Nutrition Considerations for Pediatric CKD & ESRD Undergoing Bariatric Surgery

Annual Dialysis Conference
February 11, 2020
Leah Oladitan
Objectives

1. Provide context for bariatric surgery practice including risks and benefits
2. Provide a framework for discussion with a background of bariatric surgery in general pediatrics
3. Discuss case examples of bariatric surgery in pediatric renal patients
4. Foster clinical thinking about potential issues or precautions related to bariatric surgery in this population
Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory, BRFSS, 2018
https://www.cdc.gov/obesity/data/prevalence-maps.html#overall
2017
Percent of students in grades 9-12 who have obesity †
View by: Total

† Obesity is defined as body mass index (BMI)-for-age and sex ≥95th percentile based on the 2000 CDC growth chart; BMI was calculated from self-reported weight and height (weight [kg]/height [m²]).

**Data Source:** Youth Risk Behavior Surveillance System (YRBSS)
2014
Percent of WIC children aged 2 to 4 years who have obesity †

View by: Total

† Obesity is defined as body mass index (BMI) for age and sex ≥95th percentile based on the 2000 CDC growth chart; BMI was calculated from measured weight and height (weight [kg] / height [m²]). Children with missing values of height, weight, and BMI were excluded. In addition, children with biological implausible values for height, weight, and BMI defined as the following z-scores values, were excluded from the analyses: height-for-age < -5.0 or > 4.0, weight-for-age < -5.0 or > 8.0, and BMI-for-age < -4.0 or > 8.0.

Data Source: Women, Infants, and Children Participant and Program Characteristics (WIC)
Outcomes in pediatric bariatric surgery

Improvement
• Cardiovascular benefits
• Type 2 diabetes
• Obstructive Sleep Apnea
• Nonalcoholic fatty liver disease
• QOL
• Mental health

Reduction
• Idiopathic Intracranial hypertension
• SCFE/Blount’s disease
• GERD

ASMBS pediatric metabolic and bariatric surgery guidelines 2018
Nehus et al 2017
AAP guidance calls for better access to bariatric surgery for teens with severe obesity

Sarah C. Armstrong, M.D., FAAP

October 27, 2019

Metabolic and Bariatric Surgery for Pediatric Patients With Severe Obesity

Christopher R. Bellinger, MD, FAAP, Sarah C. Armstrong, MD, FAAP, Kirk W. Reichert, MD, MBA, FAAP, Marc P. Mehlsawy, MD, FACs, FAAP, TASM82, SECTION ON OBESITY, SECTION ON SURGERY

Severe obesity affects the health and well-being of millions of children and adolescents in the United States and is widely considered to be an “epidemic within an epidemic” that poses a major public health crisis. Currently, few effective treatments for severe obesity exist. Metabolic and bariatric surgery are existing but underuse treatment options for pediatric patients with severe obesity. Roux-en-Y gastric bypass and vertical sleeve gastrectomy are the most commonly performed metabolic and bariatric procedures in the United States and have been shown to result in sustained short-, mid-, and long-term weight loss, with associated resolution of multiple obesity-related comorbid diseases. Substantial evidence supports the safety and effectiveness of surgical weight loss for children and adolescents, and robust best practice guidelines for these procedures exist.

abstract
Improved eGFR in obese adolescents

Figure 1 | Three-year follow-up evaluation of estimated glomerular filtration rate (eGFR) in the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) cohort. Least-squares means and 95% confidence intervals are presented at each time point using generalized linear mixed models analysis. Participants were stratified according to baseline kidney function. Base, baseline.
Types of Bariatric Surgery

- Gastric Bypass or Roux-en-y Bypass (RYGB)
- Sleeve Gastrectomy (SG)
- Adjustable Gastric Band (AGB)
- Biliopancreatic Diversion with Duodenal Switch (BPD/DS)
Gastric Bypass/Roux-en-y Bypass (RYGB)

- ~ 1oz stomach

- Pros:
  - 60-80% excess weight loss
  - maintenance of ~50% excess weight loss
  - Food restriction
  - Increased energy expenditure
  - Positive gut hormone changes

- Cons:
  - Higher complication rates than AGB & SG
  - B12, iron, *calcium, folate deficiency risk
  - Longer LOS than AGB
  - Lifelong adherence to diet & vitamin/mineral supplements

https://asmbs.org/patients/bariatric-surgery-procedures
Gastric Bypass (Roux-en-y Bypass) - Pediatrics

- Attendance to follow up visits for several years needed
- Concern for bone demineralization due to calcium losses

https://asmbs.org/patients/bariatric-surgery-procedures
Corbeels et al 2018
RYGB nutrient absorption

