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Understanding Nutrient Deficiencies in Infants with Growth Challenges

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Disclosures

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- Honorarium provided by Nutricia

This does not pose a conflict of interest for this presentation

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Learning Objectives

- Identify common nutrient deficiencies in infants with growth challenges.
- Discuss the impact of these deficiencies on overall health and development.
- Explore strategies for early detection and intervention.
- Review case studies on infants with growth challenges requiring intervention.

Function of Nutrients in Infancy

- Support Overall Growth
- Motor Skills
- Cognitive Development and Function
- Immunity
- Metabolic Pathways

NIH Vitamin and Mineral Fact Sheets

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Common Deficiencies

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Calories | Fat | Iron | Vitamin D | Zinc

But we need to dig deeper…

What is truly important for infant growth & development ?

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Macronutrients

- Carbohydrates
- Protein
- Fat

Micronutrients

- Iron
- Vitamin D
- Vitamin A
- Copper
- Zinc
- Vitamin B12
- Folate
- Calcium
- Choline
- Iodine
- Carnitine

Electrolytes

- Sodium
- Potassium
- Magnesium
- Phosphorus
- Bicarbonate
- Chloride

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Nutrients for Brain Development

Brain Development: Glucose, protein, long-chain PUFAs, iron, zinc, vitamin B12, copper, choline, iodine, vitamin A, folate, carnitine

Neurotransmitter Function: Protein, iron, zinc, copper, choline

Georgieff, MK, et al. Nutritional Influences on Brain Development. Acta Paediatr. 2018;107(8): 1310–1321.

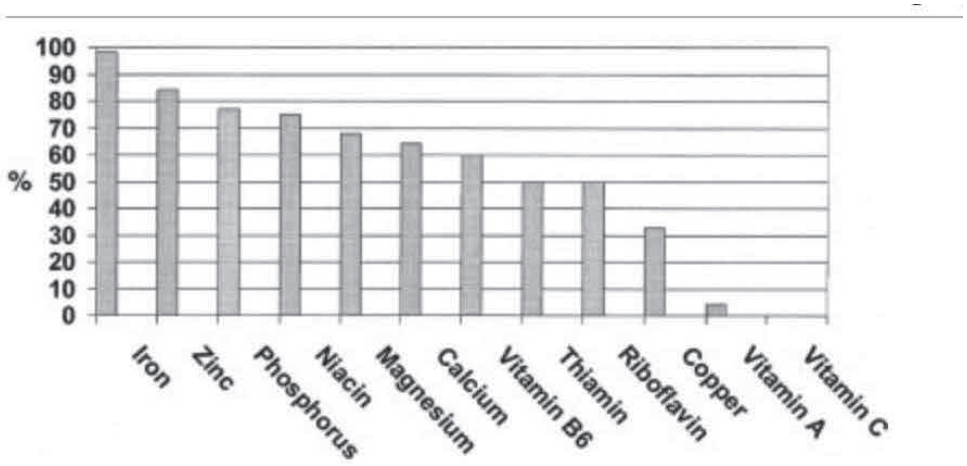
Nutrients for Motor Skills

Muscle development: protein, iron, zinc, vitamin D, calcium, vitamin C, carnitine

Nervous system: vitamin B12, vitamin A, vitamin C, choline, omega-3 fatty acids, folate, carnitine

Bone development: calcium, vitamin D, phosphorus, magnesium, zinc, vitamin C, protein

Role of Complementary Foods



Lutter, Chessa K, Rivera, Juan A. Nutritional Status of Infants and Young Children and Chacteristics of Their Diets. J of Nutrition. 2003;133(9):2941S-2949S.

Maternal Diet

Human milk relies on adequate maternal dietary intake of:

Vitamin A	B Vitamins	Vitamin D	DHA	Choline	Selenium	Iodine

Low breastmilk concentrations of thiamine, B6, B12 could contribute to growth stunting in the first year of life

Allen LH. Advances in Nutrition: An International Review Journal. 2012 May 1;3(3):362–9. .
Copp, K, et al. NCP. 2018;33(5):687-693.

