Vitamin Deficiencies: Common Nutrient Deficiencies in Practice

George Edward Guthrie, MD, MPH, CDE, FAAFP, FACLM

ACTIVITY DISCLAIMER

The material presented here is being made available by the American Academy of Family Physicians for educational purposes only. Please note that medical information is constantly changing; the information contained in this activity was accurate at the time of publication. This material is not intended to represent the only, nor necessarily best, methods or procedures appropriate for the medical situations discussed. Rather, it is intended to present an approach, view, statement, or opinion of the faculty, which may be helpful to others who face similar situations.

The AAFP disclaims any and all liability for injury or other damages resulting to any individual using this material and for all claims that might arise out of the use of the techniques demonstrated therein by such individuals, whether these claims shall be asserted by a physician or any other person. Physicians may care to check specific details such as drug doses and contraindications, etc., in standard sources prior to clinical application. This material might contain recommendations/guidelines developed by other organizations. Please note that although these guidelines might be included, this does not necessarily imply the endorsement by the AAFP.
DISCLOSURE

It is the policy of the AAFP that all individuals in a position to control content disclose any relationships with commercial interests upon nomination/invitation of participation. Disclosure documents are reviewed for potential conflict of interest (COI), and if identified, conflicts are resolved prior to confirmation of participation. Only those participants who had no conflict of interest or who agreed to an identified resolution process prior to their participation were involved in this CME activity.

All individuals in a position to control content for this session have indicated they have no relevant financial relationships to disclose.

The content of my material/presentation in this CME activity will not include discussion of unapproved or investigational uses of products or devices.

George Edward Guthrie, MD, MPH, CDE, FAAFP, FACLM

Assistant Director, Florida Hospital Family Practice Residency, Winter Park

Dr. Guthrie graduated from medical school at Loma Linda University, California, in 1981. He completed his family medicine residency at Hinsdale Hospital, Illinois. Following residency, he practiced in Guam for seven years, where he was chiefly responsible for starting a new AAFP chapter. Due to his interest in the lifestyle treatment of chronic disease, particularly diabetes, he returned to Loma Linda University to earn his Master of Public Health (MPH) degree, with an emphasis on nutrition. He proceeded to teach at Loma Linda University School of Medicine and in the nutrition department of the Loma Linda University School of Public Health. Later, he provided outpatient services in a rural clinic in northern California for seven years and then spent nearly five years as the medical and program director of the Lifestyle Center of America near Ardmore, Oklahoma.

For the past 12-plus years, Dr. Guthrie has taught in the family medicine residency program at Florida Hospital, Winter Park. He has helped pilot and/or develop several patient-focused lifestyle change programs, including the Complete Health Improvement Project, CREATION Health, and the Wellspring Diabetes Program. Most recently, he completed a term as president of the American College of Lifestyle Medicine (ACLM), a rapidly growing professional organization for caregivers focused on non-drug therapy for chronic lifestyle-related disease.
Learning Objectives

1. Identify patients at risk of vitamin deficiency (e.g. D, B12), or at risk for potential vitamin-drug interactions.

2. Counsel patients regarding the efficacy and appropriate use of vitamin supplementation.

3. Establish protocols to evaluate and monitor vitamin and nutritional needs of hospitalized and long-term care patients.

Audience Engagement System

Step 1

Step 2

Step 3
Addressing nutrition in practice.

“Farmacy”

Poll Question 1

According to the NHANES, which is the most common nutritional deficiency in the country today?

A. Potassium  
B. Magnesium  
C. Zinc  
D. Vitamin D  
E. Vitamin B-12  
F. Fiber
Common Nutrient Deficiencies

• Potassium – 98%
• Magnesium – Gen Pop 48% -- Older 83% Older AA 90.6%
• Zinc
• Vitamin D
• Vitamin B-12
• Fiber – 95%

Potassium deficiency

• Causes
  • Low serum levels -- Medications or endocrine/adrenal
  • Chronic low intake
• Chronic deficiency – 98% do not get the RDA
  • HTN
Poll Question 2

Which of the foods listed below has the greatest amount of potassium per serving? (USDA Nutrient Database)

A. White Beans - 1 cup
B. Sun Dried Tomato – 1 cup
C. Russet Potato - 3 to 4-1/4”
D. Raisins packed– 1 cup
E. Banana mashed– 1 cup