- Shaded area bypassed with RYGB
- Calcium
- Phosphorus
- Magnesium
- Iron
- Copper
- Selenium
- Thiamin
- Riboflavin
- Niacin
- Biotin
- Folate
- Vitamins A, D, E, K
- Lipids
- Monosaccharides
- Amino acids
- Small peptides
- Vitamin C
- Folate
- Vitamin B12
- Vitamin D
- Vitamin K
- Magnesium
- Others*
- Water
- Vitamin K
- Biotin
- Water
- Ethyl alcohol
- Copper
- Iodide
- Fluoride
- Molybdenum
- Thiamin
- Riboflavin
- Niacin
- Pantothenate
- Biotin
- Folate
- Vitamin B6
- Vitamin C
- Vitamins A, D, E, K
- Calcium
- Phosphorus
- Magnesium
- Iron
- Zinc
- Chromium
- Manganese
- Molybdenum
- Lipids
- Monosaccharides
- Amino acids
- Small peptides
- Bile salts and acids
- Sodium
- Chloride
- Potassium
- Short chain fatty acids
Sleeve Gastrectomy (SG)

• Pyloric sphincter & intestines remain intact
• Pros
  • Food restriction, pathway not altered
  • Weight loss similar to RYGB of >50% for 3-5+ years
  • Requires no foreign objects (AGB)
  • No bypass or re-routing of the food stream (RYGB)
  • LOS ~ 2 days
  • Causes favorable changes in gut hormones

• Cons
  • non-reversible
  • Potential long-term vitamin deficiencies
  • Has a higher early complication rate than the AGB

https://asmbs.org/patients/bariatric-surgery-procedures
Sleeve Gastrectomy - Pediatrics

- Long term data not yet available
- Similar complications to adult population
- Good weight loss results
- Comorbidity reversal

https://asmbs.org/patients/bariatric-surgery-procedures
Adjustable Gastric Band (AGB)

- **Pros**
  - Food restriction
  - Weight loss ~ 40 – 50%
  - No cutting of the stomach or rerouting of the intestines
  - LOS 24 hours (or less)
  - Is reversible and adjustable
  - Lowest rate of early postoperative complications, mortality, & vitamin/mineral deficiencies

- **Cons**
  - Slower weight loss
  - Foreign device in the body
  - Esophageal dilation with overeating
  - Strict adherence to the postoperative diet & visits
  - Highest rate of re-operation

https://asmbs.org/patients/bariatric-surgery-procedures
Adjustable Gastric Band (AGB) - Pediatrics

- Not yet approved by FDA for <18 years
- Fewer nutritional complications
- Similar weight loss & comorbidity improvements
- 8-25% 2nd operation to fix mechanical issues
- More effective than behavioral interventions alone
- Lacking long-term data

https://asmbs.org/patients/bariatric-surgery-procedures
Additional considerations for pediatrics

• Psychosocial
  • Improvement in depression, eating disturbances & QOL
  • Negative psychosocial risks not well studied

• Nutritional
  • Ability to follow nutrition recommendations post-surgery critical in pre-surgery evaluation
  • Nutrition deficiencies common for iron, vitamin B12, vitamin D, & calcium.

• Informed consent (assent)
  • <18yrs understanding of risks, benefits
  • Agree to procedure

https://asmbs.org/patients/bariatric-surgery-procedures
Metabolic Bariatric Evaluation
Multidisciplinary team

- Bariatric Surgeon – experienced in performing bariatric procedures
- Pediatric specialist – experienced in adolescent care
- Registered dietitian – experienced in pediatric obesity, weight management and bariatric surgery.
- Mental health specialist – specialty training in pediatric, adolescent and family treatment. The specialist should also be trained in the treatment of eating disorders and obesity, with special experience evaluating patients and families for bariatric surgery
- Coordinator – coordinates the evaluation and follow-up care for each child
- Exercise specialist – trained to provide safe physical activity prescriptions to adolescents affected by severe obesity

https://asmbs.org/patients/adolescent-obesity
Armstrong et al 2019
Who is a good candidate?