Consequences of Deficiencies

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- Growth Retardation
- Bone Disease
- Short/Long-Term Neurodevelopmental Deficits
- Immune Dysfunction
- Developmental Delays
- Altered Energy Production
- Hematologic Abnormalities
- Decreased Quality of Life
- Increased Morbidity & Mortality

Namjoshi S, et al. *JPEN*, 2018.
Georgieff, MK, et al. Acta Paediatr. 2018;107(8): 1310–1321.

Who is at risk?

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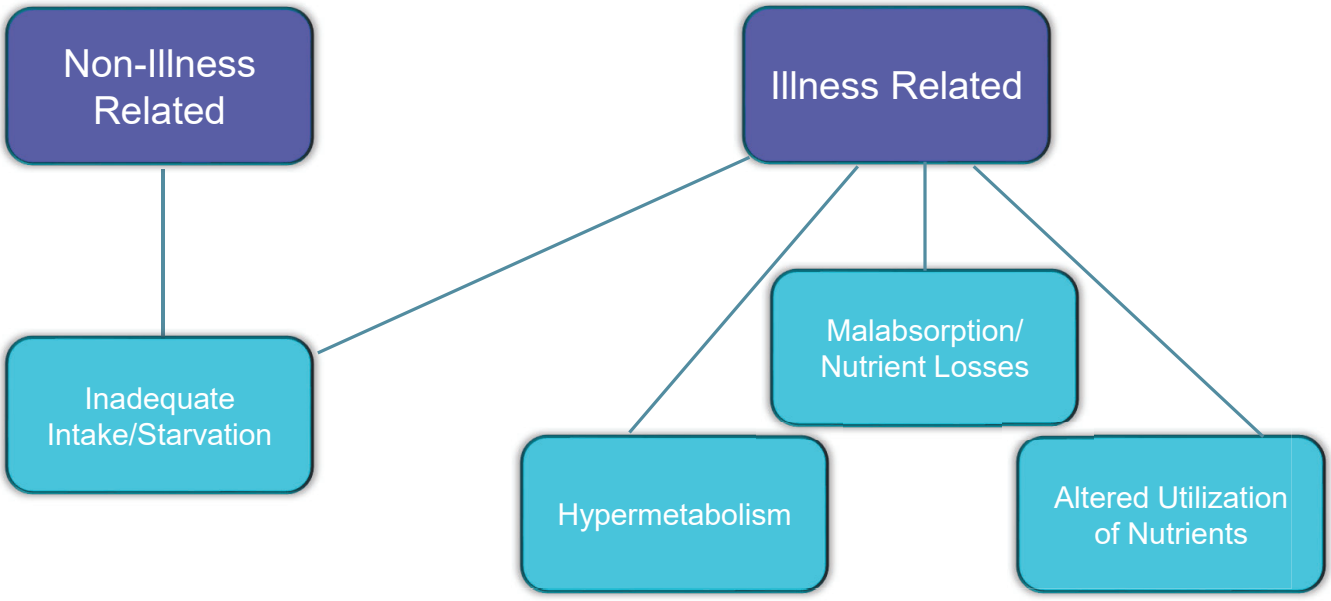
- Limited intake
- Periods of rapid or catch-up growth
- Altered GI anatomy
- Significant GI losses, malabsorption
- Chronic parenteral nutrition
- Conditions with low-energy needs
- Chronic wounds
- Losses via dialysis
- Meds that interfere with absorption/utilization
- Prematurity
- Maternal deficient diet

Namjoshi S, et al. *JPEN*, 2018.
Barberi J, Petrea Cober M. *NCP*. 2023.
Berger M, et al. Clinical Nutrition. 2022.
Corkins K. *NCP*. 2015.

How Deficiencies Might Present

- Altered growth
- Weight loss
- Lethargy, excessive sleeping for age
- Can't stay awake through a feeding
- Neurologic changes
- Unexplained fractures
- Laboratory changes
- Nausea/vomiting
- Physical findings

Etiology & Mechanism of Poor Growth



Mehta N, et al. JPEN. 2013;37(4):460-481.

