Objectives:

• Identify most common postoperative nutritional deficiencies by surgery type
• Identify signs and symptoms of nutritional deficiencies
• Management of nutritional deficiencies
What is Nutritional Deficiency?

Types of Nutritional Deficiencies:

- Macronutrient deficiencies
  - Carbohydrates
  - Protein
  - Fat
- Micronutrient deficiencies
  - Vitamins
  - Minerals
## Nutritional Deficiency Risk by Surgery Type

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Vitamins at Risk</th>
<th>Minerals at Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>RYGBP</td>
<td>Vitamin B12, Vitamin D, Folate, Thiamin</td>
<td>Calcium, Iron</td>
</tr>
<tr>
<td>Vertical Sleeve Gastrectomy</td>
<td>Vitamin B12, Thiamin</td>
<td>Calcium, Iron</td>
</tr>
<tr>
<td>BPD/Duodenal Switch</td>
<td>Vitamin A, Vitamin D, Vitamin K</td>
<td>Calcium, Iron, Zinc</td>
</tr>
<tr>
<td>Adjustable Gastric Banding</td>
<td>Vitamin B12, Folate, Thiamin</td>
<td></td>
</tr>
</tbody>
</table>
## Pre-WLS Nutrition Screenings

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommendation</th>
<th>Pre-WLS Prevalence of Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin (Vitamin B1)</td>
<td>Routine for all patients</td>
<td>16-29% reported</td>
</tr>
<tr>
<td>Cyanocobalamin (Vitamin B12)</td>
<td>Routine for all patients</td>
<td>2-18% in the obese, 6-30% in those on PPI</td>
</tr>
<tr>
<td>Folate (Folic Acid)</td>
<td>Routine for all patients</td>
<td>Up to 54% in the obese</td>
</tr>
<tr>
<td>Iron</td>
<td>Routine for all patients</td>
<td>Up to 45% in the obese</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Routine for all patients</td>
<td>Up to 90% in the obese</td>
</tr>
<tr>
<td>Calcium</td>
<td>Routine for all patients</td>
<td>5-20 µg/mL</td>
</tr>
<tr>
<td>Fat-soluble Vitamins (A, E, K)</td>
<td>Routine for all patients</td>
<td>14% for vitamin A and 2.2% for vitamin E</td>
</tr>
<tr>
<td>Zinc</td>
<td>Routine for RYGBP and BPD-DS</td>
<td>24-28% in WLS patients, 74% in those seeking BPD/DS</td>
</tr>
<tr>
<td>Copper</td>
<td>Routine for RYGBP and BPD/DS</td>
<td>Up to 70% in pre-BPD women</td>
</tr>
</tbody>
</table>
THIAMIN (VITAMIN B1)

• Post-WLS prevalence of deficiency - <1-49%
• Post-WLS screening recommended for patients with:
  – Rapid weight loss
  – Protracted vomiting
  – Parenteral nutrition
  – Excess alcohol use/alcoholism
  – Neuropathy/encephalopathy/heart failure
  – Malnourished patients
  – Female patients
  – African American and Hispanic patients
  – Patients with GI symptoms
THIAMIN (VITAMIN B1)

• Post-WLS supplementation for preventing deficiency:
  – At least 12 mg thiamin daily
    and
  – Preferably 50 mg dose of thiamin from a B-complex supplement or multivitamin once or twice a day

• Post WLS supplementation for repletion:
  – Oral therapy: 100 mg 2-3x/day until symptoms resolve
  – IV therapy: 200 mg TID to 500 mg once daily or BID for 3-5 days, then 250 mg/day for 3-5 days or until symptoms resolve.
  – Should consider treatment with 100 mg/day orally
  – IM repletion: 250 mg once/day for 3-5 days or 100-250 mg monthly
Vitamin B12 (Cyanocobalamin)

- Post WLS prevalence of deficiency at 2-5 years:
  - <20% in RYGB and 4-20% in SG
- Post WLS screening recommended for RYGB, SG and BPD/DS
  - Every 3 months in the first post-WLS year
  - At least annually or as clinically indicated
- Include serum MMA with or without homocysteine:
  - in symptomatic and asymptomatic patients
  - in patients with h/o B12 deficiency or preexisting neuropathy
Vitamin B12 (Cyanocobalamin)