- BMI > 40
- BMI > 35 with severe obesity related comorbidities
- >99th% weight
- At least 6 months of medically supervised weight loss and psychological evaluation, sleep study
- Stable support system
- Fit to tolerate an operation
- Mental maturity to understand diet and physical activity changes

*Note no age limit

https://asmbs.org/patients/adolescent-obesity
Not a candidate

- Medically correctable cause of obesity
- Active/recent (1 year) substance abuse
- Breast feeding, pregnant, or going to become pregnant in next two years
- Unable to tolerate anesthesia
- Not able or willing to follow nutritional guidelines
- Not able to understand what the surgery is and its lifelong ramifications
- Lacking insurance coverage

https://asmbs.org/patients/adolescent-obesity
Developmental delay, autism spectrum & syndromic obesity

- Should not be a contraindication
  - Each patient and caregiver team will need to be assessed for ability to make dietary and lifestyle changes required for surgery
  - Multidisciplinary teams should agree on the specific needs and abilities of the given patient and caregiver
  - Patients should be considered on a case-by-case basis with the assistance of the hospital ethics committee where appropriate

ASMBS pediatric metabolic and bariatric surgery guidelines 2018
Nutrition assessment pre-op

- Anthropometrics
  - Excess body weight calculated at BMI of 25
- Previous weight loss attempts & weight history
- Diet history and patterns
- Supplement use
- Cultural/social meal factors
- Physical activity habits
- Knowledge of bariatric surgery & expectations

Nutrition assessment pre-op continued

- Knowledge of healthy dietary and lifestyle habits
- Family support
- Adherence to dietary/vitamin supplements
- Trial feeding supplements for post-surgery
- Identify & correcting vitamin/mineral deficiencies

Fullmer et al 2011, Nogueira et al 2014
Pre-op renal nutrition considerations

- Identify & correct malnutrition
  - Predictors of poor nutritional status
  - Low cholesterol
  - Lean vs fat body mass
  - Functional status
  - Dietary record by multiple 24 hr recalls or 3-7 day diet history

Ben-porat et al 2019
Pre-op vitamin/mineral assessment

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Presurgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron status, serum folate, ferritin, TIBC</td>
<td>✓</td>
</tr>
<tr>
<td>Thiamin (B₁)</td>
<td>✓</td>
</tr>
<tr>
<td>B₁₂, cobalamin methylmalonic acid (optional)</td>
<td>✓</td>
</tr>
<tr>
<td>Vitamin D, 25-OH, serum calcium, PTH, alkaline phosphatase</td>
<td>✓</td>
</tr>
<tr>
<td>Hemoglobin A₁c</td>
<td>✓</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>✓</td>
</tr>
<tr>
<td>Magnesium</td>
<td>✓</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>x</td>
</tr>
<tr>
<td>Zinc</td>
<td>✓</td>
</tr>
<tr>
<td>Copper</td>
<td>x</td>
</tr>
<tr>
<td>Selenium</td>
<td>x</td>
</tr>
</tbody>
</table>
Pre-op pediatric renal considerations

- Correct micronutrient deficiencies
  - Iron
    - CKD: Tsat >20% & ferritin >100ng/mL
    - Dialysis: Tsat >20% & ferritin >200ng/mL
  - vitamin D
    - >30 ng/ml total vitamin D
  - B12
    - Serum B12
  - Thiamin (B1)
    - Erythrocyte thiamin transketolase
  - Folate
    - Serum folate or red blood cell folate level

Ben-porat et al 2019
Pre-op pediatric renal considerations

Fig. 3. Complications of bariatric surgery: intestinal calcium malabsorption and secondary PTH stimulation, GI alkali loss, intestinal fat malabsorption, and increased intestinal oxalate absorption.
Pre-op pediatric renal considerations

- DEXA Scan
  - Assess bone health
  - Establish baseline
- kidney stone risk
  - RYGB increased risk post surgery

Corbeels et al 2018
Pre-op education

• 2-week diet prior to surgery
• Post-operative diet stages
• Fluid requirements
• Supplement requirements
• Vitamin & mineral requirements
• Healthy eating and healthy meal structure

Collaborative discussion with nephrology & bariatric teams

Noguire et al 2014
Post-OP
Common complications

- Fatigue, weakness, fever
- Leg cramps
- Dehydration
- Vomiting
- Constipation
- Diarrhea
- Nausea & heartburn
Common complications → renal considerations

- Fatigue, weakness, fever → infection
- Leg cramps → dry weight
- Dehydration → transplant allograft damage
- Vomiting → electrolyte abnormalities nutrient losses
- Constipation → peritonitis
- Diarrhea → increased nutrient losses & dehydration
- Nausea & heartburn → inadequate intake & dehydration
Preventing complications

- No Caffeine
  - Gastric acid secretion stimulant & exacerbates GERD
- No Carbonation
  - Exacerbate GERD, abdominal discomfort, increase in belching and gas
  - No evidence of it stretching pouch
- No Straws
  - Cause abdominal discomfort, increase in belching and gas
- No gulping
- No hot or cold drinks
# Post-op diet advancement

