Micronutrient Deficiencies: Historical Oddity or Today’s Reality?

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Objectives

At the end of this session, attendees will be able to...
- State definitions of micronutrients (MN) & name/describe deficiency syndromes of 6 MN;
- Recognize presentations that suggest possibility of MN deficiency;
- Categorize signs/symptoms w/ MN deficiencies (Table)

Micronutrients

- Micronutrients are essential nutrients that are not used for energy, as are the macronutrients
- Vitamins ≠ minerals
  (So don't call Fe & Zn "vitamins"!)
- All have specific metabolic functions, but several overlap w/ each other;
  Deficiency signs often non-specific. 😞

~ Common MN Deficiencies

- Iron
- Zinc
- Vitamin D
- Fat soluble vitamins (A,D,E,K)
- Vitamin C
- Thiamine (B₁)
- Vitamin B₁₂
- (Vitamin A + Iodine - global)

Chapters on Micronutrients.....

Pediatric Nutrition Handbook
NUTRITION IN PEDIATRICS 4

are boring!!!!
When to consider MN deficiencies...

Know who’s at risk

Medical conditions that should prompt a full nutrition assessment (textbook):
- Ex-premature infant
- Ill newborn
- Critically ill patient
- Pt receiving home nutrition support
- Necrotizing enterocolitis
- Short bowel syndrome
- Inflammatory bowel disease
- GI pseudo-obstruction
- Chronic diarrhea
- Liver disease
- Organ or bone marrow transplantation
- Diabetes mellitus
- BPD
- Cancer
- Inborn errors
- Cystic fibrosis

Or….

When to consider MN deficiencies...

Know who’s at risk

- Restricted diet: ↓ variety, 1° inadequate / imbalanced food intake
- Increased requirements
  - physiologic (age, growth, prematurity)
  - metabolic stress (e.g. obesity, healing)
- Increased losses
  - malnutrition, malabsorption
- Unusual exam (or lab) findings

Nutrition Assessment:

Key Elements

GROWTH

AGE

DIET

P.E.

LABS

Nutrition Assessment

If diet & growth status are so important, why do we do such a lousy job with them? *

- Diet: “Appropriate for age”
  - Code for: “don’t know / didn’t ask / don’t care”
- Anthropometry
  - Not done (esp lengths / heights)
  - Not done in timely fashion (admit, repeats)
  - Not done accurately

“Good history and exam are the most important & cheapest things we can do for patients’ diagnosis & care.” (PL-2 to NFK!)

Diet: Minimum Info

- Infants:
  - Breastfed
  - Formula fed
    - Standard infant formula?
    - Non-standard – alternative or specialized?
- Older infant & Child:
  - Variety – all food groups? If not, which not?
  - Oral or GT? (ad lib vs Rx)
  - (More essential info dependent on situation & growth)

Iron & Zinc
Iron Deficiency

Who?
- LBW/premature
- BFI - ????
- Denver: 36% ID, 20% IDA (Krebs, 2006)
- NHANES 02: EBF vs EBF - anemia, ferritin
- Toddlers - (NHANES’02: 9.2% ID, 2.34% IDA; 20-25% in small series)

Why?
- Human milk low (always); infant endowment at birth critical
- Diets: low Fe fortified cereal, high cow milk, low meat

Iron Deficiency in 1-3 yr olds
(NYC, n = 504)

Toddlers – (NHANES’02: 9.2% ID, 2.34% IDA; 20-25% in small series)

Iron Deficiency: Consequences

Anemia = late effect
- rbc=priority tissue, so ID already in other tissues
- Poor predictor of ID (b/c ID less common now)

Iron deficiency w/o anemia
- Child development & behavior
- > 40 studies document effects on neurodevelopmental outcomes
- Motor & mental
- Developmental effects in early childhood likely irreversible

Behavioral Outcomes: Linear effects of iron status
(Lozoff, J Peds, 2008)

Orientation-engagement: + affect, energy, interest in test materials, exploration, social engagement; Shyness (l latency to become engaged w/ examiner) + scores = + hesitancy/wariness

