



Europaediatrics
Zagreb, Croatia
7 - 9 October **2021**

Round Table



European Society of
Paediatric and Neonatal
Intensive Care



European Confederation of
Primary Care Paediatricians
Confédération Européenne de
Pédiatrie Ambulatoire - C E P A

Sat 9th October 15:45-17:15

Congress Hall

*The follow up and care of
the complicated newborn in
the primary care setting*

SHIMON BARAK
PRIMARY CARE PEDIATRICIAN

5-18% of the babies born Worldwide (~15 million!) are treated in NICUs, (75%) due to prematurity.

Prematurity complications are the leading cause of death in children under the age of 5 years (~1 million).

75% of these deaths could be prevented with current, cost-effective interventions.

Treatment of these graduates requires coping with chronic morbidity & complications and fulfilling unique medical, developmental, nutritional & emotional needs that impose a great deal of physical-emotional-budgetary burden on parents, family, environment and medical/social services.

WHO ARE THOSE COMPLICATED NEWBORNS

**BORN
PREMATURELY
(bef. 38w)**

**LOW BIRTH
WEIGHT
(<2500grms)**

**ASPHYXIA
OR LOW
APGAR
SCORE**

**HAVING BEEN
IN NEED OF
MONITORING**

**HAVING HAD
NEONATAL
SURGERY**

**HAVING
CONGENITAL
DISEASES**

**SUSPECTED
SYNDROMATIC**

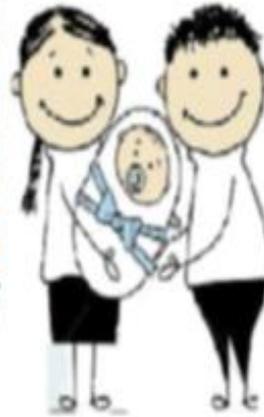
**HAVING
SUFFERED
FROM
INFECTIONS**

**NEEDING O2
OR
RESPIRATORY
SUPPORT**

**INAPPROPRIATE
BIRTH WEIGHT
(SGA; LGA)**



N.I.C.U.



FOLLOW UP
of
PHYSICAL
GROWTH



EYES

NEURO



When graduating from NICU, newborns & their parents begin a long journey where they'll be in need of professional advice & medical investigations that is both a challenge and a burden. To embark in this journey there are minimal requirements from all

LUNGS

BRAIN
US

HEARING
TESTS

N
U
T
R
I
T
I
O
N

THE BABY



- 36 weeks corrected age
- 2000 grams weight
- Keeps body temperature in open crib
- Eats (PO or PG) and gains 20-30g/d
- Medicines that do not need monitoring
- No change in O2/medicines lately

PARENTS

- Knowledgeable in the baby's needs
- Able & trained in feeding techniques
- Trained in deliverance of medicines
- Aware and capable of recognizing problems and emergencies
- Trained in First Aid and CPR





HEALTH CARE SYSTEM



- If medical equipment needed: it's in place, assembled, in working condition and parents know how to use it
- Safety car seat adapted/adjusted to size & parents know how to harness
- Critical follow ups either scheduled or performed
- Vaccinations done according to age including RSV palivizumab
- Baby's home has been examined and fits his/her requirements



- A program of parental support such as home health nurse visits has been ordered, especially to monitor weight gain
- Follow-up with a primary care physician (PCP) *scheduled*.
- Direct communication between discharging physician & PCP prior to discharge + discharge summary sent to PCP on the day of discharge.
- To avoid potential fragmentation of care, discharge on weekends, especially of infants with special needs, should be avoided.
- All follow-up appointments with specialists made prior to discharge

In the months to come the PCP will have to follow up (with the help of other health professionals) after many risk factors in the following fields



NUTRITION

MONITORING OF PHYSICAL GROWTH

NEURO-PSYCHOLOGICAL DEVELOPMENT

INTELLECTUAL PERFORMANCE & LEARNING

PHYSIOTHERAPY

PULMONARY FUNCTION & RESP. MORBIDITY

F/U OF OPHTHALMOLOGY MORBIDITY

HEARING

CONSIDERATIONS ON VACCINATION

In this presentation I will
limit myself to 4 fields:

HEARING

**CONSIDERATIONS ON
VACCINATION**

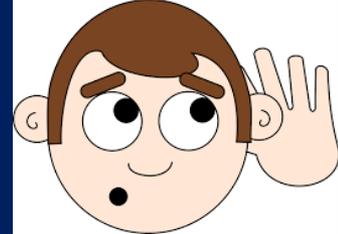
NUTRITION

**MONITORING OF PHYSICAL
GROWTH**



HEARING

WHO definition of hearing loss: <25 dB on the "good ear" in 500, 1000 & 2000 Hz frequencies



By these standards, 5% of premature babies born <32 W will be impaired by the age of 5y, mainly due to sensory-neural etiologies



Main risk factors: Infections (CMV, meningitis) brain tissue infarcts/hypoxia, ototoxic drugs and medicines



VACCINES

As a rule vaccinations are done according to chronological age, including influenza, except **HEPATITIS B**

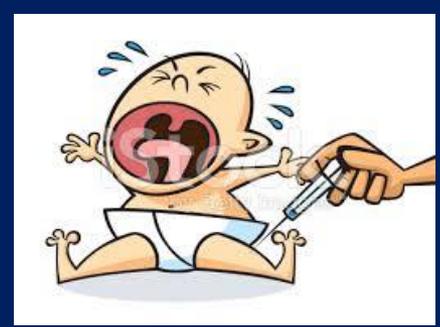


Since the efficacy of the vaccine is reduced when given to infants weighing less than 2000 grams, vaccination is usually postponed until this weight or the aged of one month except if the newborn's mother is a carrier (when he'll get passive + active vaccines but these will not be "counted" and he will get three doses as everybody else when arriving to 2 kgs/one month of age.