<table>
<thead>
<tr>
<th>TABLE 3. Diet advancement protocols for Roux-en-Y gastric bypass, vertical sleeve gastrectomy, and laparoscopic adjustable gastric banding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1</strong>: ice chips, water, sugar-free clear liquids</td>
</tr>
<tr>
<td><strong>Roux-en Y</strong></td>
</tr>
<tr>
<td><strong>Gastric band</strong></td>
</tr>
<tr>
<td><strong>Sleeve gastrectomy</strong></td>
</tr>
</tbody>
</table>

Fullmer et al 2011
Typical Supplement consumed post bariatric surgery

Ingredients

Water, Shake Protein Blend (Milk Protein Concentrate, Calcium Caseinate, Whey Protein Concentrate), Cocoa Powder (processed with alkali), Contains 1% or less of the following: High Oleic Sunflower Oil, Inulin, Cellulose Gel and Cellulose Gum, Magnesium Phosphate, DATEM, Salt, Natural and Artificial Flavors, Sucralose, Acesulfame Potassium, Carrageenan, Vitamin and Mineral Blend (Sodium Ascorbate [Vitamin C], dl-alpha Tocopheryl Acetate [Vitamin E], Zinc Amino Acid Chelate, Biotin, Vitamin A Palmitate, Niacinamide, Potassium Iodide, Copper Amino Acid Chelate, Calcium D-Pantothenate, Chromium Chloride, Cyanocobalamin [Vitamin B12], Phytonadione [Vitamin K], Sodium Molybdate, Sodium Selenite, Folic Acid, Cholecalciferol [Vitamin D3], Pyridoxine Hydrochloride [Vitamin B6], Thiamine Mononitrate [Vitamin B1], Riboflavin [Vitamin B2]), Ferric Orthophosphate, Manganese Sulfate, Tripotassium Phosphate, Dipotassium Phosphate, Sodium Polyphosphate.

CONTAINS: MILK.
Renal considerations post-op

- **Fluids**
  - Preventing dehydration in polyuric & transplant
  - Prevent fluid overload in anuric patients with Bariatric team + nephrology team collaboration
  - Consider tools to help dry weight changes

- **Energy**
  - No standard recommendation
  - Re-evaluate with weight loss or lack of weight loss
  - Consider use of tools that assess fat and fat free mass

Protein

- Increased need with malabsorptive procedures
- Use usual KDOQI goal as starting place
- Calculate based on BMI @ 25
- Will need high protein supplement
- Monitor adequacy with labs (BUN, alb, etc) and NFPE
Electrolytes

- May need to liberalize due to restricted intake
- Potassium
  - Concern for inadequate intake & constipation
- Sodium
  - Monitor for inadequate intake, goal not less than 1500mg/day
Bone mineral density changes

Fig. 1. Bone mineral density changes at spine (panel a) and hip (panel b) following RYGB. Adapted from Yu, JBMR, 2014. Needs permission.

Vitamin D & iPTH

Fig. 2. Serum 25(OH)D (panel a) and serum PTH (panel b) following RYGB and SG.
Calcium & Phosphorus

- Phosphorus requirements similar to pre-surgery
- Calcium 1200-1500mg/day
  - calcium citrate preferred for RYGB; calcium carbonate also okay
  - divided doses 500-600mg
  - With meals
  - 2 hours away from iron
- Vitamin D 3000 IU/day
Post-op standard adolescent supplement recommendations

- Multivitamin with minerals 2 tablets/day
  - Thiamin 50mg/day; more with persistent emesis
  - Copper DRI
  - Folic acid DRI
- Iron 45-60mg/day
  - May be able to get from multivitamin
- B12
  - 350ug/day PO
  - 500ug/week nasal
  - 1000mcg/month intramuscular
- When deficiency noted
  - Zinc
  - Magnesium
  - Omega 3 fatty acids

