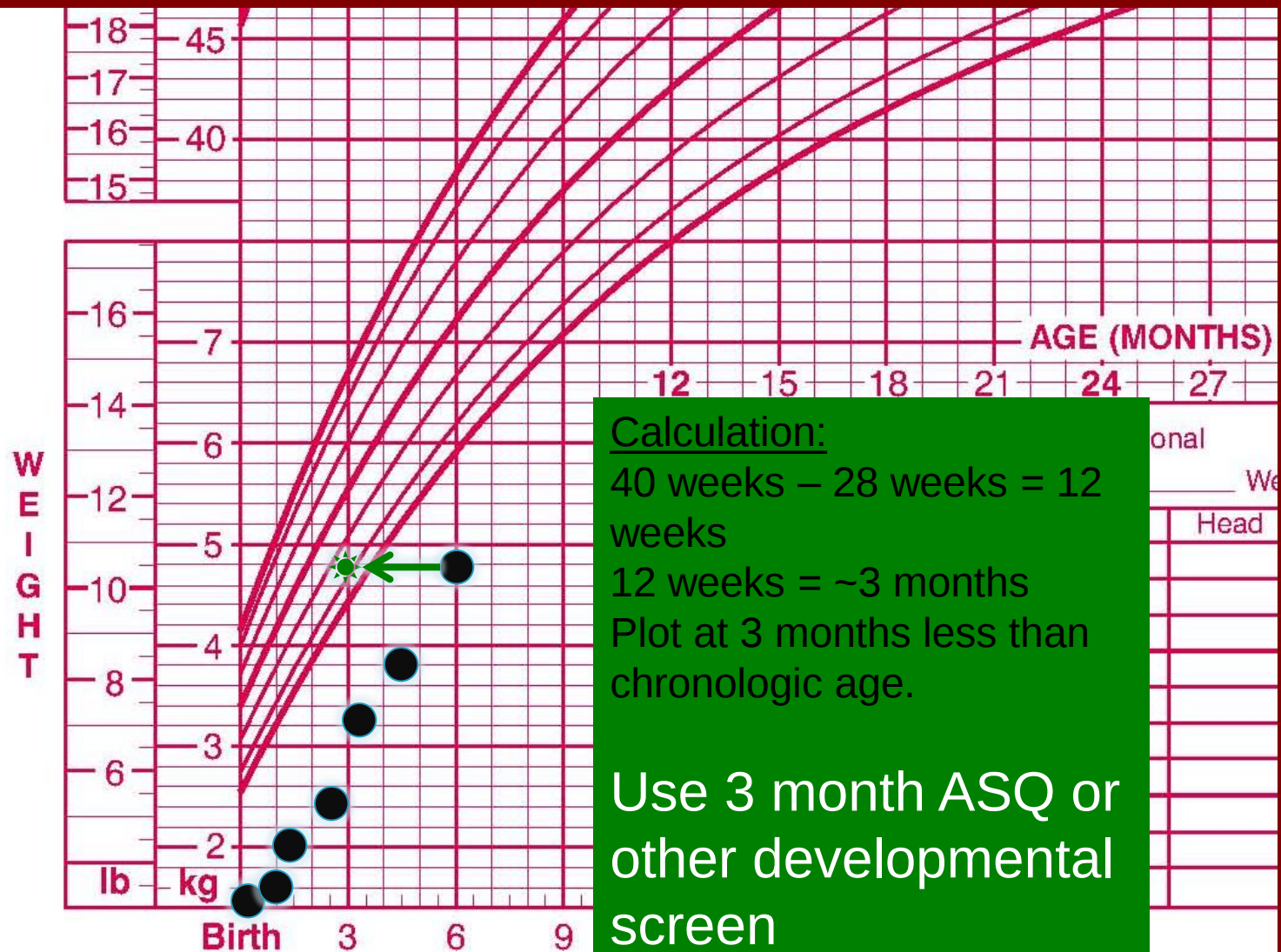


Corrected Gestational Age (CGA)

- Use until the infant reaches 24-36 months
- Use for all growth and developmental milestones, including introduction of foods
- The only schedule that should follow preterm infants' chronological age is their immunization schedule (except hep B and maybe rotavirus)

Example: Growth and development, 28 week infant 6 months after birth





Calculation:

40 weeks – 28 weeks = 12 weeks

12 weeks = ~3 months

Plot at 3 months less than chronologic age.