• **Post WLS supplementation for preventing deficiency:**
  – All post-WLS patients
  – Orally – 350-500 mcg daily
  – Nasal spray – as directed by manufacturer
  – Parenteral – 1000 mcg monthly

• **Post-WLS supplementation for repletion:**
  – 1000 mcg per day to achieve normal levels
  – Resume dosing recommended for preventing deficiency once normal levels reached
Folate (Folic Acid)

• Post-WLS prevalence of deficiency:
  – Reported in up to 65% of patients
• Post-WLS screening is recommended for all patients
  – Monitor post-WLS female child bearing age patients

• Post-WLS supplementation for preventing deficiency:
  – 400-800 mcg orally from multivitamin
  – 800-1000mcg orally for child bearing age women
• Post-WLS supplementation for repletion:
  – 1000 mcg daily to achieve normal levels, then resume dosage to maintain normal levels
  – Supplementation of 1 mg per day not recommended
Iron

- Post WLS prevalence of deficiency:
  - Reported to occur in post-WLS patients from 3 months to 10 years:
    - AGB – 14%
    - SG - <18%
    - RYGB – 20-55%
    - BPD – 13-62%
    - DS – 8-50%
- Post WLS screening is recommended for all patients:
  - Within 3 months post surgery
  - Every 3-6 months until 12-month visit
  - Annually after first year
  - Monitor iron status including iron panel, CBC, TIBC, ferritin, soluble transferrin receptor (if available)
  - Additional iron screening based on clinical s/s and/or lab findings or if deficiency is suspected
Iron

- **Post-WLS supplementation to prevent deficiency:**
  - Low risk patients: at least 18 mg from multivitamin
  - Menstruating women post RYGB, SG or BDP/DS:
    - 45-60 mg elemental iron total from all supplements
    - Iron should be taken separate from calcium supplements, acid-reducing medications and foods high phytates, polyphenols or tannins

- **Post-WLS supplementation for repletion:**
  - 150-200 mg of elemental iron daily up to 300 mg 2-3 times daily
  - Intravenous iron infusion may be needed if deficiency does not respond to oral iron therapy
Vitamin D and Calcium

• Post-WLS prevalence of deficiency:
  – Reported in up to 100% of post-WLS patients
  – More pronounced in RYGB and BPD/DS

• Post-WLS screening is recommended for all patients
  – 25(OH)D is preferred assay
  – DXA and PTH important to interpret vitamin D and calcium levels and detect later-developing deficiencies
Vitamin D and Calcium

- Post-WLS supplementation to prevent deficiency:
  - Preventative dosing of vitamin D is based on serum vitamin D levels:
    - 3,000 IU/day until blood levels of 25(OH)D is greater than sufficient
  - Calcium supplementation recommended for all post-WLS patients
  - Dosing by surgical procedure:
    - LAGB/SG/RYGB – 1200-1500 mg/day
    - BPD/DS – 1800-2400 mg/day
Vitamin D and Calcium

• **Dosing considerations for enhancing calcium absorption:**
  – Take calcium in divided doses
  – Calcium carbonate should be taken with meals
  – Calcium citrate may be taken without regard to food
• **Post-WLS supplementation for vitamin D repletion:**
  – 2000-6000 IU vitamin D3
  – 50000 IU vitamin D2 one to three times/week
• **Post-WLS supplementation for calcium repletion:**
  – LAGB/SG/RYGB: 1200-1500 mg/day
  – BPD/DS: 1800-2400 mg/day
Vitamins A, E and K

• Post-WLS prevalence of Vitamin A deficiency:
  – Up to 70% within 4 years post surgery
  – Associated with low prealbumin
  – Should be suspected in those with protein-calorie malnutrition

• Post-WLS screening is recommended within first year post-WLS, especially for BDP/DS
Vitamins A, E and K

• Post-WLS prevalence of Vitamin E and vitamin K deficiency:
  – Low prevalence of vitamin E deficiency post-WLS
  – Vitamin E levels may increase after RNYGB and BPD/DS
  – Complications related to vitamin K deficiency are rare
Vitamins A, E and K