Noguira et al 2014
# Bariatric multivitamin examples

<table>
<thead>
<tr>
<th>Serving Size: 1 Chewable</th>
<th>Per Serving</th>
<th>Daily Value %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (from Beta Carotene &amp; Vitamin A Acetate)</td>
<td>10,000 IU</td>
<td>200%</td>
</tr>
<tr>
<td>Vitamin C (as Ascorbic Acid)</td>
<td>130 mg</td>
<td>220%</td>
</tr>
<tr>
<td>Vitamin D (as Cholecalciferol)</td>
<td>3,000 IU</td>
<td>750%</td>
</tr>
<tr>
<td>Vitamin E (as D-alpha tocopheryl succinate)</td>
<td>60 IU</td>
<td>200%</td>
</tr>
<tr>
<td>Vitamin K (as Phytonadione)</td>
<td>150 mcg</td>
<td>150%</td>
</tr>
<tr>
<td>Vitamin B1 (as Thiamine HCI)</td>
<td>20 mg</td>
<td>1,333%</td>
</tr>
<tr>
<td>Vitamin B2 (as Riboflavin)</td>
<td>12 mg</td>
<td>710%</td>
</tr>
<tr>
<td>Niacin (as Nicotinamide USP)</td>
<td>40 mg</td>
<td>200%</td>
</tr>
<tr>
<td>Vitamin B6 (as Pyridoxine HCl)</td>
<td>12 mg</td>
<td>600%</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>800 mcg</td>
<td>200%</td>
</tr>
<tr>
<td>Vitamin B12 (as Cyanocobalamin and Methylcobalamin)</td>
<td>1,000 mcg</td>
<td>16,670%</td>
</tr>
<tr>
<td>Biotin USP</td>
<td>600 mcg</td>
<td>200%</td>
</tr>
<tr>
<td>Pantothenic Acid (as Calcium D-Pantothenate USP)</td>
<td>20 mg</td>
<td>200%</td>
</tr>
<tr>
<td>Iron (from Ferrous Fumarate)</td>
<td>45 mg</td>
<td>250%</td>
</tr>
<tr>
<td>Magnesium (as Magnesium Oxide, Magnesium Amino Acid Chelate &amp; Magnesium Citrate)</td>
<td>200 mg</td>
<td>50%</td>
</tr>
<tr>
<td>Iodine (as Potassium Iodide)</td>
<td>150 mcg</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Daily value not established

Other Ingredients: Natural flavors, Sucralose, Vanillin, Maltodextrin
## Post-op common nutritional deficiencies

<table>
<thead>
<tr>
<th>Nutritional factor</th>
<th>Laboratory parameter</th>
<th>Normal value</th>
<th>Effects of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin (B₁)</td>
<td>Red blood cell transketolase stimulation</td>
<td>&lt;15%</td>
<td>Beriberi, neuritis, edema, cardiac failure, anorexia, hoarseness, restlessness, aphonias</td>
</tr>
<tr>
<td>Pyridoxine (B₆)</td>
<td>Plasma PLP</td>
<td>&lt;20 nmol/L</td>
<td></td>
</tr>
<tr>
<td>Folic acid (B₉)</td>
<td>Serum folate, RBC folate, homocysteine</td>
<td>&gt;6 ng/mL, &gt;160 ng/mL</td>
<td>Neuritis, photosensitivity, megaloblastic anemia, irritability, paranoid behavior</td>
</tr>
<tr>
<td>Cobalamin (B₁₂)</td>
<td>Urine/serum B₁₂</td>
<td>&lt;3.60 nmol/mol creatinine or 200–900 pg/mL</td>
<td>Pernicious anemia, neurological deterioration</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Plasma retinol</td>
<td>20–72 µg/dL</td>
<td>Night blindness, xerophthalmia, dermatomalacia, impaired resistance to infection, follicular hyperkeratosis, poor bone growth</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ionized calcium</td>
<td>4.48–4.92 mg/dL</td>
<td>Numbness and tingling in the fingers, muscle cramps, convulsions, lethargy, poor appetite, and abnormal heart rhythms</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Serum 25-OHID</td>
<td>&lt;50 nmol/L</td>
<td>Rickets, osteomalacia</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Plasma vitamin C</td>
<td>0.2–2 mg/dL</td>
<td>Bleeding gums, diarrhea, perifollicular hemorrhage, scurvy</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Plasma α-tocopherol</td>
<td>0.7–10 mg/dL</td>
<td>Hyporeflexia spinocerebellar and retinal degeneration</td>
</tr>
<tr>
<td>Zinc</td>
<td>Serum zinc</td>
<td>0.75–1.2 mg/L</td>
<td>Anorexia, hypoguesia, delayed growth or sexual maturation, impaired wound healing</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Serum magnesium</td>
<td>1.5–2.0 mg/dL</td>
<td>Convulsions, neuropsychiatric disorders, hypomagnesemia</td>
</tr>
<tr>
<td>Copper</td>
<td>Serum copper</td>
<td>1.10–1.45 mg/L</td>
<td>Microcytic, hypochromic anemia, delayed growth osteoporosis, neutropenia</td>
</tr>
</tbody>
</table>