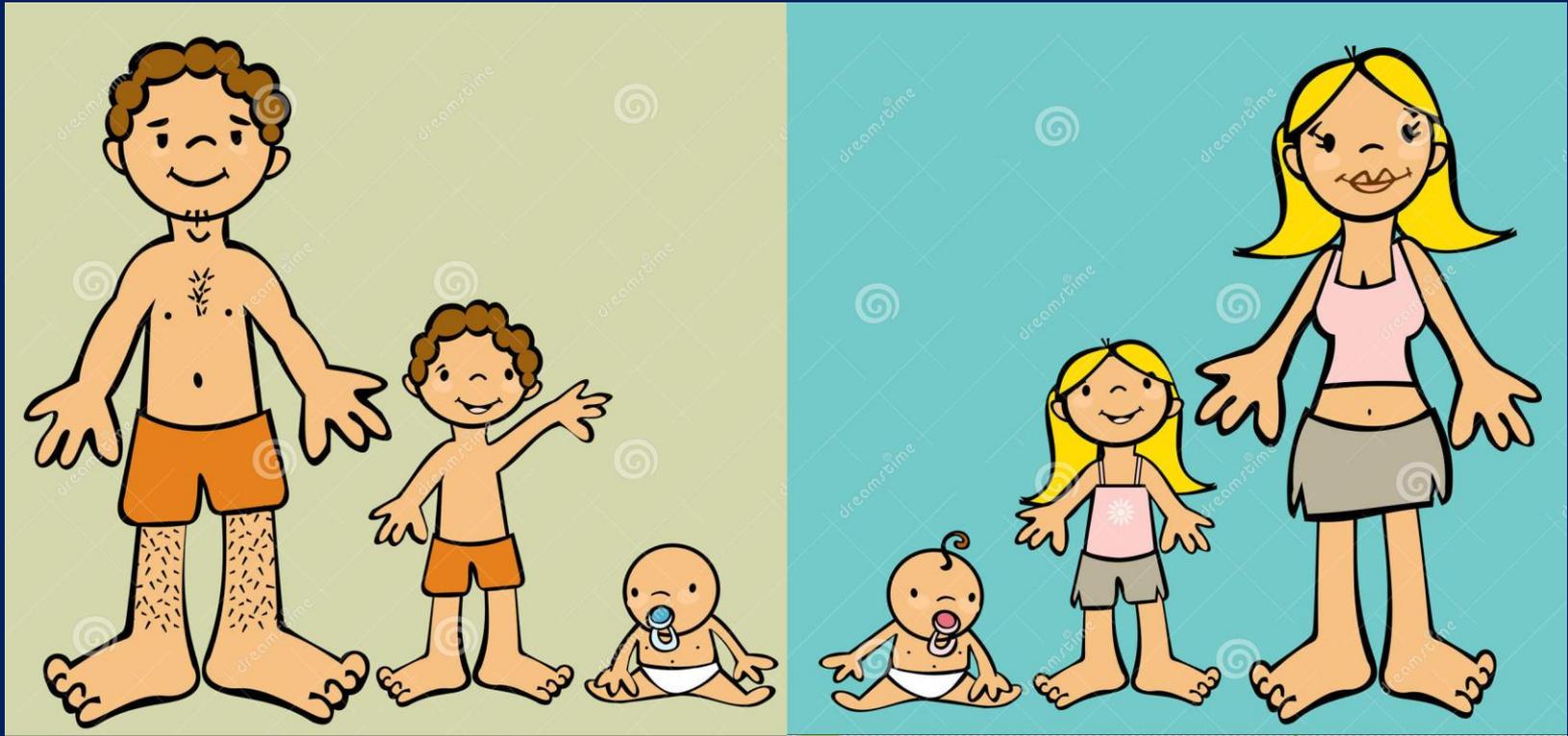
RSV PROPHYLAXIS (PALIVIZUMAB)



For prevention of serious RSV lower respiratory tract disease requiring hospitalization in children born at or less certain gestational age & aged 6 m or less at the RSV season or aged less than 2y requiring BPD treatment in last 6 m or having an hemodynamically significant Cong. Heart Disease. AAP recommends the vaccine to infants younger than 1y, born at <29 weeks or younger than one year, with BPD as well as older than 12m in need of O₂, bronchodilator/steroids.

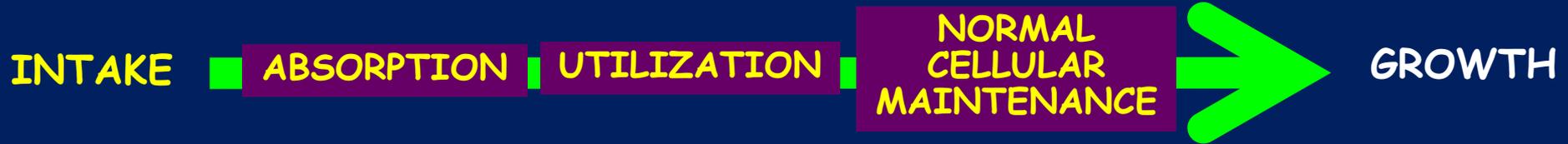
Additional RSV Prophylaxis Target Groups are:

- Less than 1y with neuromuscular disorders
- Younger than 2y who are immunocompromised.
- Down syndrome with risk factors (CHD, lung disease)
- Alaska Native and American Indian infants.



