Nutritional Evaluation of the Obesity Surgery Patient: Micronutrient Testing, Surveillance and Repletion for the PA Clinician

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Disclosures

No relevant commercial relationships to disclose

Learning Objectives

- Definition of obesity, its prevalence and impact
- Quantify the micronutrient deficiencies in pre and post bariatric surgery patients
- Implement laboratory screening protocols for pre and post bariatric surgery patients

Learning Objectives

- Prescribe appropriate dietary supplementation based on current bariatric nutritional guidelines
- Identify micronutrient deficiencies and discuss repletion protocols
- Utilize micronutrient repletion protocols when moderate to severe deficiencies are identified

Rationale for nutritional testing

The “Why”

Obesity Defined

- Clinical Definitions of Obesity
  - Body Mass Index Definition
    - Stage 1: >30kg/m^2- 34.9kg/m^2
    - Severe Stage 2: 35kg/m^2- 39.9kg/m^2
    - Morbid Stage 3: >40kg/m^2
    - Extreme or Super Obesity: >50kg/m^2
  - Waist to Hip Circumference Definition
    - Caucasian Males: ≥ 40 inches correlates with obesity
    - Caucasian Females: ≥ 35 inches correlates with obesity
    - Asian Males: ≥ 35 inches correlates
    - Asian Females: ≥ 31 inches correlates with obesity

"Definition of Obesity - Obesity Medicine Association," August 29, 2017 Accessed January 30, 2021. https://obesitymedicine.org/definition-of-obesity/.

Obesity Defined

- Clinical Definitions of Obesity
  - Body Fat Percentage Definition
    - Males: Obesity ≥ 25% body fat
    - Females: Obesity ≥ 32% body fat
- Medical Definition of Obesity
  - The Obesity Medicine Association's definition of obesity is "a chronic, relapsing, multifactorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences."

"Definition of Obesity - Obesity Medicine Association," August 29, 2017 Accessed January 30, 2021. https://obesitymedicine.org/definition-of-obesity/.

Obesity Defined

- A possible new definition by the American Association of Clinical Endocrinologists and American College of Endocrinology (Mechanick, Hurley and Garvey, 2017)
  - "Adiposity-Based Chronic Disease (ABCD) is a new diagnostic term for obesity that explicitly identifies a chronic disease, alludes to a precise pathophysiologic basis, and avoids the stigmata and confusion related to the differential use and multiple meanings of the term 'obesity.'"
  - Proposes 4 key elements: Lifestyle medicine as central theme, standardized treatment protocols, obesity in context (biopsychosocial), evidence-based strategies for implementation, monitoring and optimization.

Mechanick JI, Hurley DL, Garvey WT. Adiposity-Based Chronic Disease as a New Diagnostic Term: The American Association of Clinical Endocrinologists and American College of Endocrinology Position Statement. *Endocrine Practice*. 2017;23(3):372-378. doi: http://dx.doi.org.lmunet.idm.oclc.org/10.4158/EP161688.PS

The Obesity Impact

- 1 in 5 children and 2 in 5 (40%) adults struggle with obesity
- Rates of obesity are similar between men and women
- Non-Hispanic whites have lower rates of obesity (37.9%) compared with all Hispanics (47.0%) and non-Hispanic blacks (46.8%)
- Linked to more than 40 diseases
  - T2DM, HTN, Heart Disease, Stroke, Sleep Apnea, Osteoarthritis and at a minimum 13 types of cancers
- National Security Threat
  - According to the CDC approximately 71% of young people in the US would not be able to serve in the military

Obesity in America. American Society for Metabolic and Bariatric Surgery. Published October 1, 2018. Accessed January 30, 2021. https://asmbs.org/resources/obesity-in-america
UNFIT TO SERVE Obesity is Impacting National Secu.pdf. Accessed January 30, 2021. https://www.cdc.gov/physicalactivity/downloads/unfit-to-serve.pdf

Micronutrient Deficiencies of Obesity

- At least 1 micronutrient deficiency in 85.5% of pre-op patients.
  - Vitamin D 74.5%, folate 33.5%, iron 32%, calcium 13%, vitamin B12 10%
- Diet plans don't deliver: In 2010, Calton evaluated 4 popular diet plans including: *Atkins For Life*, *The South Beach Diet*, the *DASH* diet and *Best Life for sufficiency in 27 nutrients.*
  - Average calories 1748 for all 4 diets and only 43.52% sufficient
  - Average calories needed to achieve 100% sufficiency 27,575kcal