**Deficiency common post-surgery**

**Common ESRD deficiency**

Fullmer et al 2011
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Treatment for depletion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron²</td>
<td>CKD non-dialysis iron deficiency can be treated orally by 200 mg/d elemental iron for 1–3 mo. If the goals for correction are not achieved, i.v. supplementation should be considered. Hemodialysis patients should be treated with i.v. supplementation at the beginning of treatment for iron deficiency. Iron supplementation may be discontinued when TSAT &gt; 30% and serum ferritin &gt; 500 ng/mL.</td>
</tr>
<tr>
<td>Vitamin B-12</td>
<td>1000–2000 µg/d sublinguistic or 1000 µg/wk i.m. to achieve normal levels and then resume dosages recommended to maintain normal levels.</td>
</tr>
<tr>
<td>Folate</td>
<td>Oral dose of 1000 µg folic acid/d for a short period of 3 mo to achieve normal levels and then resume recommended dosage to maintain normal levels, check B-12 before supplementation. It is not recommended to consume more than 1 mg/d to prevent masking of B-12 deficiency.</td>
</tr>
<tr>
<td>Thiamine</td>
<td>Treat post-BS patients with suspected thiamine deficiency before or in the absence of laboratory confirmation of deficiency and monitor and evaluate resolution of signs and symptoms. Repletion dose for thiamine deficiency varies based on the route of administration and the severity of symptoms, as follows: oral therapy 100 mg 2–3 times per d until symptoms resolve; i.v. therapy 200 mg 3 times per d to 500 mg once or twice per d for 3–5 d, followed by 250 mg/d for 3–5 d or until symptoms resolve, then consider treatment with 100 mg/d orally, usually indefinitely or until risk factors have been resolved; i.m. therapy 250 mg once per d for 3–5 d or 100–250 mg monthly.</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Cholecalciferol ≥3000–6000 IU/d, or 50,000 IU vitamin D-2 1–3 times/wk, followed by maintenance therapy. Vitamin D loading should be given over a limited time frame period, together with serum calcium, 25(OH)D, PTH, and phosphorus monitoring and under medical supervision. Supplementation should be decided on a personal basis and in some conditions active oral vitamin D should be considered by the nephrologist².</td>
</tr>
<tr>
<td>Magnesium</td>
<td>In case of deficiency after BS, oral magnesium citrate 300 mg/d should be prescribed.</td>
</tr>
</tbody>
</table>
## Post-op nutritional monitoring

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Presurgery</th>
<th>2 Months Postsurgery</th>
<th>Post Month 6</th>
<th>Post Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron status, serum folate, ferritin, TIBC</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Thiamin (B₁)</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>B₁₂ cobalamin methylmalonic acid (optional)</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Vitamin D, 25-OH, serum calcium, PTH, alkaline phosphatase</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Hemoglobin A₁c</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Magnesium</td>
<td>√</td>
<td>x</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>Optional</td>
</tr>
<tr>
<td>Zinc</td>
<td>√</td>
<td>x</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Copper*</td>
<td>x</td>
<td>x</td>
<td>RYGB</td>
<td>RYGB</td>
</tr>
<tr>
<td>Selenium*</td>
<td>x</td>
<td>x</td>
<td>RYGB</td>
<td>RYGB</td>
</tr>
</tbody>
</table>

There are no data regarding copper or selenium post-VSG. PTH, parathyroid hormone; RYGB, Roux-en-Y gastric bypass; TIBC, total iron binding capacity; WLS, weight loss surgery.

*With specific findings.
Long term follow up

- Continue follow up with dietitian critical to provide guidance
  - Weight regain
  - Vitamin deficiencies
- Support groups
  - Peer to peer connection
  - Improved postoperative weight loss
Hyperoxaluria with RYGB
Hyperoxaluria with RYGB

Figure 1. Mean 24-hour urinary oxalate excretion 1 and 2 years after Roux-en-Y gastric bypass is increased 2-fold compared with baseline. Three-month urinary oxalate excretion data have been reported elsewhere.\textsuperscript{10} Bar, mg/d.

Duffey et al 2010
Kidney stones with RYGB

- 24-63% Hypocitraturia prevalence in RYGB
- Citrate plays key role in preventing calcium oxalate and calcium phosphate crystallization
- CKD also reduces oxalate excretion
- Recommend supplement calcium and check citrate levels
  - Caution citrate in ESRD as it increases aluminum absorption

Sinha et al 2007, Duffey et al 2010
Renal supplement considerations

- **Vitamin A**
  - Check levels before supplementing
  - Dialysis patients do not supplement
  - CKD only when deficient, limit to DRI or less with RAE

- **Vitamin E & Vitamin K**
  - CKD/ESRD intakes comparable to healthy controls
  - Supplement only when <DRI or deficiency noted

- **Vitamin C**
  - Excessive intake can lead to oxalate kidney stones
  - <200% DRI
Hemodialysis - James

- 16-year male with ESRD related to PUV and renal dysplasia now on HD 3x weekly 4 hours
- Comorbidities: Hypertension, obstructive sleep apnea, dysfunctional voiding with urinary incontinence
- Diet: Sodium, potassium, phosphorus controlled. Fluid limit 1500ml/day.
- Adherence
  - Takes medication as prescribed
  - Phosphorus, iPTH & potassium well controlled; nPCR 1
  - Does not self cath as recommend
  - Exceeds IDWG regularly
  - Limited desire for weight loss counseling
- Prescribed medications: calcium carbonate (1000mg elemental daily), ferrous sulfate 120mg/day, sevelamer carbonate 2400mg with meals, Vitamin D 4000 IU/day, dialyvite with zinc, calcitriol 1 mcg/day.
- Morbid obesity a concern for transplant & considering sleeve gastrectomy
- Social: Mom is stable, dad is unstable
BMI

BMI pre-dialysis initiation

BMI at time of transplant discussion
Is he a bariatric surgery candidate?