Which of the foods listed below has the greatest amount of potassium per serving? (USDA Nutrient Database)
https://ndb.nal.usda.gov/ndb/search/list?home=true

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving</th>
<th>Mg of Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Beans</td>
<td>1 cup</td>
<td>3315 mg</td>
</tr>
<tr>
<td>Sun Dried Tomato</td>
<td>1 cup</td>
<td>1839 mg</td>
</tr>
<tr>
<td>Russet Potato</td>
<td>3 to 4-1/4” diameter</td>
<td>1644 mg</td>
</tr>
<tr>
<td>Raisins</td>
<td>1 cup</td>
<td>1361 mg</td>
</tr>
<tr>
<td>Banana</td>
<td>1 cup mashed</td>
<td>806 mg</td>
</tr>
</tbody>
</table>
Magnesium

- 4th most common mineral in the body
- EAR (estimated average requirement) 50% of adults deficient
- Subclinical deficiencies in “normal range” – Serum plus urine secretion
- Animal, epidemiologic, and clinical studies indicate: pathologic role for magnesium deficiency:
  - electrolyte, neurologic, musculoskeletal, and inflammatory disorders;
  - osteoporosis, hypertension, cardiovascular diseases;
  - metabolic syndrome; and diabetes.


Poll Question 3

Which of the foods listed below has the greatest amount of magnesium per serving? (USDA Nutrient Database)

A. Pumpkin/squash seeds - 1 cup
B. Spinach – 1 Cup
C. Wild Coho Salmon – 3 ounces
D. New Zealand lamb – 1 ounce
E. Oatmeal cookie 1 ounce
F. Wheat Bread – 1 slice
Magnesium: USDA Nutrient Database

- **EAR (Estimated Average Requirement)**
  - Adult male > 18 330-350 mg/day
  - Adult female >18 255-265 mg/day

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving Size</th>
<th>Magnesium in mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumpkin/Squash seeds roasted and salted</td>
<td>1 cup</td>
<td>649</td>
</tr>
<tr>
<td>Spinach</td>
<td>1 Cup</td>
<td>131</td>
</tr>
<tr>
<td>Wild Coho Salmon</td>
<td>3 ounces</td>
<td>32</td>
</tr>
<tr>
<td>New Zealand Lamp</td>
<td>1 ounce</td>
<td>5</td>
</tr>
<tr>
<td>Oatmeal Cookie</td>
<td>1 ounce</td>
<td>5</td>
</tr>
<tr>
<td>Wheat Bread</td>
<td>1 slice</td>
<td>12</td>
</tr>
</tbody>
</table>

Case Study

- 64 y/o AA with obesity, DM2, hyperlipidemia, HTN, menopause, mild neuropathy
- OBTW: Hair loss noted for 3-4 years – breaking off at ¾” – some scalp pruritis rx with coconut oil. Recently worse spreading posteriorly. Braiding hair to cover thinning on top
- Meds, Pravastatin, Amlodipine, Glimepiride, not tolerate Metformin (Diarrhea), topical estrogen
- FH: no male pattern baldness
- EXAM: scalp normal skin. Diffuse thinning top and few short hairs. Pull test without exclamation point strands
• Potential Causes: Major Illness, iron deficiency, hypothyroid, heavy metal toxicity, female pattern baldness, Central Centrifugal Citcatrical alopecia

• Labs:
  • A1C 6.7%
  • HBG 11.4 g/dl
  • TSH 1.09 mIU/L
  • Vit B-12 1428 pg/ml
  • MMA < 50nmol/L
  • Arsenic, Lead, Mercury - low

Zinc

• Nearly 100 different enzymes in all 6 classes
• Some gene regulation (Ex: metallothionein)
• Small bowel absorption – albumin bound
• Coarse control – absorption
• Fine control – endogenous release
• 10-15 μmol/l serum – 0.1% of total
Zinc

• Excretion - Mostly stool, 10% urine
• Low:
  • Impaired growth velocity
  • Pregnancy outcome – (prematurity with < 6mg/dy)
  • Immune system (colds)
• “Clinically important features of zinc deficiency can occur with only modest degrees of dietary zinc restriction while circulating zinc concentrations are indistinguishable from normal.” IOM

Zinc

• Zinc deficiency in the oxidative stress control, immune response, proliferation,
• Pathophysiology of disease-
  • depression, cardiovascular diseases, diabetes mellitus, Alzheimer’s disease, and Wilson’s disease.

