Folate and vitamin B12 deficiency Case Study

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CASE STUDY REPORT

PI:
Patient MH is a 72 yo female with general pancytopenia admitted to facility 1014 on March 15, 2015. She weighs 165 lbs and is 5’1”.

CC:
“My doctor felt that my bloodwork needed a second opinion.”

HPI:
Over last six months, patient noticed increasing fatigue and paresthesia in hands and feet. Physician noted general pancytopenia from recent outpatient lab work and ordered hematology consult.

PMH:
Patient’s medical history includes: Gradiva 1 para 1 - vaginal delivery at age 32; vertebral compression fracture L1-L2 secondary to osteoporosis, and osteoarthritis. Patient’s surgical history includes an appendectomy at age 12 and a gastric bypass 25 years ago. Patient takes the following medications at home: Fosamax 10 mg one time daily; Celebrex 200 mg one time daily; 800 mg calcium twice daily; 800 IU vitamin D.

FH:
Patient’s mother had ovarian cancer; father had atherosclerosis and type 2 DM.

SH:
Patient is a Caucasian and identifies with Catholic religion. Patient does not smoke but does drink occasionally. She has become a widow and is a retired counselor. She has 16 years of
education and is bilingual in English and Spanish. She lives with her daughter, son-in-law, and granddaughter.

**PE:**

Patient appeared pale and obese in the abdominal area. Patient’s respiratory rate was rapid (27). Her BP was 130/78 which classifies as pre hypertension. Her temp (98.5), pulse (94), and urine output (1,562 mL) were all within normal range. Her skin appeared sticky which can be a sign of low blood oxygen levels. Blood vessels of extremities showed diminished pulses bilaterally which may be the cause of her paresthesia.

**ASSESSMENT:**

Physician noted hypoactive bowel sounds x4 which means her intestinal activity has slowed down. Physician also noted general pancytopenia from outpatient lab work. Results from assessment indicated low folate, B12, elevated MMA, and megaloblastic anemia. Patient’s diagnosis is B12 and folate deficiency with megaloblastic anemia secondary to gastric bypass and malabsorption combined with probable deficient dietary intake.

**HOSPITAL COURSE or Patient Treatment Course:**

After patient was admitted to hospital, labs such as: CBC, Chem 27, folate, B12, MMA, Hcy, antiparietal cell antibodies, anti-intrinsic factor antibodies, and Schilling test were ordered. A hematology consultation was also ordered. Vital signs need to be taken every 8 hours. Patient was to continue home medications.

Patient’s plan is to take 1000 ug cyanocobalamin, 5000 ug folate, weekly B12 injections, folate supplementation, repeat lab values, and have nutritional consultation. Abnormal lab values for the patient were cell volume, Hgb, RBC, Platelet count, and MMA.
Before admission patient was taking the following: Fosamax 10 mg one time daily, Celebrex 200 mg one time daily, Calcium 800 mg twice daily, vitamin D 800 IU. Post admission orders require MH to continue all medications plus Colace (docusate) 100 mg po two times daily if she has no bowel movement as well as Milk of Magnesia 30 mL po daily prn.

**THEORETICAL DISCUSSION OF DISEASE PROCESSES:**

Folate and Vitamin B12 deficiencies are closely related. Because both are water soluble B vitamins, one affects the other. The main sign of folate and vitamin B12 deficiency is megaloblastic anemia, which is defined as “a blood disorder marked by the appearance of very large red blood cells” (Megaloblastic Anemia). “Vitamin B12 deficiency anemia is a low red blood cell count due to a lack of vitamin B12” (Anthony AC, 2014). Normal B12 ranges are 24.4-100 ng/dL and MH’s is 11 ng/dL which is significantly low. Some reasons one might become deficient in B12 are: not eating enough foods that contain vitamin B12 (meat, fish, dairy); patient’s body is not absorbing B12 efficiently. “Your body must absorb enough vitamin B12. A special protein, called intrinsic factor, helps your body do this. This protein is released by cells in the stomach” (Anthony AC, 2014).