Use 3 month ASQ or other developmental screen

Published May 30, 2000 (modified 4/20/01).

SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).

<http://www.cdc.gov/growthcharts>

The Stats as of 2013

- ◎ ~ 4 million births per year
 - Gestational age
 - 11.4% are preterm (~450,000)
 - 8% late preterm (34-36 weeks)
 - 1.9% (<32 weeks)
 - Weight
 - VLBW (<1500 mg): 1.4%
 - LBW (<2500 gm):
 - ~8% of annual births (~320,000)
 - ~90% (~288,000) of these infants survive to discharge
 - ~ 1/3 will need specialty services



Impact in numbers?

- ◎ Average Week in New Mexico, 2012
 - 521 births
 - 60 preterm births
 - 46 LBW
 - ~ 14 infants born each week who will need some type of specialty services = ~700/year

Discharge Criteria

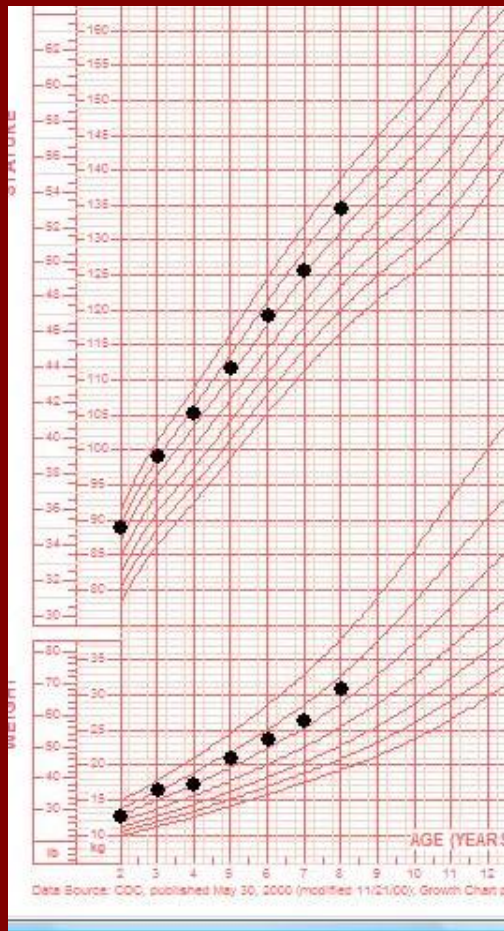
- Infant Readiness
- Family and Home Environmental Readiness
- Community and Health Care System Readiness

- AAP, Committee on Fetus and Newborn. Hospital Discharge of the High-Risk Neonate. Pediatrics. 2008;122(5):1119-1126.

Outpatient Management

- ⦿ Evaluation of growth and nutrition
- ⦿ Vision and hearing screening
- ⦿ Ongoing routine preventive care
 - Immunization status
- ⦿ Developmental progress
- ⦿ Close monitoring of common medical problems of the preterm infant
 - Lung
 - Eye
 - Ear

Growth and Nutrition



Goal of Growth and Nutrition

- Approximate the rate of growth and body composition of a healthy fetus of the same gestational age while avoiding nutritional excesses or deficiencies

Growth and Nutrition

- NICU graduates are at increased risk for inadequate growth
 - Often discharged at a weight less than the 10%ile for gestational age
 - Accumulate a significant nutrient deficit in the first weeks of life
 - Increased caloric requirement
 - increased metabolic rate, catch up growth
 - Poor feeding
- Catch-up growth can occur by 3 years CGA, but it can take longer (8-14 years)
 - May not be achieved at all

Growth and Nutrition

- Weight, length, weight/length and HC must be plotted for CGA until 3 years of age
- Any infant not approaching the lower percentiles of the curve, has a flattening or decelerating growth pattern needs an assessment
- Weight will falter first
- Weight-for-length measurements may indicate a decrease in growth velocity prior to major changes in HC or length velocity

Growth Patterns

- Head growth frequently exceeds weight gain and linear growth
- Many have a disproportionate increase in weight for length in the early months after discharge, especially VLBW
 - THIS SHOULD NOT BE USED AS EVIDENCE FOR RESTRICTION OF INTAKE
- Accelerated growth patterns usually normalize between 1 & 2 years of age