Pellegrini M, Rahimi F, Boschetti S, et al. Pre-operative micronutrient deficiencies in patients with severe obesity candidates for bariatric surgery. J Endocrinol Invest. Published online October 7, 2020. doi:10.1007/s40618-020-01439-7

Calton JB. Prevalence of micronutrient deficiency in popular diet plans. Journal of the International Society of Sports Nutrition. 2010;7(1):24. doi:10.1186/1550-2783-7-24

“I’m eating a 100% of my daily vitamins and minerals, are you?”

Micronutrient Deficiencies of Obesity

- Prevalence of deficiency pre-operatively
  - Thiamin as high as 29%
  - B12 2-18% w/ obesity and 6-30% on proton pump inhibitor
  - Folate as high as 54%
  - Iron as high as 45%
  - Vitamin D as high as 90%

Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. *Surgery for Obesity and Related Diseases*. 2017;13(5):727-741. doi:10.1016/j.soard.2016.12.018

Micronutrient Deficiencies of Obesity

- Prevalence of deficiency pre-operatively
  - A and E as high as 14%, 2.2% respectively
    - Vitamin K, none identified per Parrott, however according to M. Ewang-Emukowhate et al, 2015, vitamin K was found to be as high as 40%
  - Zinc as high as 24-28%
  - Copper as high as 70% in pre-BPD women
  - Calcium; elevated carboxy-terminal telopeptide 66.7% patients under age 50

Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. *Surgery for Obesity and Related Diseases*. 2017;13(5):727-741. doi:10.1016/j.soard.2016.12.018

Ewang-Emukowhate M, Harrington DJ, Botha A, McGowan B, Wierzbicki AS. Vitamin K and other markers of micronutrient status in morbidly obese patients before bariatric surgery. *International Journal of Clinical Practice*. 2015;69(6):638-642. doi: https://doi.org/10.1111/ijcp.12594

Micronutrient Deficiencies of Obesity Surgery

- Prevalence of deficiency post surgery
  - Thiamin <1% to 49%
  - B12 <20% in RYGB and 4-20% in LSG
  - Folate as high as 65%
  - Iron in AGB 14%, LSG <18%, RYGB 20-55%, BPD-DS 8-62%
  - Vitamin D up to 100%

Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American Society for Metabolic and Bariatric Surgery Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients. *Surgery for Obesity and Related Diseases*. 2017;13(5):727-741. doi:10.1016/j.soard.2016.12.018

Micronutrient Deficiencies of Obesity Surgery

- Prevalence of deficiency post surgery
  - Vitamin A up to 70% in RYGB and BPD-DS
    - Vitamin E and K is rare? Area of research available
  - Zinc 70% BPD-DS, 40% RYGB, 19% LSG, 34% AGB
  - Copper 90% BPD-DS, 10-20% RYGB

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Micronutrient Deficiencies of Obesity Surgery

- Post surgery trace minerals in supplemented AGB, LSG and RYGB
- Despite taking MVIs as part of post surgery recommendations
  - Zinc: Pre 7%, Post 7-15%
  - Copper: Pre 2%, Post 0-5%
  - Selenium: Pre 2%, Post 11-15%

Papamargaritis D, Aasheim ET, Sampson B, le Roux CW. Copper, selenium and zinc levels after bariatric surgery in patients recommended to take multivitamin-mineral supplementation. Journal of Trace Elements in Medicine and Biology. 2015;31:167-172. doi:10.1016/j.jtemb.2014.09.005

Micronutrients are deficient

- Take home is that micronutrients are indeed deficient in patients with obesity planning for bariatric surgery
- Although variable, each surgery increases the risk of further nutrition decline
- Low calorie food restricted diets are insufficient, and this doesn't change after surgery
- Screening, surveillance and supplementation are crucial

Nutritional and Metabolic Indices

The "What"

Current Guidelines

- American Society for Metabolic and Bariatric Surgery (ASMBS) Allied/Integrated Health Nutritional Guidelines for the Surgical Weight Loss Patient. 2008, 2013
  - **2016, Micronutrient Update**
- AACE/TOS/ASMBS Clinical Practice Guidelines for the Perioperative Nutritional, Metabolic, and Nonsurgical Support of the Bariatric Surgery Patient, 2013
  - **2019, Update**

Current Guidelines

- Current Guidelines at-a-glance:
  - All guidelines recommend nutritional testing and treatment due to the alterations in metabolism, malabsorption, alterations in dietary intake, prevention of weight regain and treatment of co-morbidities.
  - Nutritional deficiencies are now commonly found in bariatric populations. Given the importance of nutritional status and metabolic function, nutritional repletion is essential to the care of bariatric surgical patients.

