Conflict Of Interest Disclosure

- The opinions presented here are those solely of the speaker.
- I have no financial interests or other relationships with commercial manufacturers and suppliers of commercial services.

Outline

- Understand various types of bariatric surgical procedures and their impact on nutrition.
- Review roles of vitamins & micronutrients.
- Recognize some clinical acute and long term presentations of various nutritional deficiencies.
- Increase understanding of follow-up care considerations in post bariatric patient.
Obesity Epidemic

- Term obesity derived from Latin word obesus “to devour”;
  - Obesity: Defined as high amount of fat to lean body mass
- ~67% in US are overweight or obese
- 33% U.S. adults ~ 72 million defined as obese in 2005-2006\(^1\)
- $117 billion spent in 2000 to treat medical consequences of overweight and obesity
- 112,000 deaths/year attributed to obesity\(^2\)

1. Centers for Disease Control and Prevention, November 2007

Obesity Trends* Among U.S. Adults
BRFSS, 1990, 2000, 2010

(*BMI ≥ 30, or about 30 lbs. overweight for 5’4” person)

Prevalence Obesity Trends* Among U.S. Adults

*Prevalence estimates reflect BRFSS methodology changes started in 2011 and should not be compared to prevalence estimates before 2011.
Obesity Incidence Disparities

- Women > men
- Race-ethnic female disparities in obesity prevalent
  - Among women 60 and older,
    - 61% of non-Hispanic black women obese
    - 37% of Mexican-American women
    - 32% of non-Hispanic white women

Centers for Disease Control and Prevention, November 2007
2009: http://www.cdc.gov/obesity/data/trends

Why Bariatric Surgery?

- Body Mass Index (BMI) defined

<table>
<thead>
<tr>
<th>BMI</th>
<th>Weight Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal weight</td>
</tr>
<tr>
<td>25.0-29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>30 and greater</td>
<td>Obese</td>
</tr>
</tbody>
</table>

Evidenced Based Recommendation:
- Bariatric surgery leads to sustainable long-term weight loss and may reduce obesity-related co-morbidities

Cochrane Database of Systematic Reviews
Http://www.cochrane.org/reviews/en/ab003641.html

Bariatric Surgery Goals

- Gastric bypass surgery aims:
  - Reduce absorbed calories
  - Weight loss
  - Decrease co-morbidities
  - **BUT** -- Nutritional deficiencies may result!

- Co-morbidities:
  - Hypertension
  - Diabetes mellitus II
  - Sleep apnea
  - Cardiovascular disease
  - Stroke
  - Dyslipidemias
  - Osteoarthritis
  - Cancers
  - Gall bladder disease
  - Female infertility
  - Psychological issues
Bariatric Surgery Volumes

\[ \sum \text{~1.2 million in last 12 years} \]

Bariatric Surgical Options

- Two surgical weight loss mechanisms
  - Gastric restriction
    - Vertical Banded gastroplasty
    - Sleeve gastrectomy
    - Adjustable gastric banding
  - Intestinal Malabsorption
    - Roux-en-Y
    - Duodenal Switch and its variations
    - Variations of the Jejuno-Ileal Bypass (JIB)

The Restrictive Procedures
Lap-Band early 2000s
Now Rarely Performed

- Pure Restrictive Mechanism
- No Malabsorption Risk
- Outpatient Surgery
- Reversible
- Requires Significant Dietary Changes
- Low Risk
- Major Complications
  - Band Slippage – Reoperation
  - Band Erosion – Removal
The Restrictive Procedures
Sleeve Gastrectomy

Permanent partial Gastrectomy
• Resection of stomach
  • Body
  • Fundus
  • Antrum

Malabsorption Procedures
Proximal Roux-En-Y w/ Gastric Transection

Malabsorptive Procedures
Duodenal Switch

1º mechanism
- Fat malabsorption
- Very effective weight loss

Malnutrition an issue
- Protein malnutrition
- Hypoproteinemia

Frequent foul smelling stools
- Up to 7/day
- Fat soluble vitamins

Hepatotoxicity
- Elevated liver enzymes
- Potential for liver failure
Malabsorptive Procedures
Medial Gastric Bypass w/ Jejunal Interposition

Combined Procedures
Gastric Bypass

- Most common US bariatric procedure
- Combined procedure
  - Small malabsorptive limb
  - Restrictive gastric pouch
- Creates a small gastric pouch
- Creates a short Roux Limb
- Difficult to reverse