Assessment of Iron Deficiency

Early:
- ↓ [Fe], ↓%sat’n
- ↓ Ferritin

Middle:
- ↑ TReceptors,
- ↑ TIBC, ↓ sat’n

Mod Late:
- ↓ ZPP, ↓MCV,
- ↓MCHC, ↑ RDW

Late:
- ↓ [Hb]

Anemia is late & severe Fe deficiency
Iron deficiency: ≥ abnormal lab indices

Comparison of Weaning Foods: Fe, Zn, Protein (per 100 kcal)
What Do 7-11 mo Infants in the U.S. Eat? (% of infants eating ≥ 1x/d)

- 20-26% breastfed
- Protein foods: mixed dishes (starch + prot) more common than plain meats (↓↓ Zn & Fe)
- Poultry > beef, pork
- Desserts & candy:
  - 40% at 7-8 mo
  - 54% at 9-11 mo

[Fox et al, JADA, '04]

Zinc Deficiency

- Who?
  - LBW/premature
  - BFI - ??? (Denver: 36% low plasma Zn)
- Why?
  - Human milk low by ~ 6 mo;
  - Diets: Fe fortified cereal ± Zn, low meat

Sources of Fe Intake among BFI

At 6 mo of age, U.S. breastfed infants, 58% of mixed fed (BF/FF) & 70% of EBF had

- < 2 svg infant cereal, meat or formula combined and
- No oral Fe supplements ≥ 3d/wk

[Dee DL, Pediatrics, 2008(supp)]

Which Infant is Zinc Deficient?

- 7 mo EBF, severe Zn deficiency, mammary gland defect in Zn secretion
- 7 mo EBF, poor intake, poor growth, mild-mod Zn deficiency

Effects of Zinc Deficiency

- Mild:
  - Growth faltering (linear & ponderal)
  - Loss of appetite
  - Impaired neurocognitive development
  - Impaired immune function
  - [normal serum Zn]
- Moderate to severe
  - All of the above + low serum Zn, dermatitis, diarrhea, ↓ hedonic tone
5 mo presented with h/o diarrhea, growth failure, rash

Severe Zn Deficiency
(acquired Acrodermatitis Enteropathica)

12 mo old infant, slow growth
- Healthy except slow growth
- Breastfed, no formula
- Complementary foods started at 6 mo
  - “Purees” + finger foods
  - Not interested in eating
- Normal exam
- Impression?

NFK Approach
- Check Fe, start Zn
  - Iron panel (TIBC, % saturation, Fe), ferritin, ESR/CRP, CBC** (≥ 2 abnl = ID)
  - Zn: 1 mg/kg/day, liquid suspension (Rx)
    (give at mid-day, ideally apart from food)**
  - Encourage meat!
  - ** Rx Fe deficiency: 2-6 mg Fe/kg/d ÷ BID (a.m. & p.m.) [OTC drops]

Vitamins
- Vitamin D - AAP recommends...
  - ALL breastfed infants, 400 IU/d, starting w/in first few days of life (until 1 L/day formula)
  - Highest risk:
    - Maternal deficiency
    - Darkly pigmented skin
    - Those who avoid sunlight/use sunscreen
    - (30 min/wk in diaper, 2 hr/wk clothed w/o hat)
    - Fat malabsorption
    - Obese children
  - Assess: Ca, P, Alk Phos; 25-OH-Vit D levels, ± PTH; exam, X-ray