Zinc Absorption

• Iron – decreases absorption
• Calcium phosphate- decreases absorption but not high calcium diet
• Copper – Zinc protects in Wilson’s
• Protein – increase absorbability – Breast>cow milk
• Phytate – unleavened bread in mid east - decreases
• High fiber – no effect
• Avoid Zinc Picolinate supplement– increased urinary loss & decreased balance

Zinc Deficiency

Clinical Signs

• Hair loss – alopecia
• Decreased taste
• Dermatitis: acne, seborrheic dermatitis, eczema
• Frequent infections
• Glossitis, apthous ulcers
• Nail dystrophy – white spots

Labs

• Low Alk Phosphatase
• Low RBC/WBC Zn
• High Copper
• Low Vit A/beta carotene ratio
• Plasma zinc responds to supplementation
Vitamin D – 25 OH cholecalciferol

Cholesterol

7 dehydroxycholesterol

Sun Energy

UV-B 290-315 nm

cholecalciferol
VITAL -

• RCT 25,871 (5106 black)
• 2000 IU Vit D vs placebo
• 5.3 years median follow-up
• Men >50 yrs
• Women > 55 years
• 65% had blood samples before and 1 yr
• Baseline: <20ng/ml – 12.7%
  • 20-<30 ng/ml – 32.2%
• Mean -29.8 ng/ml to 41.8 ng/ml (a 40% increase)

Primary endpoints –
• Invasive Cancer Dx - Any
• Major Cardiovascular – MI, CVA, Death

Secondary
• Types of cancer
• Death from cancer
• Major cardiovascular plus revascularization


VITAL Observations and Results

• At 5 years, the prevalence of outside use of vitamin D (>800 IU per day) was 6.4% in supplement and 10.8% in placebo groups
• No difference in cancer (HR 0.83; 95% CI, 0.67 to 1.02 or cardiovascular (HR 0.97, 95% CI 0.85 to 1.12)
• Lower rate of death from cancer with vit D - excluding first 2 years. HR 0.75 [95% CI, 0.59 to 0.96]
• 2014 Meta-analysis of 4 Previous vitamin D trials testing doses of 400 to 1100 IU per day administered with or without calcium Incidence RR of 1.00 (95% CI, 0.94 Death from Cancer RR 0.88 (95% CI, 0.78 to 0.98

VITAL Observations and Results

• Limited power for site-specific cancers
• A 2-year post-intervention follow to capture latency effects
• Observational studies suggest that vitamin D may confer greater protection against death from cancer than against the initial development of clinically evident cancer
  • Strongest inverse relationships between vit D levels & colorectal cancer


Vitamin D and Survival

![Graph showing the relationship between serum vitamin D levels and survival over years of follow-up.](image)

Survival (%) vs Years of Follow-up for different serum vitamin D levels (8 ng/mL, 13 ng/mL, 19 ng/mL).

Archives of Internal Medicine 2008;168:1340-1349
Deficiency in Healthcare Professionals – (Canada)

Rates of vitamin D deficiency among healthcare professionals were:
• healthcare students 72%,
• medical residents 65%
• practicing physicians 46%
• healthcare employees 44%
• nurses 43%

Vitamin D deficiency or insufficiency (25-(OH)D < 75 nmol/L- < 30 ng/ml)


Hypertension in Blacks

• 283 Blacks, Mean age of 51 yrs - Winter Months
• 4 arm, double blind randomized trial
• Baseline, 3 month, BP & vit D
• 1.4 mmHg drop for every 1000 IU/dy (p=0.04)
• No Diastolic effects

RCT_{DB/Placebo} Influenza A and Asthma - 1200 IU/dy


B-12 the Structure

R = 5'-deoxyadenosyl, Me, OH, CN

Wickimedia Commons
Poll Question 4

Who is at greatest risk of vitamin B-12 deficiency?
A. Hindu recently moved from India to London
B. Individual with DM-2 & treated with Metformin
C. Hospitalized elderly (>65 yrs)
D. Obese middle aged male with Severe GERD on combination H2 blockers for 5 years