Bariatric Surgery Clinical Outcomes

Average BMI Pre Op = 43.5; 82% Female; 18% Male

Table 4: Reported weight loss as percentage of excess body weight after bariatric surgery.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Follow-up period (years)</th>
<th>1-2</th>
<th>3-6</th>
<th>7-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical banded gastroplasty</td>
<td></td>
<td>50-72</td>
<td>25-65</td>
<td>—</td>
</tr>
<tr>
<td>Gastric banding</td>
<td></td>
<td>29-87</td>
<td>45-72</td>
<td>14-60</td>
</tr>
<tr>
<td>Sleeve gastrectomy</td>
<td></td>
<td>33-58</td>
<td>60</td>
<td>—</td>
</tr>
<tr>
<td>Roux-en-Y gastric bypass</td>
<td></td>
<td>48-85</td>
<td>53-77</td>
<td>25-68</td>
</tr>
<tr>
<td>Banded Roux-en-Y gastric bypass</td>
<td></td>
<td>73-80</td>
<td>66-78</td>
<td>60-70</td>
</tr>
<tr>
<td>Vertical gastroplasty with gastric bypass</td>
<td></td>
<td>52-74</td>
<td>55-72</td>
<td>—</td>
</tr>
<tr>
<td>Bilipancreatic diversion s. SP</td>
<td></td>
<td>66-82</td>
<td>62-81</td>
<td>60-80</td>
</tr>
</tbody>
</table>

VOLUME 17 SUPPLEMENT 1 S1-S70, APRIL 2009 www.obesityjournal.org
Potential Severe Immediate Post Op Complications

- Post op (first 30 days)
- Possible life-threatening complications:
  - Respiratory failure
  - Pulmonary embolism
  - Anastomotic leaks


Bariatric Short-Term Complications

- Weeks 1-6 Post-op

- Wound infections
  - Less Common in Laparoscopic procedures
  - Open Group may lead to incisional hernia
- Stoma stenosis
  - Nausea, Vomiting - inability to advance diet
  - Usually requires EGD and dilation
- Marginal ulceration
  - Rarely secondary to Acid production
    - Rx: proton pump inhibitor (PPI), sucralfate, suspension
- Constipation
  - Poor PO Fluid intake!

Bariatric Short Term Clinical Symptoms

- Three to six months post op:
  - Rapid weight loss
  - May experience one or more changes
    - Body aches
    - Feeling tired (flu-like)
    - Feeling cold when others comfortable
    - Dry skin
    - Hair thinning and hair loss
    - Changes in mood
    - Relationship issues
Clinical Outcomes Post Bariatric Surgery

- Clinical outcomes
- Disease improvement
  - Diabetes: 64 - 90%
  - Hypertension: 62 - 69%
  - Obstructive Sleep Apnea: 85%
  - Dyslipidemia: 60 - 100%
  - Nonalcoholic fatty liver disease 90%

JAMA, September 19, 2012—Vol 308, No. 11, 1122-31

Deficiencies Post Bariatric Procedure

- Macro Nutrients
  - Proteins, fats
    - 50% protein absorption occurs in duodenum

- Micro Nutrients
  - Vitamins
  - Trace minerals


Common Malabsorption Issues Post Op

- Anemia
- Vitamin deficiencies
  - Iron and B12 not absorbed sufficiently
    - Reduced appetite
    - Reduced absorption
    - Vitamins A, D and Calcium most common
- Dumping syndrome:
  - Diarrhea
- Reactive hypoglycemia:
  - result of sudden intake of sugar content, nausea, vomiting, dizziness

MGC
Long Term Metabolic Complications of Gastric Bypass Surgery

March 2015
ACOI Las Vegas

1. **Dumping Syndrome 1**
   - Common complication of extensive gastric resection in which readily soluble carbohydrates rapidly “dump” into small intestine
   - Symptoms include:
     - Cramping, full feeling
     - Rapid pulse
     - Wave of weakness, cold sweating, dizziness
     - Nausea, vomiting, diarrhea
   - Occurs 30 to 60 minutes after meal
   - Results in patient eating less food

2. **Dumping Syndrome 2**
   - Rapid influx of undigested carbohydrate into the jejunum of a hypertonic carbohydrate load
   - Procholinergic symptoms
     - Cramping, flushing, palpitations, diaphoresis, tachycardia, or hypotension.
     - Side effect of malabsorptive procedures – RYBG and biliopancreatic diversion
   - Early dumping first hour
     - May be related to the sudden distension of the jejunum by hypertonic solids or fluids.
   - Late dumping 1–3 hours pc
     - Most likely result of rapid glucose absorption
     - Hyperglycemia triggers exaggerated insulin release resulting in rebound hypoglycemia.
     - Nesidioblastosis ???