Current Guidelines

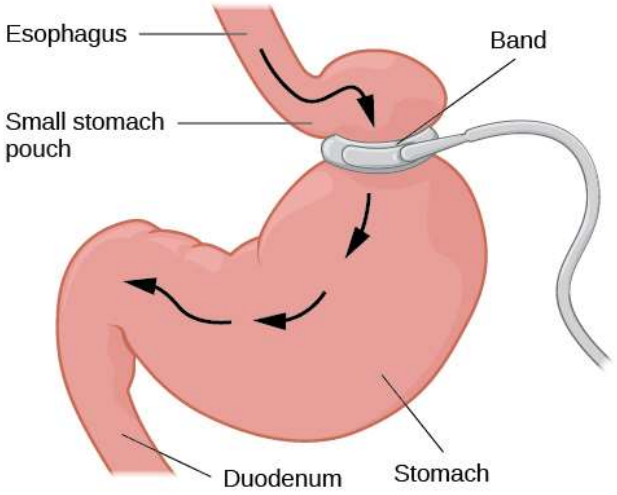
- Current Guidelines briefly:
  - Routine surgical/metabolic labs are drawn pre-op
  - Nutritional and metabolic labs are drawn at intervals as determined by type of surgery and presence of co-morbidities, typically every 3 months
  - Labs in patients with co-morbid disease or nutritional deficiencies may need labs every 1–2 months
  - In general, labs for malabsorptive procedures should include indices for nutrient deficiencies that are rare and should be checked more frequently

Types of Metabolic and Bariatric Surgery and Nutritional Consequences

- Adjustable Gastric Banding (declining demand)
- Sleeve Gastrectomy (most popular)
- Gastric Bypass (most researched)
- Biliopancreatic Diversion and Duodenal Switch (increasing demand)

Mechanick JI, Apovian C, Brethauer S, et al. Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric procedures – 2019 update: cosponsored by American Association of Clinical Endocrinologists/American College of Endocrinology, The Obesity Society, American Society for Metabolic & Bariatric Surgery, Obesity Medicine Association, and American Society of Anesthesiologists. *Surgery for Obesity and Related Diseases*. 2020;16(2):175-247. doi:10.1016/j.soard.2019.10.025

Adjustable Gastric Banding

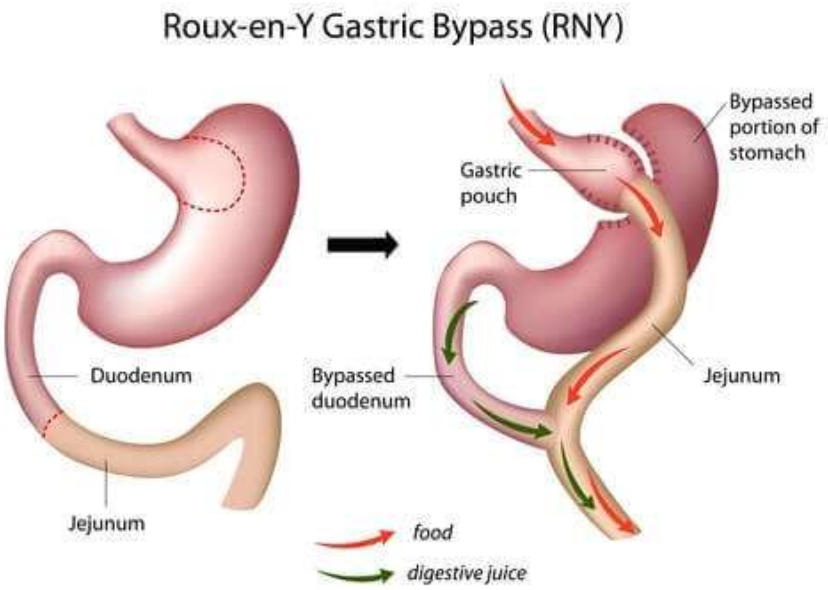


- Restrictive
- High explant/failure rate/Revisions
- High maintenance
- Lack of fullness over time
- Erosions/slip/prolapse
- Vomiting/GERD
- Maladaptive eating patterns