• Post-WLS screening for vitamin E and K:
  – Insufficient evidence to support routine screening
  – Symptomatic patients should be screened
  – Low prothrombin time used as indicator of vitamin K deficiency
  – Mean prothrombin time found to be lower in RNYGB patients

• Post-WLS supplementation to prevent deficiency:
  – LAGB/SG and RYGB: fat-soluble vitamins in multivitamins
  – BPD/DS: additional 10000 IU/day vitamin A
    300 mcg/day vitamin K
Vitamins A, E and K

- Post-WLS supplementation for repletion – Vitamin A:
  - Without corneal changes:
    - 10,000-25,000 IU/day vitamin A until clinically improved
  - With corneal changes 50,000-100,000 IU/day
    - Given IM x 3 days, then 50,000 IU/day IM x 2 weeks
    - Consider evaluating for iron and/or copper deficiencies

- Post-WLS supplementation for repletion of vitamin E:
  - Optimal therapeutic dose post-WLS not clearly defined
Vitamins A, E and K

• **Post-WLS supplementation for repletion of vitamin K:**
  – with acute malabsorption
    • 10 mg parenteral dose of vitamin K
  – with chronic malabsorption
    • 1-2 mg/day orally or 1-2 mg/wk parenterally
Zinc

- **Post-WLS screening for zinc deficiency:**
  - Annual screening for RYGB or BPD/DS
  - Serum or plasma zinc appropriate for screening
  - Should be evaluated when iron deficiency anemia screening results are negative
  - Should be evaluated in patients with chronic diarrhea
Zinc

- **Post-WLS supplementation to prevent deficiency:**
  - Based on procedure type:
    - SG/LAGB – 100% RDA in multivitamins with minerals
    - RYGB – 100-200% RDA in multivitamins with minerals
    - BPD/DS – 200% RDA in multivitamins with minerals
  - Zinc to copper ratio:
    - 8-15 mg zinc per 1 mg copper
Zinc

- **Post-WLS supplementation for repletion:**
  - Previous recommendation:
    - 60 mg elemental zinc BID
  - Insufficient data to specify new dose recommendation
  - Careful selection of dose for zinc repletion is needed to prevent copper deficiency
  - Routine monitoring of zinc status through treatment course recommended
Copper

• Post-WLS screening for copper deficiency:
  – Routine screening recommended annually after RYGB or BDP/DS
  – Serum copper and ceruloplasmin are recommended biomarkers for copper status

• Post-WLS supplementation to prevent deficiency:
  – Based on procedure type:
    • SG or LAGB: 100% of RDA (1 mg/day)
    • RYGB or BPD/DS: 200% of RDA (2 mg/day)
    • Zinc to copper ratio: 1mg copper per 8-15 mg zinc
Copper

- **Post-WLS supplementation for repletion:**
  - Varies by severity of deficiency state
    - Mild to moderate deficiency – 3-8 mg/day oral copper gluconate or sulfate until normal level attained
    - Severe deficiency – 2-4 mg/day IV copper x 6 days or until normal level attained and neurological symptoms resolve
    - Once normal copper levels return, monitor copper levels every 3 months
<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Normal Range</th>
<th>Postoperative Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 (thiamin)</td>
<td>2.5-7.5 µg/dL</td>
<td>&lt;1-49%, varies based on procedure type, post op time frame and risk factors</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>20-80 µg/dL</td>
<td>Up to 70% in RYGB and BPD/DS within 4 years</td>
</tr>
<tr>
<td>B12 (cyanocobalamin)</td>
<td>200-1,000 pg/mL</td>
<td>&lt;20% in RYGB and 4-20% in SG post-WLS at 2-5 years</td>
</tr>
<tr>
<td>Folate (Folic Acid)</td>
<td>340-1,020ng/mL</td>
<td>Reported in 65% of patients</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>&gt;30 ng/mL</td>
<td>Up to 100% of patients</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>5-20 µg/mL</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>PT: 10-13 seconds</td>
<td>Uncommon after WLS</td>
</tr>
</tbody>
</table>
# Post-WLS Mineral Deficiencies