3. **Noninsulinoma Pancretogenous Hypoglycemia Syndrome**
   - **Aka Nesidioblastosis**
     - Really reactive hypoglycemia
     - Hyperplasia of pancreatic islet cells during obese phase
     - Cells continue to secrete same insulin dose on food stimulus

Compliance Issues
Desire for a Pregnancy

- Pregnancy is contraindicated in near term
  - ACOG recommends wait 24 months
  - Wait at least 18 months after surgery
  - Rapid weight loss and adjusting nutritional requirements

- Must provide appropriate contraception


Post Op Incidence
Vitamin Deficiencies

- Vitamin A (retinol) 11%
- Vitamin C (ascorbic acid) 34.6%
- Vitamin D (calciferol) 7%
- Vitamin B₁ (thiamine) 18.3%
- Vitamin B₂ (riboflavin) 13.6%
- Vitamin B₆ (pyridoxine) 17.6%
- Vitamin B₁₂ (cobalamins) 3.6% (12 months after surgery)


Case #1

50 y.o. female, 10 years post RGB, presented to the ED incoherent, N/V, CHF and edema. No hx of ETOH per spouse, & children. Admitted to the ICU, R/O STMI was negative. Despite CHF treatment, continues to deteriorate. Echocardiogram and cardiac catheterization showed
  - Biventricular failure, non obstructive CAD
  - She continued to deteriorate with multi organ failure– She was placed on a balloon pump
  - A Thiamine level was obtained and she was started on IV thiamine daily. LV function improved, weaned off the balloon pump, and her edema resolved.

Severe dementia persisted - discharged to home in care of spouse
What is the Most Likely Etiology of her CHF on admission?

A. Idiosyncratic cardiomyopathy
B. Beriberi
C. Wet Beriberi
D. Hypothyroidism

Case #1 Dx

Diagnosis = Wet Beriberi
- Thiamine pyrophosphate
  - Coenzyme in carbohydrate metabolism
  - Integral in the pentose monophosphate pathway for glucose formation

Thiamine B₁
- Vitamin B₁ (thiamine)
  - Required for carbohydrate, fat, amino acid, glucose, & alcohol metabolism.
  - Requires an acid environment for absorption
  - Absorbed in the proximal intestine
- Enzyme systems requiring thiamine
  - Ketoacid dehydrogenases
  - Krebs cycle, Pyruvate dehydrogenase, Acetyl CoA, Pentose monophosphate shunt
Thiamine B1 Deficiency Symptoms

- **Etiologies**
  - Malabsorption, repeated vomiting, gastric resection
  - Dialysis
- **Peripheral neuropathy**
  - Ataxia, burning feet, lancinating pains,
  - Cerebellar degeneration, encephalopathy
  - Acute: Wernicke's disease, agitation, confusion, memory loss;
  - Chronic: Korsakoff's psychosis
- **Systemic organs**
  - Cardiac failure (Wet beriberi): Congestive HF; Tachycardia; Edema
  - Infantile beriberi:
    - Breast-feeding infants whose mothers are thiamine deficient
    - Infantile: Acute cardiac failure

Trace Elements Classification Approach

- **Macro or Major minerals**
  - Sodium, potassium, magnesium, calcium, phosphorus, sulfur, chloride
- **Micro or Trace minerals**
  - Chromium, manganese, iron, cobalt, molybdenum, copper, zinc, fluoride, iodine, selenium, silicon, tin, arsenic, nickel...
  - Present in concentrations of body tissues at <50 mg/kg (50 ppm)

Case #2

46 y.o. female, 28 months post RGB.
Taking “lots of supplements and vitamins”
100 pound weight loss post surgery.
Pale, hair dull, skin poor elasticity
“Numbness” in her feet that progressed over an approximately 12 month period
  - Progressive worsening, unsteady gait, paresthesias of the lower extremities & hands
CBC was consistent with a microcytic anemia.
B12 level low normal, iron level low normal,
Serum copper level < 0.2 μg/mL (normal, 0.75 μg/mL to 1.45 μg/mL)
Copper Deficiency Symptoms