PHYSICAL GROWTH

GROWTH VELOCITY IS THE MOST SENSITIVE INDICATOR
OF A CHILD'S HEALTH



"LINEAR GROWTH" IS TO BE CONSIDERED AS A "LUXURY"

"WEIGHT GAIN" IS TO BE CONSIDERED AS A "NECESSITY"

AS WELL AS AN INDICATION
THAT THE BODY IS TRYING TO
FUNCTION "NORMALLY"

GROWTH ASSESSMENT

- Weight, length and head circumference should be plotted on appropriate growth chart corrected for gestational age at birth.
- PCP must be alert to signs of growth failure with particular emphasis on head growth as it is a predictor of future outcome.
- Certain conditions place infants at risk for *growth failure* and include:
 - Bronchopulmonary dysplasia
 - CNS injuries such as severe IVH
 - Asphyxia
 - Congenital heart disease
 - Short-gut syndrome
 - Esophageal/intestinal anomalies
 - Renal disease
 - Inborn errors of metabolism
 - Chromosomal and/or major malformation syndromes

ORIGINS OF GROWTH FAILURE MUST BE EXPLORED

- Failure to feed versus failure to thrive?
- Increased work of breathing?
- Choking/aspiration due to swallowing dysphagia?
 - Ask: "How long does it take for the child to take a bottle?"
 - If feedings routinely take > 20 minutes may need further evaluation for swallowing dysfunction
- Some infants have accelerating growth patterns after discharge and head growth commonly exceeds weight gain and linear growth. (Must still be alert to post-hemorrhagic hydrocephalus as a cause for excessive head growth after discharge)
- Catch-up growth may not be complete until 2.5 - 3 years of age.
- Some small for gestational age infants (SGA) may experience a rapid growth in body mass but a substantial number have little catch-up growth. (May require referral to a pediatric endocrinologist for recombinant growth hormone therapy)

GOAL: Obtain a "normal" growth rate & maintain normal "body composition"

Definition of Catch Up is arbitrary and based on growth acceleration and not on being on a certain percentile

In every meeting an accurate anamnesis that includes besides anthropometric measures & vital signs also a feeding diary, physical activities, bowel movements.

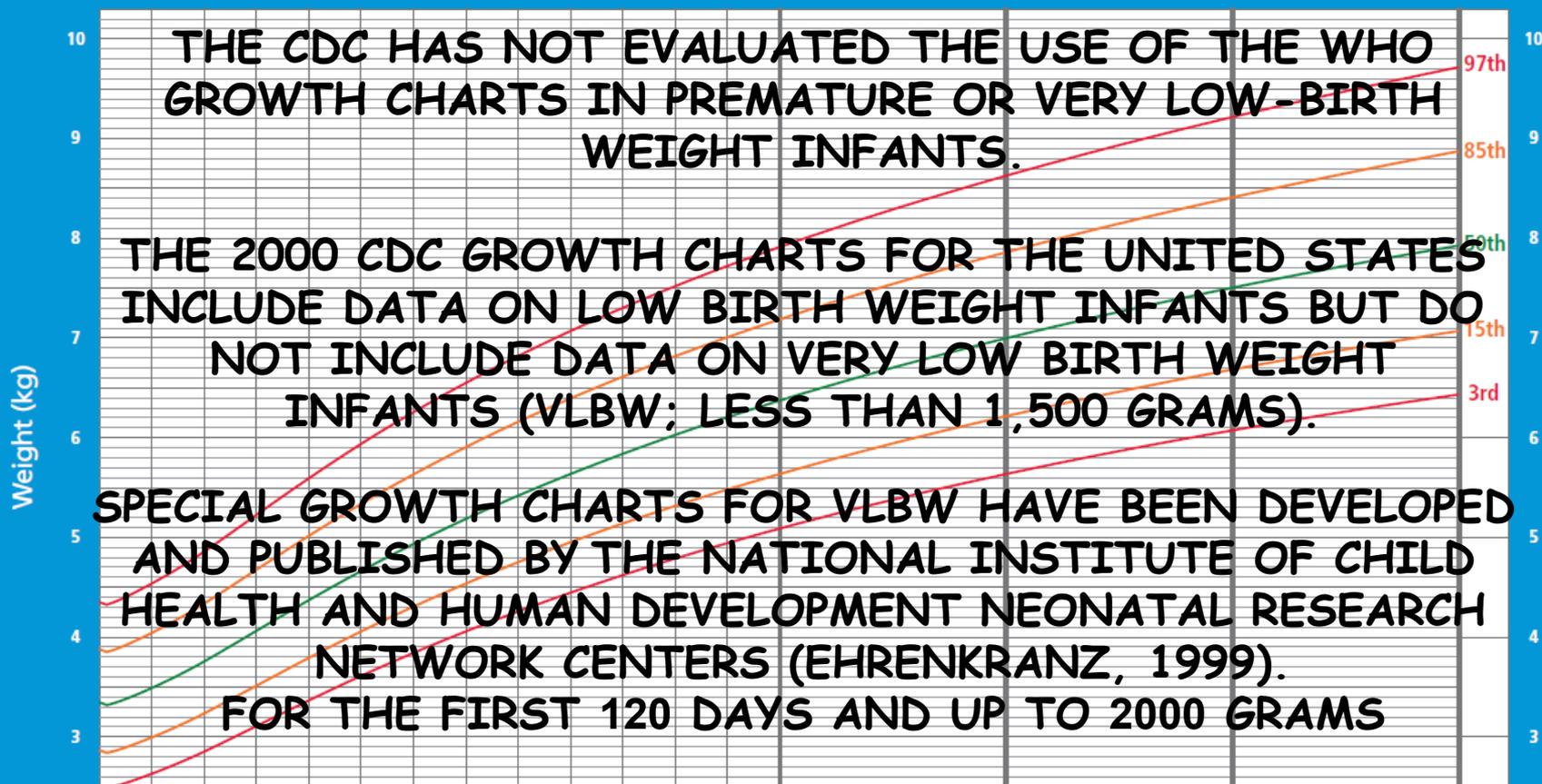
The health care personnel has to be familiar with the expected caloric expenditure in every age and step and trained to calculate fluid-calories-protein requirements, the expected weight gain and the normal boundaries of weight, height and head circumference.

All nutritional recommendations should be done according to the corrected age (iron, supplementary foods, milk, honey, etc.)