Case Study #1

Inadequate Intake

Nutrition Assessment

10-month-old, full-term female admitted with possible jaundice, worsening ascites, hypoalbuminemia, concern for possible liver disease

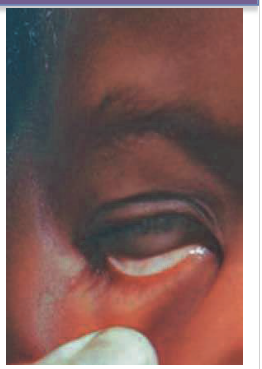
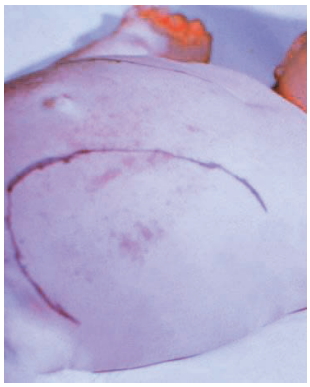
PMHx: uncomplicated birth now with 4 mo history of abdominal distention, ascites, B/L LE edema

Nutrition Evaluation:

- Baby breastfeeding around the clock, Q1-2 hrs
- Refusing any formula or bottle offered
- Minimal intake of solids – 1 tbsp daily of rice, fruit or vegetable; cookie/teething crackers; juice
- Overall, more lethargic, having difficulty sitting up - no longer babbling or making eye contact
- Mom concerned about breastmilk supply – has never pumped/seen lactation consultant
- Receive WIC benefits but poor follow-up due to transportation issues
- Food insecurity concerns

NFPE Findings

- Hair dull, thinning and easily pluckable
- General pallor (conjunctiva, skin, gums and tongue)
- Areas of purpura on belly, legs
- 2+ pitting edema
- Disengaged, poor muscle tone
- Regression of milestones