Average Growth Rates by Corrected Gestational Age

Growth Velocity of Preterm Infants from Term to 24 months of age*

Age From Term (40 wks +)	Expected Weight Gain (g/d)	Expected Length Gain (cm/mo)	Expected HC Gain (cm/mo)
1	26-40	3.0-4.5	1.6-2.5
4	15-25	2.3-3.6	0.8-1.4
8	12-17	1.0-2.0	0.3-0.8
12	9-12	0.8-1.5	0.2-0.4
18	4-10	0.7-1.3	0.1-0.4

*For catch-up growth—defined as growth greater than a term-born peer

Growth

Poor Rate of Weight Gain for Corrected Age

Age (CGA)	Weight Gain
Term-3 months	<20 gm/d (<5 oz/wk)
3-6 months	<15 gm/d (<3.5 oz/wk)
6-9 months	<10 gm/d (<2 oz/wk)
9-12 months	< 6 gm/d (<1.5 oz/wk)
1-2 years	<1 kg or < 2 lb in 6 months
2-5 years	< 0.7 kg or < 1.5 lb in 6 months

Nutrition Requirements

- Caloric needs for appropriate growth:
 - Most infants: 108 kcal/kg/day
 - Premature infants: 110-130 kcal/kg/day
 - Infants with BPD: 120-150 kcal/kg/day
- Preterm infants have increased requirements for protein, calcium, phosphorus and iron intake



Human Milk



- ◎ The optimal choice, but....
 - Deficient in calcium, phosphorous, and vitamin D for bone mineralization and protein for adequate growth
 - Human milk fortifiers add these factors
 - Recommended until nipping—if d/c to home on HMF, needs close monitoring as potential for inappropriate vitamin intake
- ◎ Transitioning from enhanced HM to exclusive BM and/or something in between
 - No best practice available
 - No good studies available
 - NEEDS TO BE INDIVIDUALIZED WITH CLOSE FOLLOW-UP

Human Milk



- ◎ Two potential strategies:
 - Feed pumped breast milk at increased energy density at discharge; gradually increase exclusive nursing sessions by eliminating one bottle feeding at a time
 - Caloric supplementation of BM can be done using powdered formula
 - Nurse on demand but have a specific required daily intake of nutrient enriched post-discharge formula
- ◎ With either strategy, close follow-up should be done to ensure adequate growth and bone mineralization

Formulas

- VLBW infants should remain on nutrient enriched post-discharge formulas (transitional) until at least 9 months CGA
 - Standard caloric content: 22kcal/oz
 - Additional caloric supplementation can be provided using powered formula
 - If growth above the birth channel or if weight/length exceeds 90%tile, 20cal/oz term infant formula may be considered earlier



Other Formulas

- No role for the use of low-iron formulas (ever!)
- Soy protein-based formula not recommended for preterm infants weighing < 1800 grams
 - Lacking in sufficient calcium, phosphorus and protein
 - The presence of phytates in soy formula decreases bioavailability of minerals in the gut



Calcium, Phosphorus, and Vitamin D Intakes at 160ml/kg/day

	Human Milk (20 cal/oz)	Fortified Human Milk (24 kcal/oz)	Preterm Formula (24 kcal/oz)	Transitional Formula (22 kcal/oz)
Calcium (mg/kg)	37	184-218	210-234	125-144
Phosphorous (mg/kg)	21	102-125	107-130	74-80
Vitamin D (IU/day)	2.4	283-379	290-468	125-127

Calorie supplementation

- Specific preterm infants may continue to require at d/c, or require anew after d/c, an increased caloric supplementation above the standard concentration of 22 kcal/oz
 - Infant with flat or decelerating growth curve pattern
 - Infant is unable to take enough volume to follow a growth curve
 - Infant is volume restricted due to severe lung or cardiac disease and unable to follow a growth curve

Weaning of Caloric Supplementation

- Gradual adjustments in calorie density, followed by weight checks
- Serial measurements of growth (using CGA), including weight, HC, and length
- Breastfed
 - Regular assessments of infant's growth and adequacy of maternal milk supply
- Formula fed
 - Regular assessments of infant's volume intake

Food Introduction

- Introduction of foods should occur at a schedule consistent with a term baby, using the infant's CGA
- VLBW infants should wait until 6 months CGA