Folate functions as a coenzyme in the synthesis of DNA and RNA as well as the metabolism of amino acids. One of the primary roles of folate is the conversion of homocysteine to methionine. Normal Folate levels are 5-25 ng/dL and MH’s is 3.2 ng/mL, which is also significantly low. MH’s mean cell volume, mean cell Hgb, mean cell Hgb content, and RBC distribution are all high. Her platelet count is at 135 and low. Her serum chemistry levels are all in normal ranges. In order to evaluate vitamin B12 and Folate levels, specific tests and procedures must be conducted. A complete blood count is almost always done to determine if
blood cells are within normal range. A blood test will also determine if B12 and folate levels are normal. The following tests may be done as well:

- **Comprehensive Metabolic Panel** - evaluates organ function
- **Antinuclear Antibody** - evaluates autoimmune disorders
- **C-Reactive Protein** - identifies presence of inflammation
- **Rheumatoid Factor Tests** - to diagnose Rheumatoid Arthritis

For deficiency itself, there are no common drugs prescribed. Instead, if deficiency is related to diet, patient will see a Nutritionist for a diet plan. Dietary treatment includes eating foods with high vitamin B12 and folate such as meats, salmon, milk, and eggs. If the deficiency is non-diet related, then B12 injections are recommended every three months for the rest of the patient’s life.

**FINAL NUTRITIONAL CARE PLAN:**

The patient MH is a 72 yo female who is 5’1” tall and weighs 165 lbs. Her actual and usual body weight is 165 lbs because she has been stable at this weight for the last 5 years. Her IBW is 105 lbs, and %IBW is 157%. An adjusted IBW will be used for MH because she meets the criteria for needing adjusted IBW, which is that %IBW be above 125%. Her adjusted IBW is 120 lbs and her % IBW is 137.5% (based on adjusted IBW). Besides MH meeting the criteria, she is an elderly individual and has not been below 150 lbs for at least the past 25 years, therefore it would be very difficult and more damaging to her health, if her weight dropped to 105 lbs.

MH is obese (class 1), with a BMI of 31. Our Pt had a gastric bypass surgery (Roux-en-Y), twenty-five years ago and lost over 150 lbs. Since then, her weight has been between 150 lbs-175 lbs
and has been overweight or obese since then. Her serum albumin laboratory value is 3.7 g/dL (WNL) and her total lymphocyte count is 25% (WNL).

**Nutritional diagnoses:**

Based on the physical evaluation and laboratory values of the Pt, the three main problems of MH are that she is obese and that she has impaired nutrient utilization due to weight loss surgery. Her three diagnoses are as follows:

1. **Obesity class 1** R/T excessive caloric intake and physical inactivity **AEB** BMI of 31, 24 hour recall (700 kcal above EER) and reported inactivity.

2. **Impaired nutrient utilization of vitamin B12** R/T malabsorption due to altered GI function and poor dietary intake **AEB** abnormal vitamin B12 <100 ng/dL and elevated MMA lab values >0.56 mmol/L.

3. **Impaired nutrient utilization of folate** R/T vitamin B12 deficiency **AEB** abnormal vitamin B12 <100 ng/dL and abnormal folate levels <5 ng/dL.

**Diet History:**

Pt eats many types of foods, but most often eats fruits and vegetables, with some grains. She rarely eats meat, but does enjoy chicken, eggs, and dairy products. Currently she is taking calcium and vitamin D supplements to help treat her osteoporosis. She has no allergies and no changes in appetite, taste, or smell.

MH does not have any physical or motor skill limitations that would affect her nutrition. There are no chewing or swallowing disabilities, no presence of nausea or vomiting, and her bowel movement is normal. No teeth or denture abnormalities were noted.
Pt claims to have had an “active retirement” up until 6 months ago when she started feeling fatigue. Otherwise, there are no other physical limitations that she would need assistance with.