Weight-for-age BOYS



Birth to 6 months (percentiles)



Pediatrics 1999;104:280-289;

Longitudinal Growth of Hospitalized Very Low Birth Weight Infants

Richard A. Ehrenkranz, MD*; Naji Younes, PhD†; James A. Lemons, MD§; Avroy A. Fanaroff, MB, BCh||; Edward F. Donovan, MD¶; Linda L. Wright, MD#; Vasilis Katsikiotis, PhD‡; Jon E. Tyson, MD, MPH**;
William Oh, MD‡‡; Seetha Shankaran, MD§§; Charles R. Bauer, MD|||; Sheldon B. Korones, MD¶¶; Barbara J. Stoll, MD##; David K. Stevenson, MD***; and Lu-Ann Papile, MD†††

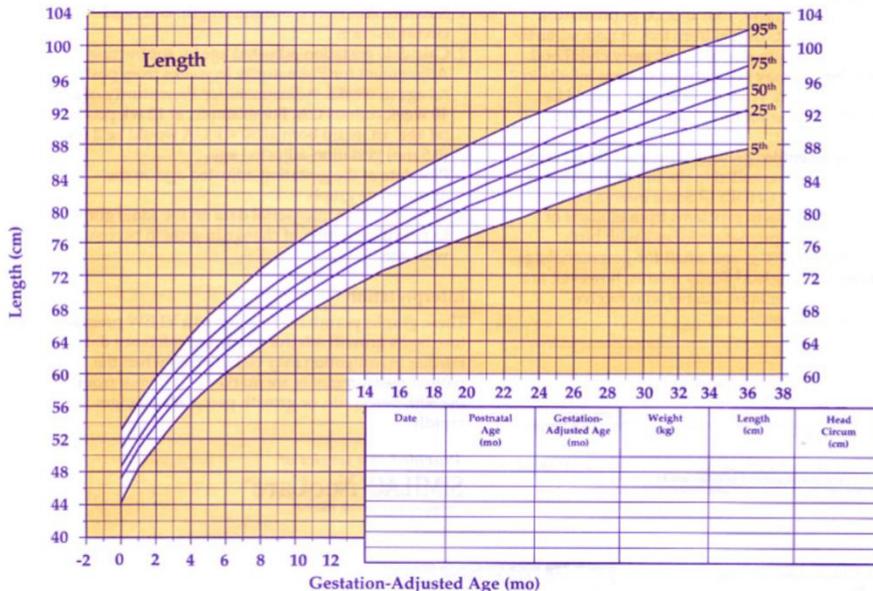
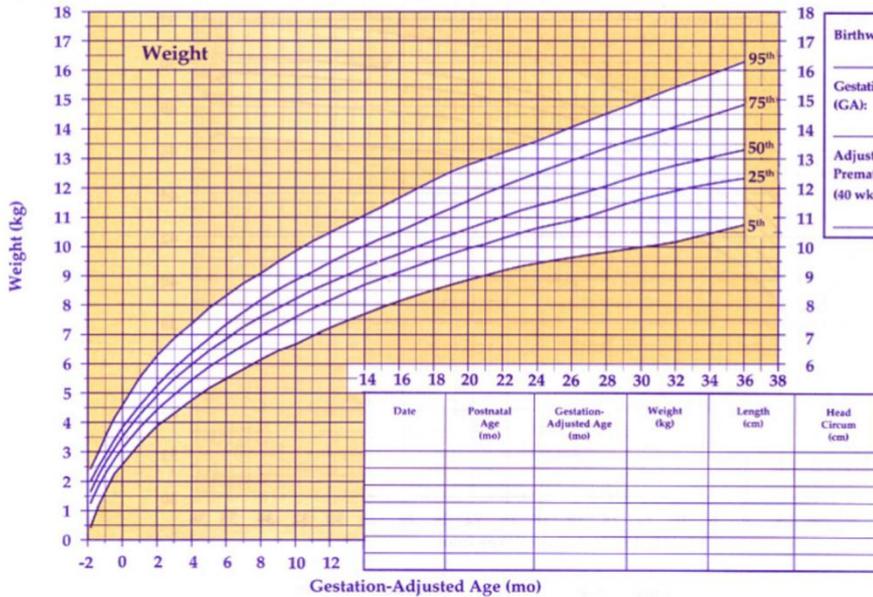
Weeks
Months

ards

**IHDP Growth Percentiles:
VLBW Premature Boys^{1,2}**
(≤ 1500 g BW, ≤ 37 wk GA)

Name _____
Record # _____

ROSS
PEDIATRICS



Birthweight (BW): _____ g
Gestational Age (GA): _____ wk
Adjustment for Prematurity (40 wk - GA): _____ wk

Special growth charts developed by **The Infant Health And Development Program (IHDP) Reference** (Guo, 1996; Guo, 1997; Roche, 1997) for growth up to 36 months postnatal.

CAVEAT:
Tables developed based on data gathered in 1985 (before "modern" nutritional guidelines)

Many syndromes and specific health situation have huge influence on growth and therefore special growth charts have been developed for children born with these conditions.

While offering accurate data, these charts were drawn on a limited number of subjects, sometimes not on a regular basis, some measurements were done not "by the book", and some of the children suffered from more than one medical problem (e.g. Down syndrome with and without Congenital Heart Disease).