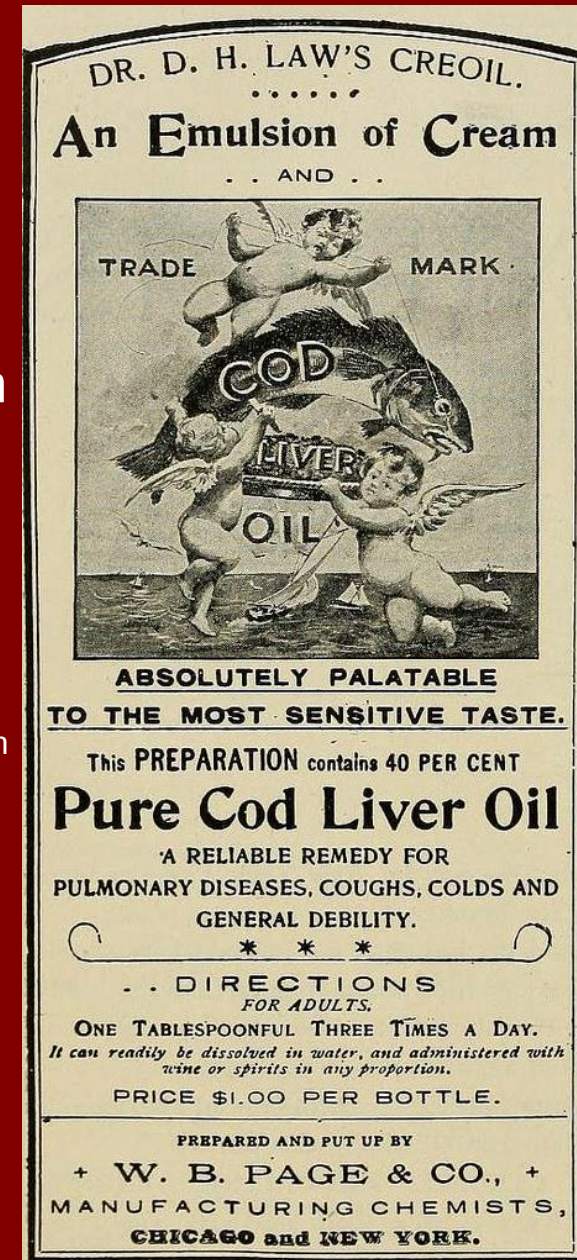
Risk Factors for Bone Disease

- Population at highest risk for bone disease
 - <27 weeks gestation and BW < 1000gm
 - 80% of mineral deposition occurs in the third trimester
 - Long term TPN need — >4 weeks
 - Aggravates the mineral deficit that a preterm infant starts with
 - Treatment with medications known to affect bone or vitamin D metabolism (diuretics, methylxanthines, glucocorticoids, antiepileptics)
 - History of severe complications—NEC, BPD, liver disease, multiple episodes of infection
 - Failure to tolerate formula or human milk fortifiers with high mineral content
 - Poor weight gain
- Still need to be concerned about the entire VLBW population and those < 32 weeks



Vitamin D

- Recommendations similar to term infants once > 2000 grams
 - All infants and children should have a minimum intake of 400 IU of vitamin D per day
 - Supplementation should continue until other dietary sources are added to ensure minimum intake
 - AAP, Prevention of Rickets and Vitamin D Deficiency in Infants, Children, and Adolescents. Wagner, et al. 2008.
- If on transitional formula, no vitamin supplementation is needed once taking approximately 27 oz/day (>800ml)



Iron Supplementation

● Breast Fed

- 2 mg/kg/day from 1 month through 12 months--current AAP recommendations
 - Tsang et al. continue to recommend 2-4 mg/kg/day for ELBW and VLBW

● Formula Fed

- Only iron fortified formulas are recommended
- Transitional formulas provide ~ 1.8 mg/kg/d at 150ml/kg/day—additional supplementation is indicated to meet the recommended 2-4 mg/kg/d

● Screening hematocrit at 2-4 weeks post-discharge is recommended with ongoing close monitoring

IMMUNIZATIONS

Standard Immunizations

- Preterm infants should receive full immunizations based upon their chronological age consistent with the schedule and dose recommended for normal full-term infants
- Exceptions:
 - First hepatitis B vaccine at 2000 gm unless mother is HBV positive
 - Rotavirus vaccine given at hospital discharge (not >8 months after birth)

Synagis (Palivizumab)

- Humanized mouse immunoglobulin monoclonal antibody
 - 95% human origin, 5% mouse
- New guidelines as of July 2014
- Who gets it now?
 - All infants born at 29 0/7 weeks or less who are younger than 12 months at start of season
 - Any preterm infant less than 32 0/7 weeks with CLD, defined as:
 - Requirement of supplemental oxygen for at least the first 28 days after birth for 1st year of life