Sleeve Gastrectomy

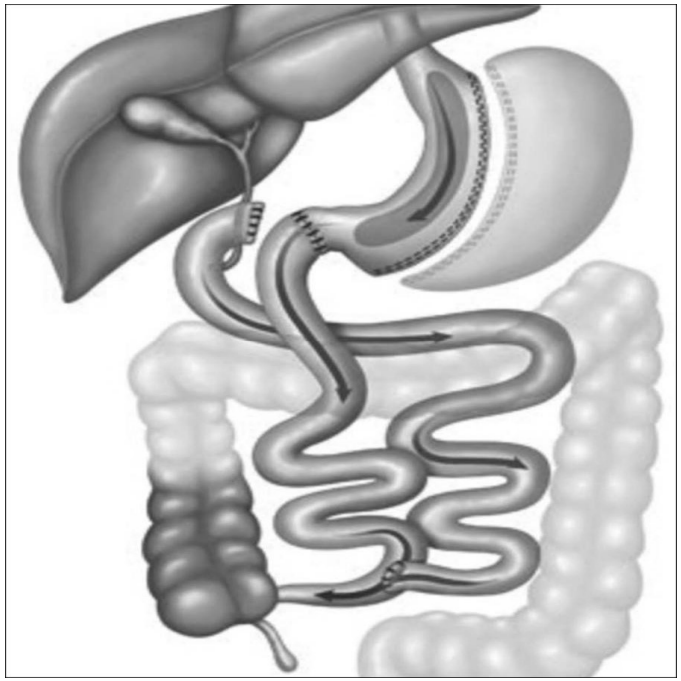
- Restrictive/Hormonal
- Difficult to manage leaks
- Vomiting/GERD
- Maladaptive eating patterns
- Still allows for revisions

Gastric Bypass



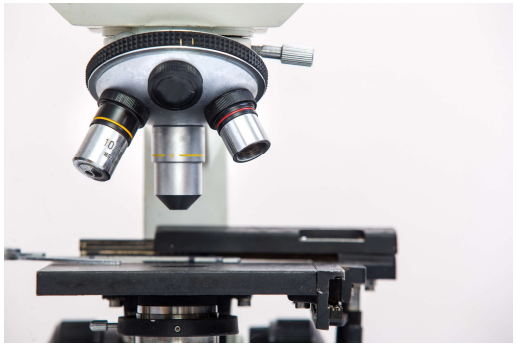
- Restrictive/hormonal w/ minimal malabsorption
- Ulcers/leaks/hernia
- Increasing risk of micronutrient deficiency over time
- Antidiabetic effect

Biliopancreatic Diversion and Duodenal Switch



- Restrictive with significant malabsorption
- Leaks/hernias/duodenal dissection
- GERD
- 3-5% Protein-calorie malnutrition
- Increased risk for rare micronutrient deficiencies

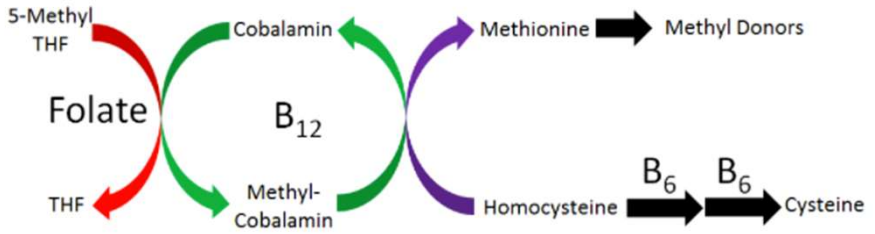
Metabolic and Micronutrient Indices to Monitor



- Lipid panel
- Hg A1c
- CBC
- CMP
- TSH
- iPTH
- Coags
- CRP ?
- Pre-surgery DEXA and at 2 years

Metabolic and Micronutrient Indices to Monitor

- B-vitamins
  - Thiamine (whole blood, albumin bound, Thiamine Diphosphate, TDP)
  - B12 (serum B12 with MMA)
  - Folate (serum folate with homocysteine, RBC Folate optional)



Metabolic and Micronutrient Indices to Monitor

- Fat soluble vitamins
  - Vitamin A (serum retinol)
  - Vitamin D 25 hydroxy
  - Vitamin E (plasma alpha-tocopherol)
  - Vitamin K (plasma protein induced in vitamin K absence II, PIVKA-II or Des-gamma carboxyprothrombin, or DCP). This study is more sensitive than prothrombin time.