7 mo female infant, “FTT” & developmental delays
- Diet: EBF; minimal solids. Mom + prenatal vitamins, no diet restrictions
- Birth Hx: Born at term, no neonatal complications.
- Hosp & Surg: Ladd’s procedure for malrotation at 4 mo (; no resection!!)
- Development: Initially met developmental milestones, but at ~ 4-5 mo, began to gradually lose milestones. At time of admission, unable to hold head up, not pushing up with arms in prone position; not rolling over.
- Medications: None; Supplements: None; SHx: non-contrib
- Anthrop: Length-for-age: < 5th%. Weight for age: < 5th %
- Exam: (positive findings only)
- General: Well developed infant, alert but fussy
- Skin: Diffuse erythematous rash on extremities (worse on legs) and diaper area; no bruises..
- Neuro: Alert; responsive to parents’ voices; hypotonic, very poor head control; areflexic; nearly constant tremors of tongue, extremities; trembling could be stopped with pressure (therefore, motor activity not consistent with seizures).
- Labs: Normal lytes, BUN & creat, LFT’s; CBC: Hb/Hct=9.5/29%; MCV 110 (↑); Stool exam: (+) for fat malabsorption
C.S. – 4 mo

- Normal development x 4 mo
- Growth faltering
- Progressive developmental delays (ie, loss of milestones)

C.S. – 7 mo, admitted for “Failure to Thrive”

- No head control, no reflexes, near constant tremors tongue & extremities

C.S. – at 2 yr

- Nearly normal neuro status

Vitamin B12 Deficiency
(maternal Graves Disease, IF-Ab & mat. B12 Def)

Zn Deficiency (other?)

9 yr old boy w/ autism, refusing to walk

- Presumptive diagnosis of Henoch-Schönlein Purpura (HSP);
- CC: acute refusal to walk, swollen knees and rash.
- Diet hx on admission: “normal for age.”
- Physical exam: agitated, uncooperative, appeared well nourished. Skin: Non-palpable purpuric lesions on feet and ankles, with extension up to knees; no petechiae; no lesions on buttocks. HEENT: no bleeding gums or oral lesions; no epistaxis. Abdomen: non-tender & without organomegaly. Extremities: 2+ pitting edema in feet and ankles, with extension up to knees. Rectal stool hem (-);
- Neuro: grossly intact but difficult to perform due to poor cooperation.
- Labs: CBC sl ↓ Hb/Hct, normal MCV; nl platelet count; ESR 15; urinalysis: negative. PT: prolonged at 15; BUN & creat normal
- On admission given Vit K for ↑ PT

9 y.o. w/ Autism

Additional Diet Hx:
- 1 food x mos;
- Current: soft pretzel + cheese
- No MVI
- No liquid supp or juice

Dx: Scurvy

(NEJM 2007)
**Scurvy (x several!)**

- 9 yr boy, rash, gingival hypertrophy (NEJM 2007)
- 5 yr boy, w/ worsening limp, refusal to eat, bleeding gums (Contemp Peds ‘07)
- 6 yr boy, ate only burgers + buns, milk, limp (What’s missing?)
- 9 yr boy, sudden onset unable to walk, bruises, very restricted diet (TCH 2005)

- Risk fx: very limited diets (no F/V)
- Get a Hx, make Dx, be a star!

**Adolescents s/p Bariatric Surgery (± Rapid Weight Loss)**

- CC: 2 wk h/o pain and weakness in legs, unsteady gait, falling down, foot dragging
- Physical exam:
  - No skin or mouth findings
  - Pt can’t look from left to right w/o turning head
- Evaluations: neurologic, rheumatologic, genetic, metabolic
- Dx: Beriberi - peripheral neuropathy, symmetrical, esp LE

**Infantile beriberi**

- 9 infants p/w:
  - Infection
  - Vomiting
  - Lethargy/restlessness
  - Ophthalmoplegia
  - ↓ thiamine pyrophos, acidosis
- Prompt response to high dose (50 mg/d x 2 wk)
- Infant formula w/o thiamine

**Micronutrient Deficiencies: When to Consider**

- Primary inadequate / imbalanced / limited diet (e.g., 1 food!)
- Increased requirements
  - physiologic (age, prematurity)
  - metabolic stress (obesity, healing, ↓↓ wt)
- Increased losses
  - mal-digestion (CF), malabsorption (celiac,CF, SBS)
- Unusual exam &/or lab findings

**Summary Checklist of MN Signs of Deficiency**

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