Other Immunizations

● Influenza vaccine

- Should be given after 6 months of age
- Given as two doses one month apart
- Household contacts should be immunized

● Pertussis Booster (DTaP or Tdap)

- All parents, siblings and care providers should be up to date
 - Booster recommended at 11-12 years of age and then every 10 years
 - Expectant mothers should receive it at 27 and 36 weeks with each pregnancy between

VISION, HEARING AND DENTAL

Retinopathy of Prematurity

**CGA= Corrected
Gestational Age**

- 2nd most common cause of childhood blindness
- Affects up to 80% of VLBW, ELBW and sick premature infants
- Presents at 32 weeks CGA, peaks at 38-40 weeks CGA, and begins to regress by 46 weeks CGA
- Infants with immature retinas at hospital d/c must be followed by ophthalmology until the retina is fully vascularized: ~44-48 weeks CGA
- If untreated, can lead to retinal detachment and blindness

Vision

- ◎ Rate of blindness ranges from 2-6% of VLBW infants
 - Incidence increases as birth weight declines
- ◎ Also at increased risk for:
 - Myopia
 - Strabismus
 - Amblyopia
- ◎ Recommended that all premature infants be evaluated by an ophthalmologist at 9-12 months CGA and then yearly

Hearing

- Risk of moderate to severe permanent hearing loss is up to 20 X higher in preterm infants
 - Prevalence of severe sensorineural hearing loss for VLBW infants: 1-10%
- A normal hearing screen prior to hospital discharge DOES NOT preclude delayed onset or acquired hearing loss
 - Infants who pass the neonatal screening but have a risk factor should have at least 1 diagnostic audiology assessment by 1 year of age

When to do Hearing Evaluations After Discharge

- Risk factors associated with permanent congenital, delayed onset, or progressive hearing loss
 - Caregiver concern for hearing, speech, language or developmental delay
 - Family history of permanent childhood hearing loss
 - NICU stay > 5 days
 - History of ECMO, assisted ventilation, exposure to ototoxic medications or loop diuretics, and hyperbilirubinemia requiring exchange transfusion

When to do Hearing Evaluations Beyond Discharge

- Syndromes associated with hearing loss or eustachian tube dysfunction
- Postnatal infections associated with hearing loss
- Congenital infections: CMV, Herpes, Rubella, Syphilis, toxoplasmosis
- Persistent middle-ear effusion for 3 months or greater
- Neurodegenerative disorders
- Head trauma
- Chemotherapy



AAP, Year 2007 Position Statement:
Principles and Guidelines for Early
Hearing Detection and Intervention
Programs, Oct. 2007.

Dental Issues



- ~ 2/3 of VLBW infants have dental enamel defects
 - Contributing factors: systemic illness, calcium and phosphorous deficiencies, prolonged intubation)
 - Predisposes infant to caries
- May have delay in tooth eruption
 - Full complement should be present by 2 years
- Decreased tooth crown size
- If history of prolonged intubation:
 - V-shaped palates, palatal groove, posterior cross bites, deformed incisal edges, and missing teeth
- Initial evaluation based on risk:
 - As early as 6 months of age, 6 month after the first tooth erupts, and no later than 12 months of age

DEVELOPMENT

Development

- ⦿ Gross motor deficits manifest by 2 years of age
- ⦿ Language deficits manifest in the pre-school years
- ⦿ Behavioral and/or learning problems may not become apparent until school age
 - New literature suggesting that prematurity is a risk factor for autism

Neurological Assessment (0-12 months CGA)

**CGA= Corrected
Gestational Age**

- Screening focuses on detection of major disabilities
 - Blindness and hearing impairment
 - Head growth abnormalities
 - Feeding issues
 - Major motor abnormalities
 - Gross and fine motor
 - Tone abnormalities
- Note: at 12 months CGA, cognitive and motor still highly intertwined, so can be highly variable
 - Some neurologic abnormalities identified previously are improving and some infants are starting to demonstrate problems

Neurological Assessment (1-5 years)

- Screening focuses on detection of less severe disabilities
 - Visual problems and mild hearing loss
 - Fine and gross motor problems
 - Behavioral issues
 - Visual/perceptual/language problems
 - Learning disabilities/intelligence
 - First assessed at 3-4 years

Development

- New Mexico's Early Intervention eligibility criteria are based on:
 1. Established conditions
 2. Identified developmental delay, OR
 3. Risk
 - Biomedical Risk
 - Environmental Risk
- What's the risk of Early Intervention if not really needed?