TRISOMY 21 (DOWN SYNDROME) (CRONK, 1988)
PRADER-WILLI SYNDROME (HOLM, 1995)
WILLIAMS SYNDROME (MORRIS, 1988)
CORNELIA DELANGE SYNDROME (KLINE, 1993)
TURNER SYNDROME (RANKE, 1983; LYON, 1985)
RUBINSTEIN-TAYBI SYNDROME (REFERENCE)
MARFAN SYNDROME (PYERITZ, 1983; PYERTIZ, 1985)
ACHONDROPLASIA (HORTON, 1978)

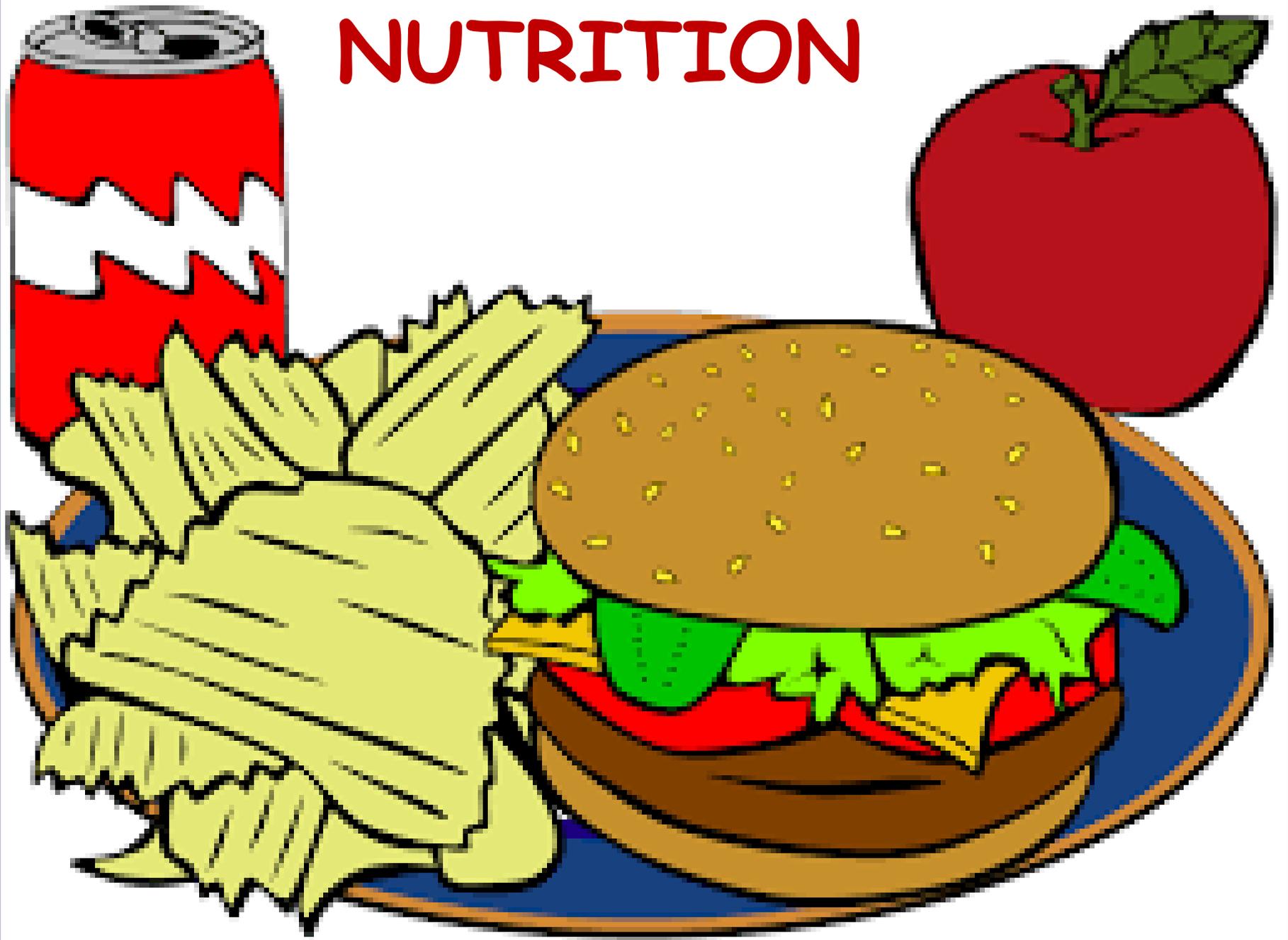


**The CDC Growth Charts for Children
with Special Health Care Needs**



<http://depts.washington.edu/growth/cshcn/text/page1a.htm>

NUTRITION

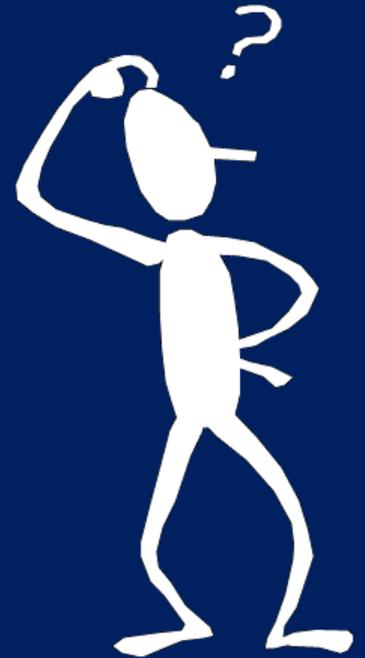


NUTRITION

THE UNDERLYING QUESTION...

"Do you want a smart, tall, fat adult who will die prematurely of cardiovascular disease or a dumb, short, thin adult who will outlive the other?"