Images: CDC PHIL

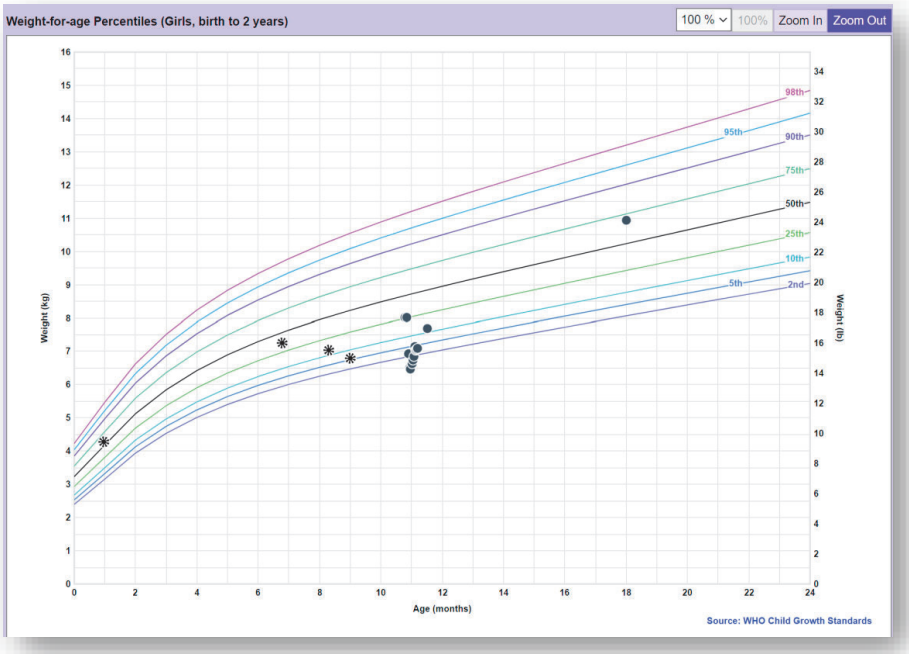
Lab Assessment

Lab Value	Upon Admission	Normal Reference Range
INR	1.7	0.9-1.1
PTT	15.6 seconds	10.1-13.4 seconds
Serum Vitamin B12	<60 pg/mL	299-1054 pg/mL
Methylmalonic Acid	1.93 umol/L	0.00-0.40 umol/L
Folate	5.3 ng/mL	>/=4.8 ng/mL
Hemoglobin	6.7 g/dL	10.2-12.7 g/dL
MCV	86.9 fL	71.3-82.6 fL
Serum Iron	29 mcg/dL	37-145 mcg/dL
Ferritin	11 ng/mL	13-150 ng/mL
Vitamin 25(OH)D	13.3 ng/mL	30-50 ng/mL
Plasma Zinc	39 mcg/dL	>70 mcg/dL
Alkaline Phosphatase	49 U/L	122-469 U/L
C-Reactive Protein	0.75 mg/L	0-10.0 mg/L
Albumin	2.4 g/dL	3.9-5.2 g/dL

Nutrition Plan

- PO: Initiate formula supplementation with standard infant formula, 20 kcal/oz, minimum volume goal per day
  - Age-appropriate solids
  - Feeding therapist support for bottle acceptance, advancement with solids
- Vitamin/Mineral Repletion:
  - Oral vitamin B12 125 mcg/d x 8 weeks (crushed with applesauce)
  - Daily peds MVI 1 mL/d
  - Ferrous sulfate drops 15 mg/d x 8 weeks
  - IV Vitamin K 2.5 mg x 2 doses to correct INR, as d/w MD
- Lactation consultant support for breastmilk supply/nursing
  - Reinforce with mom importance of maintaining her own nutrition
- Initiate social support
- PT/OT

Growth After Nutrition Plan Implemented



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Discharge Plan

- PO Standard Infant Formula, 20 kcal/oz PO ad lib
  - Continued WIC services – WIC to provide formula, complementary foods
  - Ongoing breastfeeding support for mom
  - Monitor need to increase kcal concentration of formula to support adequate growth
- Vitamin/Mineral supplementation & monitoring:
  - B12, iron + MVI daily
  - Recheck serum B12, iron panel, vitamin D in 8 weeks
  - Follow iron, vitamin D levels Q3 months with PMD
  - Once vitamin/mineral levels improved → maintenance dosing (peds liquid MVI with iron)
  - Ongoing vitamin K not needed based on labwork
- Social support with social work/multidisciplinary team
  - Transportation for appointments
- PT/OT/Speech & Feeding Therapy at home
- Close follow-up after discharge with Pediatrician/Nutrition

Case Study #2

Nutrient Losses

Nutrition Assessment

Pt admitted to NICU after birth for evaluation and management of respiratory distress syndrome, hydronephrosis and hydroureter

PMHx: Born at 35w0d via C-Section - prenatally diagnosed hydronephrosis. Birth wt 2390 g.