Pros
• Takes medication as prescribed
• Stable home life with mom
• Has demonstrated weight maintenance on dialysis

Cons
• Unable to follow all dietary recommendations
• Not interested in lifestyle modifications to address weight
Moving forward with bariatric surgery

- What concerns do you have?
- What would you assess & monitor in pre-bariatric phase?
- What recommendations do you have with bariatric team pre-surgery and for surgery admission?

- Adhere post-surgery
- NFPE, BIA, bone mineral
- Dietary recall & intake
- Adherence
- Supplement pending labs & diet recall: renal MV, Calcium, vitamin D, iron, excessive vitamin A
- Discuss post-surgery vitamins, supplements, fluid & diet with bariatric team
Pre-op timeline of events

- **Initial visit**
  - Bariatric Surgeon

- **Month 1**
  - ESRD clinic
  - Renal Psychology

- **Month 2**
  - ESRD Clinic
  - Bariatric team clinic

- **Month 3**
  - ESRD clinic
  - Bariatric team visit

- **Month 4**
  - Renal Psychology
  - Indirect calorimetry

- **Month 5**
  - ESRD clinic
  - Bariatric Psychology visit

- **Month 6**
  - Renal Psychology
  - Bariatric clinic

- **Month 7**
  - Psychology
  - Bariatric clinic

- **Month 8**
  - ESRD clinic
  - Exercise Physiology
  - Bariatric clinic

- **Month 9**
  - Pre-op surgery
  - Psychology
  - Renal ESRD clinic
What are you looking at post-op?
### What are you looking for post op?

**TABLE 7. Age-appropriate laboratory parameters to be monitored postadolescent obesity surgery**

<table>
<thead>
<tr>
<th>Nutritional factor</th>
<th>Laboratory parameter</th>
<th>Normal value</th>
<th>Effects of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>✡ Thiamin (B₁)</td>
<td>Red blood cell transketolase stimulation</td>
<td>&lt;15%</td>
<td>Beriberi, neuritis, edema, cardiac failure, anorexia, hoarseness, restlessness, aphonia</td>
</tr>
<tr>
<td>✡ Pyridoxine (B₆)</td>
<td>Plasma PLP</td>
<td>&lt;20 nmol/L</td>
<td>Neuropathy, photosensitivity</td>
</tr>
<tr>
<td>✡ Folic acid (B₉)</td>
<td>Serum folate, RBC folate, homocysteine</td>
<td>&gt;6 ng/mL, &gt;160 ng/mL</td>
<td>Megaloblastic anemia, irritability, paranoid behavior</td>
</tr>
<tr>
<td>✡ Cobalamin (B₁₂)</td>
<td>Urine/serum B₁₂ *</td>
<td>&lt;3.60 mmol/mol creatinine or 200–900 pg/mL</td>
<td>Pernicious anemia, neurological deterioration</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Plasma retinol</td>
<td>20–72 µg/dL</td>
<td>Night blindness, xerophthalmia, dermatomalacia, impaired resistance to infection, follicular hyperkeratosis, poor bone growth</td>
</tr>
<tr>
<td>✡ Calcium</td>
<td>Ionized calcium</td>
<td>4.48–4.92 mg/dL</td>
<td>Numbness and tingling in the fingers, muscle cramps, convulsions, lethargy, poor appetite, and abnormal heart rhythms</td>
</tr>
<tr>
<td>✡ Vitamin D</td>
<td>Serum 25-OHID</td>
<td>&lt;50 nmol/L</td>
<td>Rickets, osteomalacia</td>
</tr>
<tr>
<td>✡ Vitamin C</td>
<td>Plasma vitamin C</td>
<td>0.2–2 mg/dL</td>
<td>Bleeding gums, diarrhea, perifollicular hemorrhage, scurvy</td>
</tr>
<tr>
<td>✡ Vitamin E</td>
<td>Plasma α-tocopherol</td>
<td>0.7–10 mg/dL</td>
<td>Hyporeflexia spinocerebellar and retinal degeneration</td>
</tr>
<tr>
<td>✡ Zinc</td>
<td>Serum zinc</td>
<td>0.75–1.2 mg/L</td>
<td>Anorexia, hypogeusia, delayed growth or sexual maturation, impaired wound healing</td>
</tr>
<tr>
<td>✡ Magnesium</td>
<td>Serum magnesium</td>
<td>1.5–2.0 mg/dL</td>
<td>Convulsions, neuropsychiatric disorders, hypomagnesemia</td>
</tr>
<tr>
<td>✡ Copper</td>
<td>Serum copper</td>
<td>1.10–1.45 mg/L</td>
<td>Microcytic, hypochromic anemia, delayed growth osteoporosis, neutropenia</td>
</tr>
</tbody>
</table>