- Highlighted in 2001 in Neurology journals
- Neurologic manifestations variable
  - Usually consist of myelopathy with or without neuropathy,
  - Sensory ataxia
    - CNS demyelination, peripheral neuropathy, and optic neuropathy
    - Some of the abnormalities seem to mimic multiple sclerosis
- If early recognition neurological symptoms may be reversible


Copper Deficiency Recognition

- Unexplained pancytopenia concurrent with neurologic manifestations
  - Should prompt a serum copper evaluation
  - Early recognition of easily reversible myeloneuropathy and myelodysplasia
    - Essential to prevent progressive neurologic deterioration


Copper & Anemia

- Anemia from Copper Deficiency
- Acquired deficiency is rare, but deficiency has metabolic impact
- Etiologies of induced deficiency
  - Malabsorption
  - Omission from TPN
  - High intake of Zinc
  - Renal dialysis patients
  - Use of copper chelating agents (penicillamine)

Copper Deficiency Post Bariatric Surgery

- Consider in differential dx of etiologies for neuropathy and myelodysplasia
  - Anyone with a remote history of bariatric surgery
  - Can occur at any point up to decades post surgery


Other Risk Factors For Copper Deficiency

- Gastrectomy
- Small bowel resection or bypass
- Zinc overload
- Zinc supplementation
- Ingestion of zinc containing dental fixatives
- Malabsorption syndromes

Copper

- Essential cofactor
  - Vital to the normal hematologic function, vascular, skeletal, antioxidant, and neurologic systems.
- Copper deficiency anemia neutropenia, less commonly, thrombocytopenia
- Anemia almost always present
  - Frequently masquerades as myelodysplastic syndrome
  - Mechanism of anemia/pancytopenia
    - Impaired iron absorption, defective iron transfer from the reticuloendothelial cells to plasma, and decreased cytochrome oxidase activity in the mitochondria
Copper Dependent Enzymes

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Function</th>
<th>Localization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysyl oxidase</td>
<td>Collagen formation</td>
<td>Secreted</td>
</tr>
<tr>
<td>Ceruloplasmin</td>
<td>Iron transport</td>
<td>Secreted</td>
</tr>
<tr>
<td>Hephaestin</td>
<td>Pigmentation</td>
<td>Cell surface</td>
</tr>
<tr>
<td>Tyrosine oxidase</td>
<td>Neurotransmitter synthesis</td>
<td>Synaptic vesicles</td>
</tr>
<tr>
<td>Dopamine b-hydroxylase</td>
<td>Neurotransmitter synthesis</td>
<td>Synaptic vesicles</td>
</tr>
<tr>
<td>Tyrosine hydroxylase</td>
<td>Peptide hormone synthesis</td>
<td>Pituitary, vesicles</td>
</tr>
<tr>
<td>Peptidylglycine a-hydroxyase</td>
<td>Oxidative phosphorylation</td>
<td>Mitochondria</td>
</tr>
<tr>
<td>Cu/Zn superoxide dismutase-</td>
<td>Antioxidant</td>
<td>Cytoplasmic</td>
</tr>
<tr>
<td>monoxygenase*</td>
<td>* = requires vitamin C for activity</td>
<td></td>
</tr>
</tbody>
</table>

Copper Dietary Sources & Bioavailability

- Stored in most tissues, especially liver
- Bioavailability decreases with
  - Iron supplements
  - Antacids
- Organ meats, shellfish, whole-grain products, mushrooms, nuts, legumes

Unappreciated Copper Deficiency Post Bariatric Surgery

- Absorption
  - Duodenum and proximal jejunum postulated to be primary absorption sites
- Inhibitory effect of iron, zinc, and calcium
  - Usually supplemented at rather high doses in bariatric patients

---

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### Severe Copper Deficiency Treatment

- **Treatment of severe deficiency**
  - Daily oral copper sulphate supplementation (2.0 mg/d)
  - Intravenous copper chloride 2.0 mg of copper

- The American Society for Metabolic and Bariatric Surgery Clinical Practice guidelines recommend routine oral copper supplementation (2 mg/d).
- Guidelines advise intravenous copper (2-4 mg/d) for six days for severe deficiency. Treatment of mild to moderate deficiency, with oral copper (3-8 mg/d) until levels are acceptable.