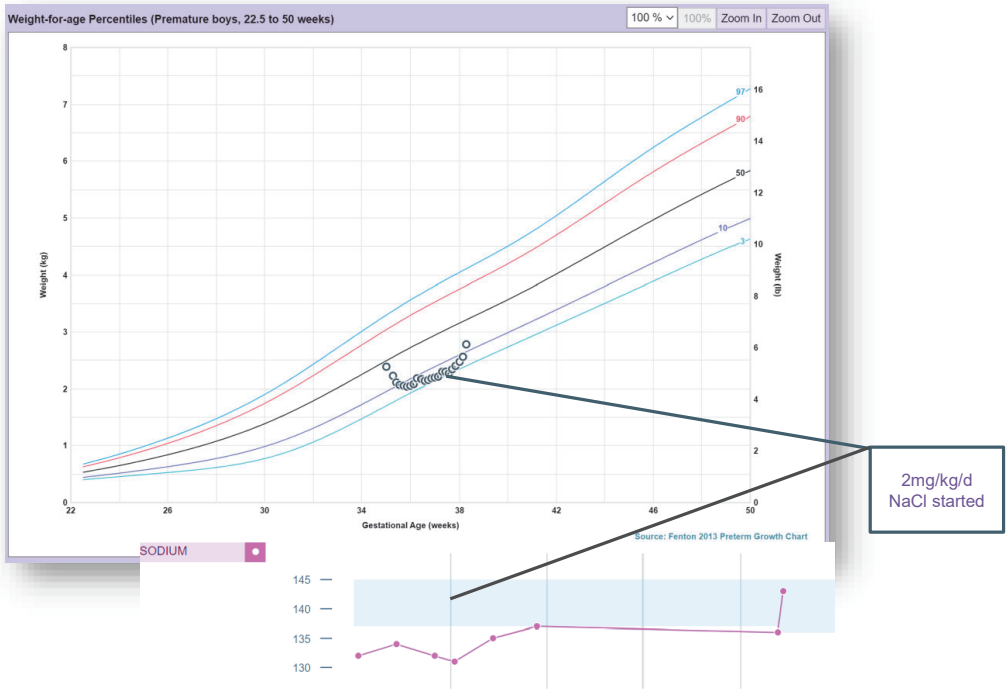
Nutrition Course:

- Received D10% IV fluids at 80mL/kg on day of life 0-1.
- Attempted PO ad lib feeds on DOL1 with poor intake → PO/NGT feeds started on DOL2 advancing to goal of 180 mL/kg/d
- By DOL7 lost 15% birth weight
- Poor growth overall despite >120 kcal/kg via PO/NG
- Ongoing hyponatremia

Nutrition Plan

- PO/NGT feeds with EBM/Standard Infant Formula – 20kcal/oz to provide 180 mL/kg/d
- 2mEq/kg/d NaCl supplements for hyponatremia and hx of poor growth
  - Weight adjust per lab trends and growth
- Monitor need to increase calorie concentration to EBM 22kcal/oz
- 400 IU/d vitamin D and iron 2mg/kg/d
- Continue to monitor weight gain / growth trends on Fenton curve

Growth Chart



Risk Factors for Hyponatremia

- Prematurity </= 28 weeks
- Birth weight <1000 g
- Short duration of parenteral nutrition
- Mothers Milk/Donor Milk
- Diuretics
- Respiratory Distress Syndrome
- Kidney disorders

Marin T, et al. Late Onset of Hyponatremia in Premature Infants. J Perinat Neonat Nurs. 2023;37(4):325-331.

Case Study #3

Malabsorption + Losses
+ Hypermetabolism

Nutrition Assessment

3-week-old female, ex 39-weeks referred to ER from PMD for FTT/weight loss.

Upon further imaging – pt dx'd with large choledochal cyst causing biliary obstruction, s/p PTC placement for external biliary drainage. Awaiting surgical intervention.

PMHx: prenatal diagnosis of mesenteric cyst

Nutrition Evaluation:

- Mom reports pt initially on standard infant formula, 20 kcal/oz for the first 3 days of life until her milk came in, since then breastfed ad lib q1.5-2 hrs
- 5-6 episodes of emesis/day
- Some improvement in emesis with smaller, more frequent feeds (Q1-1.5 hrs)
- Receiving vitamin D 400 IU/d
- Daily BM – loose, acholic stools
- Minimal weight gain since birth
- NFPE: minimal fat stores (cheeks, b/l upper and lower extremities), general pallor, jaundice

Nutrition Course

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ND tube placed for enteral feeds → High-MCT formula + EBM → Additional MCT Oil → >150 kcal/kg

⚠ Poor weight gain | Bile losses of 100 mL/d | Electrolyte derangements ⚠

>200 kcal/kg with high-MCT, elemental formula → Pancreatic Enzyme Replacement Therapy → Refeeding of bile → Aggressive electrolyte repletion