Answer – All are at risk – We don’t know which has the greatest risk

A. Hindu who moved from India to London
B. Individual with DM-2 & treated with Metformin
C. Hospitalized elderly (>65 yrs)
D. Obese middle aged male with severe GERD on H2 blocker & PPI for 5 years
Vitamin B-12
• Source – **Cyanocobalamine, Methylcobalamin**
• Absorption
  • Salivary R-factor
  • Intrinsic Factor
  • Meat < Fortified cereals < Milk/diary < Supplements
  • Also Passive absorption in small intestine
• Actions
  • Methyl management
  • Anemia and Neuropathy
  • Recycling Homocysteine

Vitamin B-12 Deficiency
• Diagnosis
  • Symptoms
  • Macrocytic Anemia
  • Blood tests
    • Vitamin B-12 level; Methylmalonate and Homocysteine;
    Holotranscobalamin and Holohaptocorrin
• Prevalence
  • Up to **15% of population > 65 yr/old**
Framingham B-12 Experience

Vit B-12 Deficient %
• <148 pmol/L 8%
• < 185 pmol/L 16%
• < 258 pmol/L 29%

• No difference with age
• Correlated with intake


“Functional Cobalamin Deficiency”

Elevations in methylmalonate > Homocysteine
• Age ≥70 years
• After exercise, folate excess
• Inflammation: DM, Tobacco, CRF, Cancers, neurodegenerative disorders, chronic infection, rheumatologic dz, asthma, pregnancy, IBD, iron overload, hyperthyroidism, cirrhosis, unexplained high ESR.

### Spec Sheet

**ENGINE**  
Engine type SKYACTIV®-G1 2.0L DOHC 16-valve 4-cylinder with VVT  
Horsepower 181 hp @ 7000 rpm  
Torque 151 lb-ft @ 4000 rpm  
Redline 7500 rpm  
Displacement (cc) 1998  
Bore x stroke (mm) 83.5 x 91.2  
Compression ratio 13 : 1  
Chain-driven dual overhead cams, 4 valves per cylinder with variable intake valve timing (VVT)  
Engine block Aluminum alloy  
Cylinder head Aluminum alloy  
Emission Control (50 State emissions) DRIVETRAIN  
Type Front-midship engine, rear-wheel drive  
Manual transmission  
SKYACTIV®-MT17 6-speed manual transmission with short-throw shifter  
Automatic transmission 6-speed Sport automatic transmission with paddle shifters  
**GEAR RATIOS (1:1) 6 MT**  
1st 5.087  
2nd 2.991  
3rd 2.035  
4th 1.594  
5th 1.286  
6th 1.000  
Reverse 4.696  
Final Drive 2.866  
**CHASSIS**  
Chassis Monocoque unibody with backbone frame construction and front and rear suspension subframes  
Brakes 4-wheel disc  
- Front 11-inch vented disc with single piston calipers  
- Rear 11-inch solid disc with single piston calipers  
- ABS 4-wheel, 4-channel with Overall steering ratio 15.5:1  
Steering wheel turns, lock-to-lock 2.7  
Turning circle diameter, curb-to-curb (ft) 30.8  
Suspension 4-wheel independent  
- Front Double wishbone with aluminum control arms and monotube dampers  
- Rear Multi-link with aluminum bearing support and monotube dampers

---

Mazda MX-5 --World’s Best Selling Sports Car

![](image)
Complexity

- The number of chemical entities in food that participates in nutritional function is infinitely large and mostly unknowable, yet highly integrated and managed.


Questions?

- Does the nutrient Dose effects cellular function?
- Does a pill form work like a food form?
- One nutrient effected by others?
- Can we measure or predict nutrient-nutrient interactions?
- Does the storage form predict active form’s function?
- How active is homeostasis at the tissue level?

Reductionism vs Eating Pattern

“Value Added”

Increased cost, increased profit, 
Increased Pleasure/Addiction potential

Practice Recommendations

• Encourage the intake of more minimally processed whole plants – Legumes, etc. – Healthy eating patterns
• Look for the signs/symptoms of zinc deficiency and supplement when deficiency is suspected.
• Test for vitamin B-12 deficiency (including MMA) in at risk individuals.
• Supplement in situations that are supported by evidence
Contact Information

• George E Guthrie MD MPH CDE FAAFP FACLM
• gguthrie54@mac.com

Questions
Resources/Supplemental Material


• Keum N, Giovannucci E. Vitamin D supplements and cancer incidence and mortality: a meta-analysis. Br J Cancer 2014;111:976-80.