- ✡ Deficiency common post-surgery
- ✦ Common ESRD deficiency

Fullmer et al 2011
What are you looking at post-op?

• S/S vitamin/mineral deficiencies
• Adherence to diet, supplements & fluids
• Need to liberalize or adjust diet
• Adjustment of dry weight frequently
Chronic Kidney Disease - Val

- 18-year-old female
- CKD stage II related to Henoch-Schonlein Nephritis/IgA Nephropathy
- Comorbidities Hypertension, morbid obesity, hyperlipidemia
- Renal nutrition involvement only seen for Transplant meeting
- Initial visit BP meds, calcium carbonate 800mg elemental, omega 3, atorvastatin, metformin, vitamin D 5000
- Working with bariatric team for RYGB
Pre-surgery BMI
Discussion

• What concerns do you have?
• What would you assess & monitor in pre-bariatric phase?
• What recommendations do you have with bariatric team pre-surgery and for surgery admission?
• Nutrient deficiencies post-op
• Per bariatric program monitoring, available PRN
• Supplement pending labs & diet
• No renal nutrition concerns supplements per bariatric team with renal dietitian review
Pre-op timeline

Month 1: Bariatric Surgeon
Month 2: CKD clinic (no RD) Bariatric clinic team
Month 3: Bariatric clinic
Month 4: Psych with Bariatric MB team
Month 5: Bariatric team
Month 6: IUD placement
Month 7: CKD clinic (no RD) Bariatric clinic no show
Month 8: CKD clinic (no RD) Bariatric clinic no show
Month 9: Bariatric clinic
Month 10: Bariatric clinic ESRD meeting
Month 11: CKD clinic (no RD)
Month 12: Bariatric clinic
Month 13: CKD clinic (no RD)
Month 14: Bariatric & CKD III
Month 15: Exercise Physiologist
Month 16: Awaiting insurance approval working with bariatric program on diet changes
Month 17: Bariatric clinic
Month 18: Bariatric clinic
Month 19: Bariatric clinic
Month 20: Bariatric clinic
# What are you looking at post-op

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Presurgery</th>
<th>2 Months Postsurgery</th>
<th>Post Month 6</th>
<th>Post Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron status, serum folate, ferritin, TIBC</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Thiamin (B&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>B&lt;sub&gt;12&lt;/sub&gt; cobalamin methylmalonic acid (optional)</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Vitamin D, 25-OH, serum calcium, PTH, alkaline phosphatase</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Hemoglobin A&lt;sub&gt;1c&lt;/sub&gt;</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Magnesium</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>√</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>Optional</td>
</tr>
<tr>
<td>Zinc</td>
<td>√</td>
<td>x</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Copper&lt;sup&gt;a&lt;/sup&gt;</td>
<td>x</td>
<td>x</td>
<td>RYGB</td>
<td>RYGB</td>
</tr>
<tr>
<td>Selenium&lt;sup&gt;a&lt;/sup&gt;</td>
<td>x</td>
<td>x</td>
<td>RYGB</td>
<td>RYGB</td>
</tr>
</tbody>
</table>

There are not data regarding copper or selenium post-VSG. PTH, parathyroid hormone; RYGB, Roux-en-Y gastric bypass; TIBC, total iron binding capacity; WLS, weight loss surgery.

<sup>a</sup>With specific findings.

- kidney stone risk
  - Calcium Citrate/Vitamin D
  - Vitamin C intake
What are you looking at post-op

• kidney stone risk
  • Calcium Citrate/Vitamin D
  • Vitamin C intake
Pediatric patients with renal diseases can be good candidates for metabolic bariatric surgery.

Bariatric surgery requires close monitoring and coordination between nephrology and bariatric surgery teams.

All nutritional monitors for renal patients should continued to be monitored and assessed following bariatric surgery.

Bariatric surgery increases risk of micronutrient deficiencies both short and long term, decreased bone mineral density, and kidney stone formation.


LOVE WILL.