Metabolic and Micronutrient Indices to Monitor

- Minerals
  - Iron (iron panel with ferritin)
  - Calcium (telopeptide, 24-hour urine calcium))
  - Copper (serum copper/ceruloplasmin)
  - Zinc (plasma)
  - Selenium (serum)
  - Magnesium wasn't added, but nonetheless important

Current Frequency Guidelines for Gastric Band and Sleeve

Test	Pre-Op	Post-1 mo	Post-3 mo	Post-6mo	Post-12 mo	Annually
CBC	✓	✓	✓	✓	✓	✓
CMP	✓	✓	✓	✓	✓	✓
TSH	✓					Symptom-based
A1c	✓	Per standard of care				
Lipid panel	✓	q 6 months, risk/benefit		✓		✓
Coags	✓					

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Current Frequency Guidelines for Gastric Band and Sleeve

Test	Pre- Op	Post-3mo	Post- 6 mo	Post- 12 mo	Post- 18 mo	Annually
Vitamin D, iPTH Calcium	✓ ✓	As needed				
Thiamine	✓	Symptom-based				
Iron studies, ferritin	✓	Symptom-based				
B12, MMA Folate, homocysteine	✓ ✓	✓	✓	✓	✓	✓
Vitamin A, E, K	✓	Not Rec'd				
Zinc Copper Selenium	✓	Not Rec'd				

Current Frequency Guidelines for Gastric Bypass

Test	Pre-Op	Post-1 mo	Post-3 mo	Post-6mo	Post-12 mo	Annually
CBC	✓	✓	✓	✓	✓	✓
CMP	✓	✓	✓	✓	✓	✓
TSH	✓					Symptom-based
A1c	✓	Per standard of care				
Lipid panel	✓	q 6 months, risk/benefit		✓		✓
Coags	✓					

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Current Frequency Guidelines for Gastric Bypass

Test	Pre- Op	Post-3mo	Post- 6 mo	Post- 12 mo	Post- 18 mo	Annually
Vitamin D, iPTH Calcium	✓ ✓	✓	✓	✓	✓	✓
Thiamine	✓	Symptom-based	✓	✓	✓	✓
Iron studies, ferritin	✓	✓	✓	✓	✓	✓
B12, MMA Folate, homocysteine	✓ ✓	✓	✓	✓	✓	✓
Vitamin A, E, K	✓	optional	→			
Zinc Copper Selenium	✓	Symptom-based				

Current Frequency Guidelines for BPD-DS

Test	Pre-Op	Post-1 mo	Post-3 mo	Post-6mo	Post-12 mo	Annually
CBC	✓	✓	✓	✓	✓	✓
CMP	✓	✓	✓	✓	✓	✓
TSH	✓					Symptom-based
A1c	✓	Per standard of care				
Lipid panel	✓	q 6 months, risk/benefit		✓		✓
Coags	✓					

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Current Frequency Guidelines for BPD-DS

Test	Pre- Op	Post-3mo	Post-6 mo	Post-12 mo	Post-18 mo	Annually
Vitamin D, iPTH Calcium	✓ ✓	✓	✓	✓	✓	✓
Thiamine	✓	Symptom-based	✓	✓	✓	✓
Iron studies, ferritin	✓	✓	✓	✓	✓	✓
B12, MMA Folate, homocysteine	✓ ✓	✓	✓	✓	✓	✓
Vitamin A, E, K	✓		✓	✓		✓
Zinc, Copper Selenium	✓	Symptom-based	?			?