---

### Selenium

- **Deficiency known as Keshan disease**
  - Can cause a congestive cardiomyopathy

- Primarily absorbed in duodenum

- **Clinical signs of deficiency**
  - Proximal muscle pain
  - Proximal & Symmetric weakness
  - Rare, only in a minority of selenium deficient patients

- **Laboratory diagnosis**
  - Serum selenium: Low
  - Serum CK: High or Normal
  - Vitamin E levels: Commonly low
  - Muscle fiber atrophy, thinned myofibrils, Vacuoles
  - Mitochondria: Enlargement; Reduced Number

- **Treatment:** Selenium supplementation

- Latency to improvement post replacement: ~4 weeks

---

### Selenium

- **Selenium is a Co factor to deiodinate thyroid hormones**

- Part of enzyme glutathione peroxidase
  - metabolizes hydroperoxides formed from polyunsaturated fatty acids.
  - Selenium found in poultry, meats, fish, and nuts.

- **Selenium RDA is 70 micrograms (mcg).**
  - Upper adult level of selenium is 400 mcg/day based on the prevention of hair and nail brittleness and early signs of chronic toxicity.
  - Toxic effects when blood selenium concentrations reach a level corresponding to an intake of 850 mcg/day.
Riboflavin (B\textsubscript{2})

- Involved in carbohydrate metabolism
- Essential Coenzyme in oxidation-reduction reactions
- Essentially nontoxic
- Usually accompanies other B-vitamin deficiencies.
- Symptoms
  - Sore throat, lesions of the lips, mouth mucosa, glossitis,
  - Conjunctivitis, seborrheic dermatitis, and normochromic-normocytic anemia.
- USRDA 1.7 mg

Niacin B\textsubscript{3}

- Coenzymes in oxidation-reduction reactions
- Mild deficiency shown to slow metabolism
- Pellagra
  - Diarrhea, dermatitis, “necklace” lesions on lower neck, hyperpigmentation,
    thickening of the skin, inflammation of the mouth and tongue, digestive disturbances, amnesia, delirium, death
- Common psychiatric symptoms
  - Irritability, poor concentration, anxiety, fatigue, restlessness, apathy, depression

Pantothenic Acid (B\textsubscript{5})

- Required to form coenzyme-A (CoA),
- Critical for metabolism and synthesis
  - Carbohydrates
  - Proteins, and fats.
- Adults require about 5 mg/day.
Long Term Metabolic Complications of Gastric Bypass Surgery

B₁₂ Deficiency Symptoms
- Polyneuropathy
  - Sensory change: 2° spinal or peripheral nerve lesions
  - Early: Parasthesia
  - Reflexes Reduced or absent at ankles
    - Plantar: Up going
- Autonomic: Postural hypotension
- Spinal cord: Earliest locus of involvement
  - Major cause of sensory & motor disability
  - Posterior column fiber loss
  - Gait ataxia
  - Spasticity in legs
- Other CNS
  - Cognitive impairment in adults: Leukoencephalopathy on MRI
  - Sensory: Reduced smell & taste
- Anemia:
  - Megaloblastic (reduced DNA synthesis)

More B₁₂
- Low B₁₂
  - Clinically significant: < 100 pg/ml
  - Suspicious: < 200 pg/ml
  - High homocysteine & methymalonic acid
    - Confirms biological significance of low B₁₂ levels
- Pathology Spinal cord
  - Multifocal axonal loss & demyelination
  - Localization
    - Cervical & thoracic
    - Posterior column > Anterolateral & Anterior
  - MRI
    - Hyperintense T2 lesions in posterior columns (50%)
Folic Acid (B₉)
- Red blood cells formation
- Synthesis of purines and pyrimidines
- Absorbed in the duodenum & upper jejunum
- Deficiency of folate in old age
  - Significantly increases the risk of developing dementia
- RDA for folate is 400 μg

Molybdenum
- Coenzymes component
  - Xanthine oxidase, sulfite oxidase, and aldehyde oxidase
  - Transformation of sulfite to sulfate which is necessary for the metabolism of sulfur-containing amino acids, such as cysteine.
- Adult RDA is 45 micrograms/day.
  - Legumes such as lentils, beans, & peas are good sources of molybdenum.