Richard Schandler, MD
Neonatologist

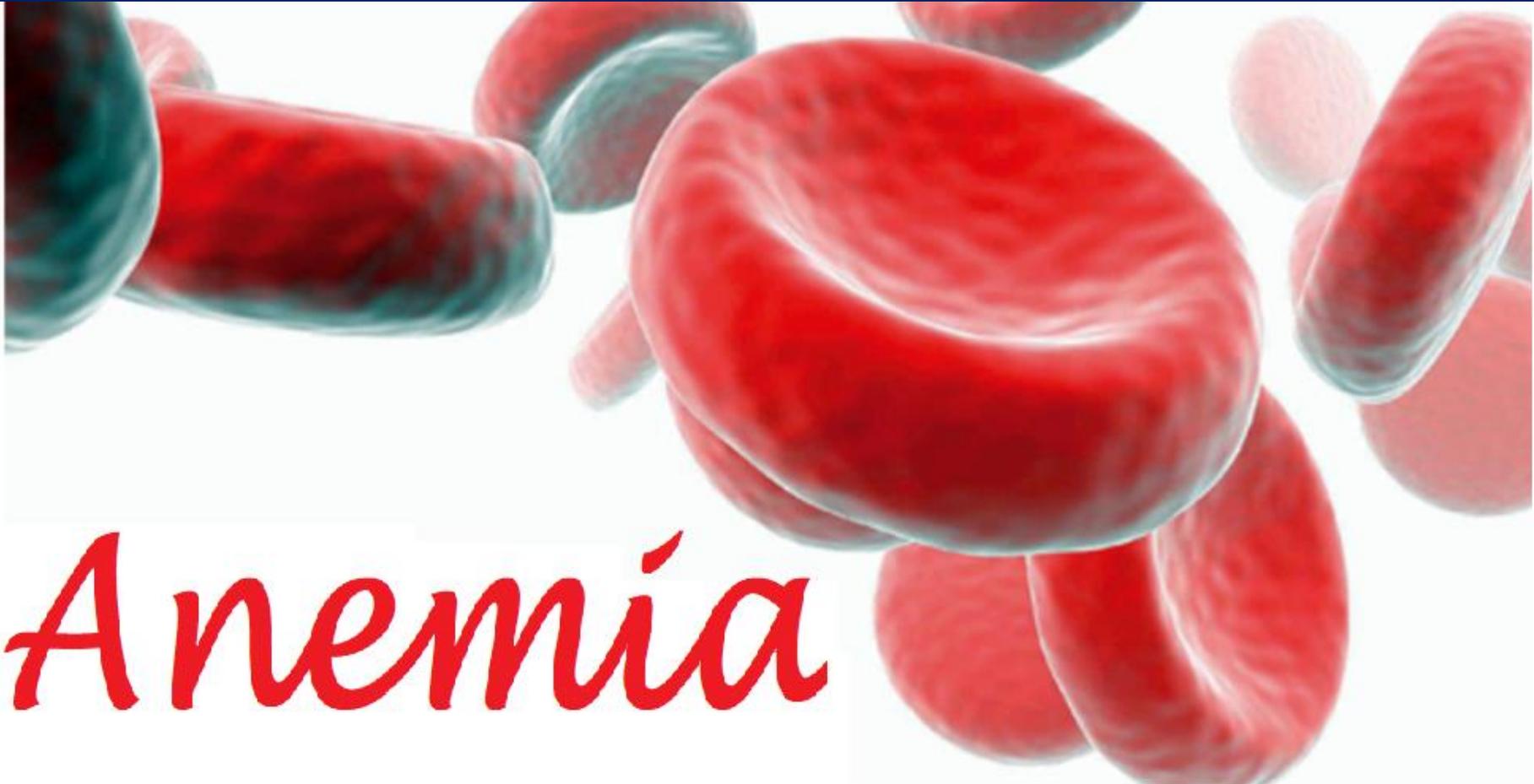


On discharge from NICU most premature babies are in a nutritional deficit status

- Most didn't have enough time to fill stores
- Most premature babies are in a catabolic state
- Preterm babies need more calories (e.g. to fight infections and due to increased respiratory effort and need also more protein, Ca, P, Fe, electrolytes, etc.

If this situation will not be corrected

- Impaired growth (lack of protein)
- Impaired development (related to physical growth!)
- Osteopenia
- Anemia
- Deficiency of trace elements and vitamins (Cu, Zn, Mg, I, Se, vitamins, etc.)

A 3D medical illustration of several red blood cells. The cells are depicted as biconcave discs, with a prominent central indentation. They are rendered in a vibrant red color with a slightly glossy, semi-transparent surface that shows internal structures like the cytoskeleton. The cells are scattered across the frame, with some in sharp focus and others blurred in the background, creating a sense of depth. The background is a plain, light color, making the red cells stand out.