The Nutrition Prescription

The “How”

Nutrient Supplement Protocol

- Multivitamin plus minerals (no. of tablets for minimal requirement)
  - 1 tablet for AGB
  - 2 tablets daily for LSG, RYGBP, BPD-DS
- Elemental calcium (as calcium citrate)
  - 1200–1500 AGB, RYGBP, BPD-DS
  - 1800–2400 BPD-DS
- Vitamin D, at least 3000 units/d, titrate to 30 ng/mL (50 to 60 ng/mL) (maybe even higher 4000 to 5000 units/day)

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Nutrient Supplement Protocol

- Vitamin B12 as needed for normal range levels (350-500 µg/day)
  - Oral, intranasal, sublingual or 1000 µg/month injection
- Thiamin 12 mg minimum and preferrable 50mg B-complex once or twice daily
- Folate 400-800 µg and 800 to 1000 µg for women of childbearing age

Nutrient Supplement Protocol

- Iron supplementation
  - Men 18mg daily
  - Menstruating women (LSG, RYGB, BPD-DS) 45-60mg daily
  - Oral supplements should be taken separate from calcium, acid reducing medication.
- Vitamin A
  - AGB 5000 IU/day
  - RYGB and LSG 5000 to 10000 IU/day
  - BPD-DS 10000 IU/day

Nutrient Supplement Protocol

- Vitamin E
  - AGB, RYGB, LSG, BPD-DS 15mg/day which is 33 IU of dl alpha and 22 of d alpha tocopherol. (hint d alpha is natural)
    - Unclear about optimal doses given impact of vitamin E on fatty liver
- Vitamin K
  - AGB, RYGB, LSG 90-120 µg/day
  - BPD-DS 300 µg/day
- Water soluble forms of these nutrients are available
- Avoid excess synthetic vit A and K during pregnancy

Nutrient Supplement Protocol

- Zinc supplementation
  - AGB, LSG 100% RDA 8-11 mg/day
  - RYGP, 100-200% 8-22 mg/day
  - BPD-DS 200% 16-22 mg/day
  - Take with copper to avoid competitive depletion at least 1 mg (megamineral sideroblastic anemia)
- Copper supplementation
  - AGB, LSG 100% RDA 1 mg/day
  - RYGP, BPD-DS 200% 2 mg/day
  - Copper gluconate or sulfate is recommended for supplementation

Other Important Dietary Matters

- Maintain adequate hydration (usually .1.5 L/d PO)
- Protein 60g/day, 1.5 to 2.1g/kg
- General principles
  - Get on the chew chew train
  - Fluid throughout the day, not eating and drinking at the same time
  - Eat protein foods first (premature satiety)
  - Complete meal with fresh fruit, veggies, whole grains
- Diets start out high protein and fat (more ketogenic) then progress to include increased volume, calories and variety.

Recognizing Nutrient Deficiency

- **Thiamine:** peripheral neuropathy, hyperreflexia, muscle weakness, lower extremity pain, heart failure with high cardiac output, edema, slow gastric emptying, nausea/vomiting
- **B12:** Anemia, glossitis, fatigue, anorexia, diarrhea, numbness and paresthesia, peripheral nerve disease, dizzy, short of breath, tinnitus, advanced disease encephalopathy, heart failure
- **Folate:** skin pigment changes, skin ulcers

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Recognizing Nutrient Deficiency

- **Iron:** fatigue, anemia, depression-like symptoms, glossitis, koilonychias, pica/pagophagia, palpitations
- **Zinc:** Rash, acne, hypo/ageusia, immune deficiency, inc. infections, infertility, growth and sexual delay, hypogonadism, diarrhea, impaired appetite, night blindness
- **Calcium:** leg cramps, neuromuscular hyperexcitability, muscle weakness, osteoporosis
- **Selenium:** heart, muscle, joint abnormalities, infertility in men, neurologic problems, short fingernails, pediatric growth problems, vitamin E deficiency
- **Copper:** Anemia, neutropenia, hypopigmentation skin, hair, nails, hypercholesterolemia, impaired bone formation, gait abnormalities.