Nutrition Course

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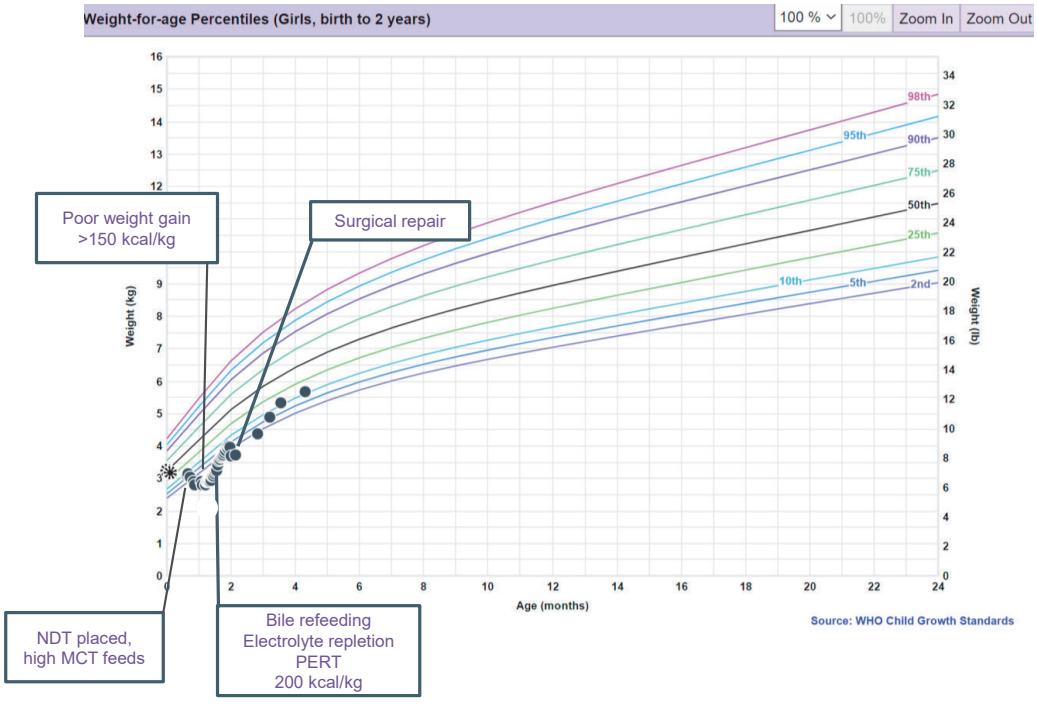

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Nutrition Plan

- PO + NG feeds with High-MCT formula at 30cal/oz + added table salt, daily goal at least 600mL/d
  - Daytime - PO/NG gavage 90mL QID with PO PERT
  - Overnight - NG 240mL with PERT cartridge @ 40mL/hr x 6 hours
  - MCT 2mL QID
  - *Total enteral provision provides 600mL (191mL/kg), 661kcal (210kcal/kg), 21g protein*
- Refeeding biliary drainage via NG - 7mL 6x/day and increase as tolerated
- Electrolyte adjustments via table salt, bicitra, fludrocortisone per MD
- Vitamin/Mineral Supplementation:
  - DEKAs 1mL daily
  - Vitamin D 2000 units/d
  - Thiamine 2 mg/kg x 7 days for concern for refeeding
- Daily weights, weekly MUAC
- Mom encouraged to keep pumping to resume EBM after surgery

Nutrition Plan

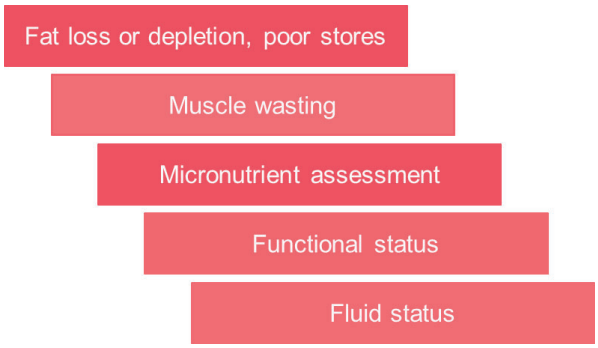
Post-operative Course:

- Continued 30 kcal/oz formula for catch-up growth
- Stopped MCT oil, PERT, DEKAs
- Continued vitamin D supplementation 2000 IU/d & close monitoring
  - Level WNL ~1 month after surgery

What to look for?