Anemia

& other deficiencies

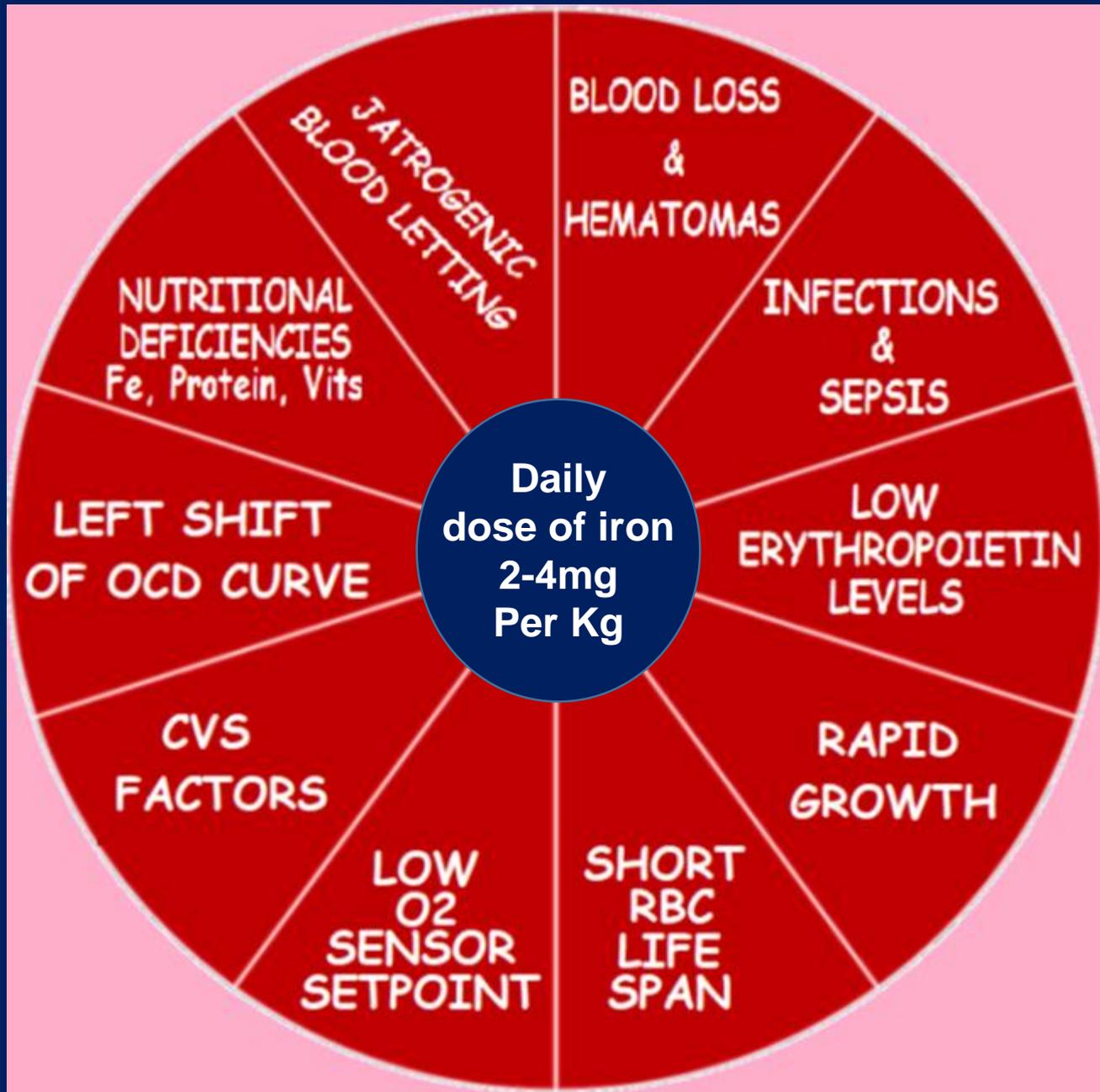


TABLE 3

Signs and Symptoms of Copper, Zinc and Vitamin D Deficiencies in Infants

<i>DEFICIENCY</i>	<i>REQUIREMENTS IN PRETERM INFANTS</i>	<i>REQUIREMENTS IN TERM INFANTS</i>	<i>TEST TO CONFIRM DEFICIENCY</i>	<i>SIGNS AND SYMPTOMS</i>
Copper	100 µg per kg per day	Up to 6 months: 0.4 to 0.6 mg daily 6 to 12 months: 0.6 to 0.7 mg daily 1 to 2 years: 0.7 to 1.0 mg daily	Serum copper, serum ceruloplasmin	Microcytic hypochromic anemia, neutropenia, depigmentation of skin and hair, skin lesions resembling seborrheic dermatitis, anorexia, diarrhea, psychomotor retardation, apneic spells, failure to thrive
Zinc	750 µg per kg per day	5 mg daily	Plasma zinc	Acrodermatitis enteropathica (dermatitis around body openings and on extremities), diarrhea, alopecia, failure to thrive, increased susceptibility to infection
Vitamin D	400 IU daily	400 IU daily	Serum vitamin D	Enlarged costochondral junctions (rachitic rosary), bowlegs and knock knees, failure to thrive, hypocalcemia, hypophosphatemia

Premie Grower: Nutritional Risks

- **Protein** => Intrauterine rate + deficit from transition
 - Target 4g/kg daily
 - Considerations: Unknown maternal milk composition & Renal status
- **Energy** => Intrauterine weight gain + deficit
 - Target 135 kcal/kg daily
 - Considerations: Fuel source & balance (CHO/Fat)
- **Iron** => Is anemia of prematurity pure iron deficiency?

Feeding Recommendations

Nutrient	Term Infant	Preterm Infant*
Energy	108 kcal/kg	105-130 kcal/kg
Protein	2.2 gm/kg	3.0-4.0 gm/kg
Vitamin A	600 mcg	210-450 mcg/kg
Vitamin D	25 mcg	3.75-10 mcg/kg
Vitamin E	3 mg	6-12 mg/kg
Calcium	67 mg/kg	120 –230 mg/kg
Phosphorus	50 mg/kg	60-140 mg/kg
Iron	1.0 mg/kg	2.0-3.0 mg/kg
Zinc	0.83 mg/kg	1 mg/kg

20 G/DAY FROM 0-3 MONTHS CORRECTED AGE

15 G/DAY FROM 3-6 MONTHS CORRECTED AGE

10 G/DAY FROM 6-9 MONTHS CORRECTED AGE

5 G/DAY FROM 9-12 MONTHS CORRECTED AGE



Breast milk is the best food for infants

Every effort should be made including pumps and consultants (LA LECHE)

Low caloric content - large volumes are needed

Low Ca and P concentration: might impair bone mineralization

Low Sodium: should be considered if the prem is on diuretics





ADVANTAGES

INSURES ENERGY, PROTEIN, MINERAL, VITAMIN
DELIVERY WHEN INTAKE VOLUME IS LOW

IMPROVES WEIGHT GAIN, HEAD GROWTH AND
MINERALIZATION

DISADVANTAGES

COMMITTS INFANT TO BOTTLE FEEDING
POTENTIALLY "JEOPARDIZES" BREASTFEEDING ENTIRELY
DILUTES POSITIVE FACTORS IN HUMAN MILK

HUMAN MILK: SELECTIVE SUPPLEMENTATION/FORTIFICATION

- Healthy LBW infants typically need no supplementation if mother's milk supply is adequate (>350 ml/day for 2kg infant at discharge)
 - More energy stores at birth
 - Less malabsorption
 - Less fluid overload issues
 - More complete Ca and Fe stores
- VLBW and ELBW will likely need fortification/supplementation
 - Larger accrued deficit (more need for catch-up)
 - Lower mineral and iron stores
 - More dysfunctional feeders (weaker, longer intubation ⇒ takes smaller volumes)
 - Eats to volume rather than to calories (early after discharge)
- Infants with BPD, short gut

PRETERM DISCHARGE FORMULA ADVANTAGES

- Represents hybrid/transitional formula assuming preterm infant is “turning into” term infant
- Acknowledges transition in intestinal physiology
- Energy delivery adjustable based on volume concerns
- Supplemental in nutrients likely to have large deficits
 - Energy, protein, Ca/P
- Better Phase 3 growth than term formula

PRETERM DISCHARGE FORMULA: CONCERNS

- Estimate most likely needs of discharged prematures
 - Wide variation in nutrient needs/deliverability in this population (e.g. Fe)
- Still undermined duration of use
 - Safety - nutrient overload
 - Efficacy - when is it just as good as term?
- Unknown long term growth and neurodevelopment effect - Does it make a difference?