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Shreenath AP, Ameer MA, Dooley J. Selenium Deficiency. In: *StatPearls*. StatPearls Publishing; 2020. Accesed February 13, 2021. http://www.ncbi.nlm.nih.gov/books/NBK482260/

Recognizing Nutrient Deficiency

- **Vitamin A:** night blindness, Bitot's spots (foamy white spots on sclera), poor wound healing, hyperkerantinization of the skin, loss of taste (related to zinc), corneal damage, xerosis, blindness
- **Vitamin D:** hypocalcemia, tetany, tingling, cramping, metabolic bone disease, altered immune function
- **Vitamin E:** Hyporeflexia, gair disturbance, neurologic damage, muscle weakness, gaze/vision disorders, hemolytic anemia
- **Vitamin K:** hemorrhage, easy bruising and bleeding, osteoporosis

Nutrient Repletion Protocol

- Thiamine
  - 100mg 2-3 times daily until symptoms resolve
  - IV therapy 200mg 3 times daily or 500mg daily for 3 to 5 days, then 250mg daily for 3-5 days, then 100mg orally thereafter
  - IM therapy 250mg daily for 3-5 days or 100-250mg monthly
- Vitamin B12
  - At least 1000 µg/day until normal levels are achieved
- Folate
  - 1000 µg/day until normal levels are achieved

Nutrient Repletion Protocol

- Iron
  - Can be given 150 to 200mg elemental daily and as high as 300mg 2-3 times a day
  - IV iron infusion would be indicated
- Vitamin D
  - 3000 to 6000 IU/day or 50,000 IU vit D2 1-3 times a week
  - Vitamin D3 is more potent
- Calcium resume standard oral supplementation, if critical deficiency exists then IV calcium is indicated

Nutrient Repletion Protocol

- Vitamin A
  - 10,000 to 25,000 IU/day in deficiency state without corneal disease until clinical improvement
  - 50,000 to 100,000 IU/day IM for 3 days followed by 50,000IU/day IM for 2 weeks for those with corneal disease
  - Supplement with proper MVI to replace iron and copper deficiency
- Vitamin E
  - Not clearly defined, possibly 100 to 400 IU daily

Nutrient Repletion Protocol

- Vitamin K
  - 10mg IV
  - For those with chronic malabsorption rec'd dose is 1-2mg/day orally or 1-2mg/wk parenterally (can be given IM)
- Zinc
  - Repletion protocol unknown, previous protocol to give 60mg twice daily needs to be investigated, supplement with copper
- Copper
  - Mild to moderate 3-8 mg/day orally until levels return to normal
  - Severe 2-4 mg/d IV for 6 days until symptoms resolve, then monitor every 3 months

Dietary Supplement Quality

- Dietary Supplement and Education Act of 1994
  - Regulated under the FDA for good manufacturing processes
  - Manufacturers are responsible for safety and labeling
  - FDA acts against adulterated and misbranded products
- Look for current good manufacturing process (cGMP) seal on the bottle
  - United States Pharmacopeia Voluntary Program
  - National Products Association (NPA) “TrueLabel” Program

Your Expertise is Needed

The “Now”

The PA In Action

- Don't be bashful to bring up weight-related issues, type of surgery, successes and failures.
- Ask about their vitamin and mineral intake. The type, brands, when and how they take them. Anything missing?
- Do a brief review of their diet
  - How are you are managing to stay within dietary guidelines?
  - In what ways are you pleased with your current adherence to dietary guidelines?
  - Please share with me three areas that you would want to improve upon.
  - How much protein are you eating, how much water? Are you within guidelines?

The PA In Action

- Recognize untreated obesity and its complications
- Recognize different bariatric surgeries and their nutritional complications
- Identify at risk patients in your work environment and make proper clinical decisions
  - Ask about diet and supplementation and encourage compliance
  - Assess routine labs
  - Prescribe appropriate supplementation per guidelines
  - Referral to bariatric surgeon and registered dietitian nutritionist

Practice Quick Links: Resources and Guidelines

- Guidelines | American Society for Metabolic and Bariatric Surgery (asmbs.org)
- Resource Category: Fact Sheets | American Society for Metabolic and Bariatric Surgery (asmbs.org)
- COVID-19 and Obesity: Clinical Obesity (wiley.com)
- Obesity Leadership Edge – AAPA
- Overweight & Obesity | CDC
- Search Results-Obesity (eatright.org)
- Weight Management (eatrightpro.org) (Locked, but browsable)
- www.npanational.org/regulatory/federal-gmps-dietary-supplements/
- https://www.fda.gov/food/dietary-supplements

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Questions?

The “I can’t remember what I just learned”