Iron
- Iron deficiency common in RYGB patients
- Multi-factorial factors contribute to deficiency
- Incidence
  - 33%
  - 49% in menstruating women
- Continual potential risk of deficiency for life
  - Monitor ferritin levels
- Administer Fe with Vit C to acidify/improve absorption

Brolin RE et al. Survey of vitamin and mineral supplementation after gastric bypass and biliopancreatic diversion for morbid obesity. Obesity Surg 1999; 9, 150-4
Calcium Deficiency Post RGB

- Calcium
  - Duodenal absorption via active transport
  - Some passive absorption in jejunum & ileum
  - Long term deficiency with bone loss
  - Consider Calcium citrate for better absorption!


Zinc Deficiency

- Absorbed in the duodenum and proximal jejunum
- ~ 50% of patients post bariatric diversions (BPD or DS-BPD)
  - Decreased zinc levels
  - 11% with low levels despite daily ingestion of multivitamins
- 3 basic functions: catalytic, structural and regulatory cell division, cell growth, wound healing and immunity
- Deficiency manifestations
  - Hair loss
  - Common after bariatric surgery
  - Impaired immune function (decreased development and activation of T lymphocytes)
  - ALTERED TASTE
  - Impaired wound healing
  - Acrodermatitis enteropathica
    - syndrome characterized by scaly, red desquamating skin lesions on the nasolabial folds and hands.


Chromium (Cr)

- Dietary Sources & Bioavailability
  - Regulates insulin
  - Bioavailability affected by:
    - Vitamin C
    - Acidic medications
    - Antacids
  - Transported in blood to liver
  - Food content dependent on soils
  - Whole grains, fruits/veg, processed meats, beer, wine
  - Excess excreted in urine & feces

MGC
Manganese (Mn) Deficiency & Toxicity

- **Deficiency**
  - Rare
  - Scaly skin, poor bone formation, growth faltering
- Whole grains, pineapples, nuts, legumes, dark green leafy vegetables, water
  - <10% absorbed
  - Excess incorporated into bile & excreted in feces
- **Toxicity**
  - Rare
  - Mining
  - Liver disease
  - High water levels

### Treatment for Deficiencies

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Deficiency Noted</th>
<th>Deficiency Formulation</th>
<th>Dose, mg of</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>Rare</td>
<td>KCl, MnO, MnCl₂</td>
<td>10-20 mg po 1x daily</td>
<td>N/A</td>
</tr>
<tr>
<td>Zinc</td>
<td>Rare</td>
<td>MnSO₄, MnCl₂</td>
<td>10 mg po 1x daily</td>
<td>N/A</td>
</tr>
<tr>
<td>Niacin</td>
<td>Rare</td>
<td>MnCl₂, MnSO₄</td>
<td>10 mg po 1x daily</td>
<td>N/A</td>
</tr>
<tr>
<td>Chromium</td>
<td>Rare</td>
<td>MnCl₂, MnSO₄</td>
<td>10 mg po 1x daily</td>
<td>N/A</td>
</tr>
<tr>
<td>Thiamine</td>
<td>Rare</td>
<td>MnCl₂, MnSO₄</td>
<td>0.6 mg po 1x daily</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Deficiency Recognition & TX

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent or prolonged iv (≥ 2 weeks), rapid weight loss (≥ 1 pound/day), and/or prolonged poor po intake</td>
<td>Check micronutrient assessment/analysis</td>
</tr>
<tr>
<td>Niacinamide, steatorrhea, diarrhea</td>
<td>Check B12, vitamin C, B3, B6, zinc</td>
</tr>
<tr>
<td>Niacinamide, myositis, gait disturbance</td>
<td>Check copper, vitamin E, vitamin B1, B12, B6, niacin</td>
</tr>
</tbody>
</table>

[Table 5: Current USMDS® Gastric Bypass Vitamin and Mineral Assessment Protocol in Those Admitted with the Following Signs/Symptoms]

- Peripheral neuropathy
- Microcytic anemia, iron deficiency
- Micronutrient deficiencies in RYGB patients; rare but potentially devastating

Parrish Carol R.; Severe Micronutrient Deficiencies in RYGB Patients: Rare but Potentially Devastating; Nutrition Issues in Gastroenterology: Series #100, Practical Gastroenterology 1-27, Nov 2011
Selected Toxicities of Supplements

<table>
<thead>
<tr>
<th>Vitamin/Mineral</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>&gt;10,000 UI for 3 months; skin, oral, bone, arthritis, neuropathy, mood swings, heartburn, hyperglycemia, poor cognition, increased risk limb fractures</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Weakness, arterial calcification, increased risk of cardiovascular disease</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>High doses may inhibit action of anticoagulants</td>
</tr>
<tr>
<td>Zinc</td>
<td>Suppression of immune function, carotid atherosclerosis, anemia due to interference with copper absorption</td>
</tr>
<tr>
<td>Copper</td>
<td>Severe leg tingling/numbness</td>
</tr>
</tbody>
</table>