(NM FIT 2014)

Infant development

Continue to stress to the caregiver(s) that developmental milestones are based on corrected gestational age and NOT chronological age

Useful Resources

- www.preemietoolkit.com
- Primary Care of the Premature Infant, D Brodsky and MA Ouellette
- Nutritional Care of Preterm Infants, R Koletzko, B. Poindexter and R. Uauy
- AAP

PRIMARY CARE of the PREMATURE INFANT



Dara Brodsky Mary Ann Ouellette

SALUNDERS
JOURNAL

World Review of Nutrition and Dietetics
Editor: B. Koletzko
Vol. 110

Nutritional Care of Preterm Infants

Scientific Basis and Practical Guidelines

Editors
B. Koletzko
B. Poindexter
R. Uauy



KARGER



THANK YOU,
New Mexico family
physicians!

Need Help?

UNM Special Baby Clinic
Contact person:
Valerie Harris
SBC clinic coordinator
505-272-3946
800-400-2002

Lanc

Extra Information

Bone Health

RSV Prophylaxis (palivizumab, Synagis®)

At Risk for Bone Disease

◉ Monitoring

- Every 4-8 weeks with physical exam
 - Calcium, phosphorus, alkaline phosphatase and 25(OH) D levels + urine ca/cr if infant on diuretics
 - If results normal—continue to follow until 6 months CGA
 - If results abnormal—need further imaging, nutrition consult to ensure adequate supplementation, endocrine consult, continue to monitor every 2-4 weeks

Outpatient Monitoring for Bone Disease—Serum

- Ca may be ↑ in hypophosphatemia or ↓ in severe vit. D deficiency
- PO₄ normal or ↓ with inadequate supplementation
- AlkP ↑ with osteomalacia
- 25(OH)D normal, but may be ↓ in:
 - unsupplemented infants
 - infants of moms with ↓ stores
 - infants treated with sz drugs

Outpatient Monitoring for Bone Disease

● Urine

- Ca/Cr ratio: > 1.5 once term in gestational age is elevated; ratios at > 1 year of life are lower (<0.25)

● Imaging

- Xrays: rickets, hypomineralization, or fractures

What lab values are you looking for?

- ⦿ Calcium: normal range—Ca: 8.4-10.4 mg/dL or iCa: 1.15-1.27 mmol/L
- ⦿ Phosphorus: > 4
- ⦿ Vitamin D (25OHD): 40-80 ng/mL
 - Insufficiency: < 20 ng/mL
 - Hypovitaminosis D: 20-30 ng/mL
 - Sufficiency: 30-100 ng/mL
 - Toxicity: >100 ng/mL
- ⦿ Alkaline Phosphatase: depends on your source
 - UNM: treat if > 500*
 - Of note: some centers treat if > 400, Primary Care of the Premature Infant by Brodsky and Ouellette recommend if > 800

Bone Mineralization: Vitamin D, Calcium and Phosphorus

- For exclusively breast fed VLBWs
 - Recommend measurement of alkaline phosphatase at 2-4 weeks post discharge
 - For levels > 800 IU/L, need close follow-up*
 - For levels > 1000 IU/L, consider supplementation*
 - Alternative: consider changing to some feeds with transitional formula
 - Maintain normal Ca and Phos
 - Supplementation with 2-3 feeds of a transitional formula will enhance mineral intake
 - Recommend following until at least 6 months CGA if normal
- *Of note: some centers treat if > 400, at UNM we use > 500 IU/L—above values from Primary Care of the Premature Infant by Brodsky and Ouellette

Synagis® (Palivizumab)

- In the 2nd year of life with ongoing CLD of prematurity as defined above, <32 weeks at birth, plus steroids, diuretic **OR** O₂ need during 6 months prior to RSV season
- 12 months or younger with hemodynamically significant heart disease
 - Infants with acyanotic heart disease receiving meds to control CHF that will require surgery
 - Infants with moderate to severe PHTN
 - Infants with cyanotic disease in consultation with cardiologist
- Repeat dose post cardiac bypass/after ECMO as concentration of Synagis reduces by >40%
- Children s/p cardiac transplant < 2 years old
- Prior Authorization form for New Mexico at http://docs.phs.org/idc/groups/public/documents/communication/pel_00179418.pdf