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Normal Range</th>
<th>Postoperative Deficiency</th>
</tr>
</thead>
</table>
| **Iron** | 15-200 ng/mL (males)  
            12-150 ng/mL (females) | 14% in LAGB  
                           <18% in SG  
                           20-55% in RYGB  
                           13-62% in BPD  
                           8-50% in DS |
| **Zinc** | 60-130 µg/dL | 34% in LAGB  
                     19% in post-SG  
                     40% in post-RYGB  
                     Up to 70% in post-BPD/DS |
| **Copper** | Copper: 11.8-22.8 mmol/L  
               Ceruloplasmin: 75-145 µg/dL | 10-20% post-RYGB  
                                         Up to 90% post-BDP/DS |
Management of Nutritional Deficiencies

• **Vitamin B1 (thiamin)**
  – *Early signs and symptoms*:
    • Dry beriberi – peripheral neuropathy and/or polyneuritis, muscle weakness and/or pain of extremities, gait ataxia, convulsions
    • Wet beriberi – heart failure, lower extremity edema, respiratory distress, lactic acidosis
  – *Advanced signs and symptoms*:
    • Wernicke’s encephalopathy
    • Korsakoff psychosis and/or Wernicke-Korsakoff syndrome
  – **Diagnosis**:
    • Favorable response to thiamin
  – **Food Sources of Vitamin B1**:
    • Fortified breakfast cereals, enriched rice, egg noodles, pork
Management of Nutritional Deficiencies

• **Vitamin B12 (cyanocobalamin)**
  
  – Early signs and symptoms:
    • Pernicious anemia/megaloblastic anemia
    • Glossitis, fatigue, anorexia, diarrhea, pale
    • Numbness and paresthesia in extremities, ataxia
    • Lightheadedness or vertigo, shortness of breath
    • Tinnitus, palpitations, rapid pulse
  
  – Advanced signs and symptoms:
    • Angina or symptoms of congestive heart failure
    • Altered mental status
Management of Nutritional Deficiencies

- **Vitamin B12 (cyanocobalamin)**
  - **Diagnosis:**
    - CBC and vitamin B12 and folate levels
    - Sometimes methylmalonic acid (MMA) levels or Schilling test
  - **Food Sources of Vitamin B12:**
    - Animal products, fortified cereal, some nutritional yeast products
Management of Nutritional Deficiencies

- **Vitamin A**
  - **Early signs and symptoms:**
    - Nyctalopia, Bitot’s spots, endophthalmitis, poor wound healing
    - Hyperkeratinization of the skin, loss of taste
  - **Advanced signs and symptoms:**
    - Corneal damage, xerosis, keratomalacia, perforation
    - blindness
Management of Nutritional Deficiencies

• **Vitamin A**
  – **Diagnosis:**
    • Plasma retinol (normal range: 20-80 µg/dL)

  – **Food Sources of Vitamin A:**
    • Sweet potato, beef liver, spinach, carrots, sweet peppers, mangoes, black-eyed peas, dried apricots, ricotta cheese, tomato juice, herring, fortified ready to eat cereal, fortified skim milk, baked beans, eggs
Management of Nutritional Deficiencies

• **Vitamin D**
  - **Symptoms:**
    • Hypocalcemia, tetany, tingling, cramping
    • Metabolic bone disease, rachitic tetany
  - **Diagnosis:**
    • Levels of 25(OH)D (D2 + D3)
    • Diagnosis may be suspected based on:
      - Hx of inadequate sunlight exposure or dietary intake
      - Symptoms and signs of rickets, osteomalacia
      - Characteristic bone changes seen on x-ray
  - **Food Sources of Vitamin D:**
    • Cod liver oil, swordfish, salmon, tuna, fortified dairy and other products
Management of Nutritional Deficiencies

• **Vitamin K**
  – **Symptoms:**
    • Hemorrhage due to deficiency of prothrombin and other factors
    • Easy bruisability and mucosal bleeding, delayed blood clotting, heavy menses, nose bleeding
  – **Diagnosis:**
    • Usually prolonged PT or elevated INR that decreases after phytonadione
  – **Food Sources of Vitamin K:**
    • Collards, turnip greens, spinach, kale, broccoli, soybeans, carrot juice
Management of Nutritional Deficiencies