Nutrition-Focused Physical Exam

- Imperative in infants to identify & address malnutrition quickly
- Fat/muscle mass may be hard to differentiate – often evaluated together in infancy
- Developmental milestones & function
- May help identify micronutrient deficiencies otherwise missed
- Cluster care with nursing, caregivers



Developmental Milestones

Considerations:

- ☐ Significant delays?
- ☐ Regressions?
- ☐ Is progress limited by disease?
- ☐ Get PT/OT/ST involved early

Your baby at 6 months

Baby's Name | Baby's Age | Today's Date

Milestones matter! How your baby plays, learns, speaks, acts, and moves offers important clues about his or her development. Check the milestones your baby has reached by 6 months. Take this with you and talk with your baby's doctor at every well-child visit about the milestones your baby has reached and what to expect next.

What most babies do by this age:

Social/Emotional Milestones
- ☐ Knows familiar people
- ☐ Likes to look at himself in a mirror
- ☐ Laughs

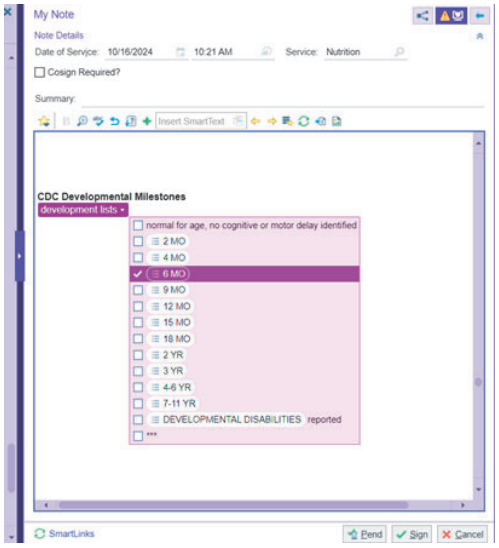
Language/Communication Milestones
- ☐ Takes turns making sounds with you
- ☐ Blows "raspberries" (sticks tongue out and blows)
- ☐ Makes squealing noises

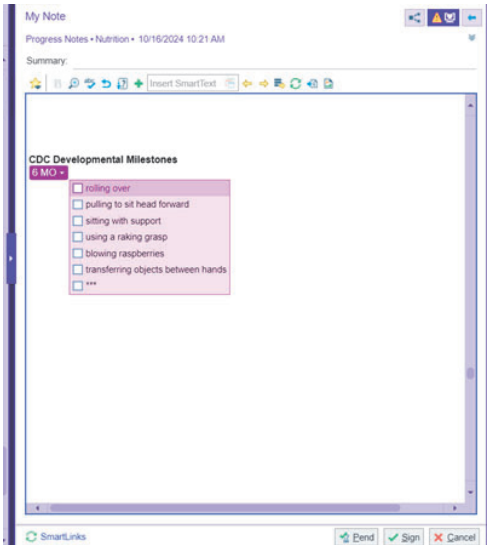
Cognitive Milestones (learning, thinking, problem-solving)
- ☐ Puts things in her mouth to explore them
- ☐ Reaches to grab a toy he wants
- ☐ Closes lips to show she doesn't want more food

Movement/Physical Development Milestones
- ☐ Rolls from tummy to back
- ☐ Pushes up with straight arms when on tummy
- ☐ Leans on hands to support himself when sitting

CDC Milestone Tracker - https://www.cdc.gov/ncbddd/actearly/milestones/index.html