WHAT TO FEED HEALTHY LBW INFANTS?

- Human milk whenever possible.
- Most likely to show catch-up without supplementation
- If not human milk, they can receive term formula
- Will need closer and earlier nutritional monitoring than term infants

WHAT TO FEED HEALTHY VLBW INFANTS?

- Human milk if they show
 - Steady growth, crossing percentiles (catch-up)
 - Adequate mineralization
 - Adequate iron status
- Supplement or fortify (premature formula rather than term formula) if
 - Growth is slow (< curve or no catch-up)
 - Persistent demineralization
 - ELBW or has BPD

SUPPLEMENTATION FORTIFICATION OF BREASTFED PREMATURES

Assuming fortification at end of hospitalization, continue fortifying (and bottle feeding the milk) or supplementing with premature discharge formula at least **2x/day**

Monitor growth, BUN, prealbumin to decide whether to increase or decrease frequency of dosing

Transfer to term formula should be considered after monitoring shows improvement in nutritional deficits (I.e. catch-up growth, mineralization

TRANSITIONAL (22-KCAL/OZ) INFANT FORMULAE

- Transitional infant formulas enriched in calories, protein, minerals, Fe, and vitamins have proved to improve infant head circumference growth, linear growth, weight gain, and IQ.
- The pioneer work of Alan Lucas has opened the way to most major manufacturers to develop transitional formulae.
- The recommendation is to continue transitional formulae until 9 months of chronological age

Nutritional Screening Assessment (4 to 6 weeks post Discharge)

Weight gain	< 25 g/day
Length growth	< 1 cm/wk
HC growth	< 0.5 cm/wk

HALL* & EHRENKRANZ**

Propose a 4-6 weeks post-discharge assessment, mostly for breastfed but also for high risk (e.g. ELBW, BPD) formula fed infants that reflects areas of highest risk: protein energy, bone mineralization, iron

* RT HALL: Nutritional follow-up of the breastfeeding premature infant after hospital discharge. *Pediatr Clin North Am.* 2001 Apr;48(2):453-60. Review.

** RA EHRENKRANZ: Nutrition, growth and clinical outcomes. *World Rev Nutr Diet.* 2014;110:11-26. doi: 10.1159/000358455. Epub 2014 Apr 11. Review.

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Weight gain	< 25 g/day
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HALL* & EHRENKRANZ**

Biochemical Test

Action Values

Phosphorus	< 4.5 mg/dL
Alkaline phosphatase	> 450 IU/L
BUN	< 5 mg/dL
Prealbumin	< 10 mg/dL
Retinol binding protein	< 2.5 mg/dL

IMPAIRED GROWTH

INADEQUATE CALORIC INTAKE

INADEQUATE ABSORPTION

INCREASED ENERGY REQUIREMENTS

DEFECTIVE UTILIZATION

INADEQUATE CALORIC INTAKE

PREPRANDIAL

Not getting the
right stuff

Not getting the
right quantity

PRANDIAL

Poor eating
habits

Mechanical
difficulties

POSTPRANDIAL

Food not reaching it's goal: G.E.R.,
Vomiting, regurgitation, rumination,
etc., etc.

PREPRANDIAL (intake is a problem)

- F/U with a pediatric dietitian and a specialized follow-up clinic for assessing and managing infants with difficult growth and nutritional problems.
- Observation by an occupational therapist trained to recognize feeding problems (should be part of the evaluation prior to discharge).
- If not:
 - Cineradiography of the suck and swallow mechanism may be indicated.
 - Tests to exclude gastroesophageal reflux may be needed.
 - Thickening of feeds may be helpful

PRANDIAL =GIT PROBLEMS IN PREMMIES

- **HIGH INCIDENCE OF GER**
 - Clinical manifestations include (besides regurgitation) apnea, aspirations, wheezing, worsening of pulmonary function.
 - Use of nasogastric tubes increases occurrence.
 - Use of theophylline lowers muscle tone of the lower esophageal sphincter and therefore increases occurrence.
 - Upright prandial and post prandial position do not help.
 - Prone position with 30 degree reclination for 2h post prandial might help. Therefore in spite the risk of SIDS it is worthwhile considering and recommended.
 - Frequent small meals are recommended.
 - Thickening of food helps clinically - does not change ph
 - Rx with H2 blockers (ranitidine 2-5 mg/kg BID), Cimetidine 2.5-5 mg QID and in some countries Prepulsid and Pramin (metoclopramide hydrochloride).
- **BABY COLIC**: kangaroo position helps and probably also probiotics
- **CONSTIPATION**: more common among premmies

INADEQUATE ABSORPTION

ANATOMIC

Gut surface ↓

HISTOLOGIC

Villous atrophy

"COFACTORS"

Rapid bowel transition

- Characteristics of stool passage and the composition of the stools may also be helpful in assessing the adequacy of nutritional intake.
- Be alert to signs of malabsorption: Presence of oily, mucoid, explosive or watery stools may indicate malabsorption.
- Referral to pediatric gastroenterology is indicated.

INCREASED ENERGY REQUIREMENTS DEFECTIVE UTILIZATION

HYPOXIA

HEART

LUNGS

BLOOD

**BUILDING UNNECESSARY
TISSUE**

Inborn Errors of Metabolism

NEED FOR EXTRA ENERGY

**e.g.
Fighting
Infection**

**Hypermetabolism
(Endocrine
abnormality?)**