• **Calcium**
  
  – **Symptoms:**
    • Hypocalcemia, muscle weakness and leg cramps, tetany, neuromuscular hyper-excitability, osteoporosis
  
  – **Diagnosis:**
    • Estimation or measurement of ionized Ca
    • Sometimes further testing with Mg, PTH, PO4, alkaline phosphatase, and vitamin D concentrations in blood and cAMP and PO4 concentrations in urine
  
  – **Food Sources of Calcium:**
    • Dairy products, Chinese cabbage, kale, broccoli, fortified products
Management of Nutritional Deficiencies

• **Iron**
  – **Symptoms:**
    • Fatigue, decreased work performance, impaired learning ability, microcytic anemia, decreased immune function, enteropathy, glossitis, dysphagia, koilonychias, vertical ridges on nails, rapid heart rate/palpitations
  – **Diagnosis:**
    • CBC, serum iron, iron-binding capacity, and serum ferritin
  – **Food Sources of iron:**
    • Fortified breakfast cereals and other products, meat, seafood, poultry, tofu, white beans, lentils, spinach
Management of Nutritional Deficiencies

• **Zinc**
  – **Early Symptoms:**
    • Rash, acne
    • Change in or absence of taste
    • Immune deficiency
    • Infertility
  – **Diagnosis:**
    • Plasma zinc
  – **Food Sources of zinc:**
    • Red meat, crab, lobster, poultry, fortified breakfast cereals and whole grains, beans, nuts, dairy products
# Vitamin and Mineral Supplementation

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Start After Discharge from Hospital</th>
<th>Start 2-3 Weeks after Surgery</th>
</tr>
</thead>
</table>
| RYGB, SG     | Multivitamins: chewable or liquid which contain:  
400mcg folic acid  
15mg zinc  
18mg iron  
Take 200% of the daily value. | **Calcium Citrate**: chewable and should contain Vitamin D₃  
500-600 mg. 2-3 times a day  
Total: 1,200 – 1,500 mg /day  
**Vitamin B-12**: sublingual daily, nasal spray weekly or injection monthly  
350 – 500 µg/day or 1,000 µg/month |
| BPD/DS       | Multivitamins: chewable or liquid which contain:  
400µg folic acid  
15mg zinc  
18mg iron  
Take 200% of the daily value. | **Calcium Citrate**: chewable and should contain Vitamin D₃  
500-600 mg. 3-4 times a day  
Total: 1,800 – 2,400 mg /day  
**Vitamin A, D, & K**: water soluble or dry form  
Vitamin A: 10,000 IU  
Vitamin D: 3,000 IU  
Vitamin K: 300 µg  
May take these individually or use a multivitamin high in Vitamins A, D, & K. |
# Vitamin and Mineral Supplementation

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<tr>
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<th>Start After Discharge from Hospital</th>
<th>Start 2-3 Weeks after Surgery</th>
</tr>
</thead>
</table>
| **AGB**      | **Multivitamins**: chewable or liquid which contain:  
400µg folic acid  
15mg zinc  
18mg iron 
Take 100% of daily value | **Calcium Citrate**: chewable or petite tablets  
500-600 mg 2-3 times a day  
Total 1500 mg /day |

## Additional Supplements

**Iron**
Patients with a history of anemia and menstruating women may need to take an additional 45-60 mg of elemental iron daily.

**Biotin**
At least 3000 µg of biotin, usually marketed as hair, skin and nail vitamins, may be helpful in minimizing hair shedding after surgery.
References:

• Allied Health Sciences Section Ad Hoc Nutrition Committee. *ASMBS Allied Health Nutritional Guidelines for the Surgical Weight Loss Patient 2016 Update: Micronutrients.* Surgery for Obesity and related Diseases; (2017) 00-00


• National Institutes of Health Office of Dietary Supplements Fact Sheets
Thank You

Mahalo

Kiitos

Toda

Thanks

Merci

Gracias

Grazie

Obrigado

Takk