Developmental Milestones





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Insensible Losses

Diuretics	B vitamins (B12, B6, thiamine, riboflavin), folate, calcium, magnesium, phosphorus, vitamin C
GI Losses/Diarrhea	Zinc, fat-soluble vitamins (A, D, E, K), B12, electrolytes, fluid
Chyle	Fat-soluble vitamins (A, D, E, K), copper, selenium, zinc, essential fatty acid deficiency (EFAD), protein
Protein-Losing Enteropathy	Protein, fat malabsorption/EFAD, fat-soluble vitamins, iron, folate, B12
ECMO	Vitamin A, E, calcium
Dialysis	Zinc, copper, iron, magnesium, water-soluble vitamins, carnitine, protein
CVVH	*Dialysis nutrients above* + focus on thiamine, B6, folic acid, vit C, selenium
Wound exudate	Vitamin C, vitamin A, zinc, protein
Biliary Drain/Diversion	Potassium, sodium, cholesterol, iron, calcium, zinc, magnesium, copper, selenium, thiamine, Vit A, D, E, essential fatty acids, bicarb, chloride

Early Detection

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- Accurate anthropometrics, growth trends
  - Frequent weights
  - Serial length/head circumference/MUAC
- Nutrition-focused physical exam
- Laboratory markers
  - Be mindful of blood draws
- Developmental assessments
- Insensible losses – from where & how much?
  - Partner with multidisciplinary team to treat & monitor
- Dig until you uncover true etiology

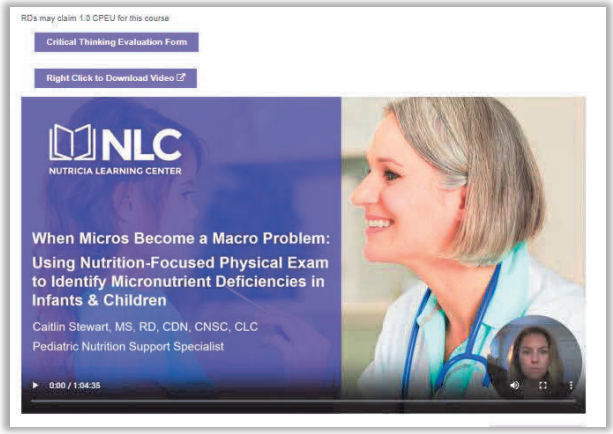
References

- Georgieff MK, et al. Nutritional Influences on Brain Development. Acta Paediatr. 2018;107(8): 1310–1321.
- Lutter, Chessa K, Rivera, Juan A. Nutritional Status of Infants and Young Children and Chacteristics of Their Diets. J of Nutrition. 2003;133(9):2941S-2949S. doi: 10.1093/jn/133.9.2941S.
- Allen LH. B vitamins in breast milk: relative importance of maternal status and intake, and effects on infant status and function. Advances in Nutrition: An International Review Journal. 2012 May 1;3(3):362–9. doi: 10.3945/an.111.001172.
- Copp K, et al. Nutrition support team (NST) guide to Maternal Diet for the Human Milk Fed Infant. NCP. 2018;33(5):687-693. doi: 10.1002/ncp.10071.
- Sharma NK, et al. Vitamin B12 deficiency in an infant with neurological and hematological findings: A case report. Clin Case Rep. 2023;11(8):e7770.
- Mehta N, et al. Defining Pediatric Malnutrition: A Paradigm Shift Toward Etiology- Related Definitions. JPEN. 2013;37(4):460-481.
- Marin T, et al. Late Onset of Hyponatremia in Premature Infants. J Perinat Neonat Nurs. 2023;37(4):325-331.
- Barbieri J, Petrea Cober M. Select micronutrients for preterm neonates. NCP. 2023;38(52):S66-S83.
- Berger M, et al. ESPEN micronutrient guideline. *Clinical Nutrition*. 2022;41(6):1357-1424.
- CDC Milestone Tracker - https://www.cdc.gov/ncbddd/actearly/milestones/index.html

Self-Study

If you want to learn more and earn additional 1.0 CPEU credit, complete the self-study module on NLC!

Scan here!



Thank you! Questions?

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