Parrish Carol R.; Severe Micronutrient Deficiencies in RYGB Patients: Rare but Potentially Devastating, Nutrition Issues in Gastroenterology, Series #100, Practical Gastroenterology 1-27, Nov. 2011

Post-Op Monitoring

<table>
<thead>
<tr>
<th>Follow-up</th>
<th>Lab Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every 3 months for the 1st year</td>
<td>CBC, glucose, creatinine</td>
</tr>
<tr>
<td>Every 6 months for the 1st year</td>
<td>LFTs, protein and albumin, iron, TIBC, ferritin, vitamin B12, folic acid, calcium, thiamine, parathyroid hormone (if hypercalcemic)</td>
</tr>
<tr>
<td>Every year after the 1st year</td>
<td>All of the above</td>
</tr>
</tbody>
</table>


Post-Op RGB Monitoring Recommendations

- Lab tests at 3, 6, 12 months, then annually:
  - CBC, Electrolytes, glucose, ALT, AST, alkaline phosphatase, bilirubin, albumin
  - Serum Iron studies, ferritin, Vitamin B12
  - Lipid profile
  - 25-hydroxyvitamin D, parathyroid hormone (PTH)
  - Thiamine & Folate levels
- Consider other lab if neurological symptoms, anemias

1. Kushner, Robert F et al in UpToDate® 2010
Recommendations Summary
Bariatric Patients Long Term Care

- Nutritional Deficiencies—Watch for them
  - Especially with malabsorptive procedures (RYGB)
- Prevention
  - Adherence to diet high in protein
  - Lifelong supplementation
    - High potency MVI with iron
    - Vitamin B12, 1000mcg IM q mo or 100 mcg p.o. qd
    - Calcium 1200 mg q d
    - Menstruating women may require parenteral iron infusions
- Monitor patient for life


Closing Thoughts

“Despite reductions in disease-related deaths after gastric bypass surgery, the risk of non–disease-related death, (accidents and suicides) increased by a factor of 1.58 compared to the control group”

NEJM 357:8 Aug 23, 2007

One of best clinical reviews with clear charts:

Questions or Comments
References 1

- Behavioral Risk Factor Surveillance System, The Prevention Status Reports CDC 2014
- May M.; Am I Hungry? What To Do When Diets Don’t Work. Phoenix: Nourish publishing

References 2

- USPSTF. Screening for obesity in adults. AFP April 15, 2004;
- Parrish Carol R.; Severe Micronutrient Deficiencies in RYGB Patients: Rare but Potentially Devastating, Nutrition Issues in Gastroenterology, Series #100, Practical Gastroenterology 1-27, Nov. 2011

References 3

- Acquired Copper Deficiency: A Potentially Serious and Preventable Complication Following Gastric Bypass Surgery; Griffith, Daniel P. et al Obesity (Silver Spring). 2009 April ; 17(4): 827–831.
References 4


References 5


References 6

- Parrish Carol R.; Severe Micronutrient Deficiencies in RYGB Patients: Rare but Potentially Devastating, Nutrition Issues in Gastroenterology, Series #100, Practical Gastroenterology, 1-27, Nov. 2011
### Vitamin Deficiencies

<table>
<thead>
<tr>
<th>Vitamin Deficiency</th>
<th>Recommended Daily Dietary Allowance</th>
<th>Recommended Daily Vitamin D Supplemental Allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>70-100 mcg/day</td>
<td>400-800 IU/day</td>
</tr>
<tr>
<td>C</td>
<td>75-150 mg/day</td>
<td>800-1000 IU/day</td>
</tr>
<tr>
<td>D</td>
<td>400-1000 IU/day</td>
<td>400-1000 IU/day</td>
</tr>
<tr>
<td>E</td>
<td>0-15 mcg/day</td>
<td>400-800 IU/day</td>
</tr>
<tr>
<td>K</td>
<td>200 mcg/day</td>
<td>400-800 IU/day</td>
</tr>
<tr>
<td>B12</td>
<td>2.4 mcg/day</td>
<td>200-800 micrograms/day</td>
</tr>
</tbody>
</table>


### References US RDA Chart

The End