**EVALUATION OF LABORATORY FINDINGS**

Folate and MMA readings are the most significant when diagnosing megaloblastic anemia, but all of the following lab readings were important to address because they were not within normal limits. The significant lab findings of our pt were mean cell volume, mean cell Hgb, RBC distribution, platelet count, vitamin B12, folate, and MMA. Bone marrow aspirate was also consistent with her diagnosis.

The mean cell volume of blood should be within the range of 80-96 µm$^3$ and her result was 130 µm$^3$. The increase in volume of cells in the pt’s blood is due to the increase in cells that are abnormally large and immature, which is a characteristic of megaloblastic anemia. Immature blood cells make it impossible for oxygenation to occur.

The normal range for the mean cell volume of Hgb is 26-32pg and her reading was 34pg, which is higher than normal. The Hgb mean cell content is also abnormal at a reading of 38pg when it should be between 31.5-36pg. These readings are clinically significant because hemoglobin is protein responsible for the transportation of oxygen in the body. Megaloblastic anemia has less red blood cells because they are larger, therefore the hemoglobin levels are more concentrated in the large immature cells. The readings indicated that there is an excessive amount of Hgb in her blood.

The RBC distribution result was 17.8%, which is higher than the normal range of 11.6-16.5%. This value may be above normal due to the large cells that are seen in megaloblastic
anemia. The distribution of red blood cells shows as higher levels because the large red blood cells take up more space.

Her platelet count was 135x10^3/mm^3, which is abnormally lower than the desired range of 140-144 x10^3/mm^3. If her platelet count is low, then it may be attributed to the low levels of B12 and folate that affect the components of blood itself. This is significant because platelets are needed for the clotting of blood.

The lab result for vitamin B12 was 11 ng/dL, which is lower than the normal range of 24.4-100 ng/dL. This is significant in diagnosing the pt because it may indicate a poor intake of vitamin B12 food sources, malabsorption related to changes in the GI tract due to gastric surgery, or a reduction in intrinsic factor that aids absorption of this vitamin. Not having enough vitamin B12 also affects utilization of the active form of folate.

The pt’s folate reading was also lower than normal. The normal desired range is 5-25 ng/dL and her result was 3.2 ng/dL. This shows that the pt is not consuming enough folate or enough vitamin B12 that helps with the body’s utilization of folate. A low folate reading may indicate megaloblastic anemia.

Lastly, the pt’s methylmalonic acid (MMA) value was higher than normal. Her result was a reading of 0.75 mmol/L when the normal range is 0.08-0.56 mmol/L. This is significant because an accumulation of MMA indicates a deficiency in vitamin B12. This vitamin assists with the metabolism of MMA. A high MMA reading may also indicate megaloblastic anemia.

**REVIEW OF MEDICATIONS AND FOOD/NUTRIENT INTERACTIONS**

Pt has not reported any side effects from the medications she is taking. Only complaints she has mentioned are fatigue and paresthesia in both hands and feet, which are more likely
associated with her megaloblastic anemia. Her stool is normal and all other significant values are associated with her anemia.

Our only concern is the interaction between her medication Fosamax and her calcium supplements. Fosamax is used to treat osteoporosis in women after menopause. No calcium supplements (nor MVI multivitamin infusion) should be taken for 2 hours before or after taking this medication. An interaction between these two may cause nausea, abdominal pain, and loose bowel movements and lower the effect of fosamax. Even though the pt has not experience any of these symptoms, this is an important food/nutrient interaction that the pt should be aware of.

**EVALUATION OF PHYSICAL OR CLINICAL FINDINGS:**

Presence of physical or clinical findings that could be affecting diagnosis, condition, nutrition status or outcome as well as tolerance to current diet orders (includes p.o., EN or PN). As MH’s physical findings of diet for meals is proper by mouth, she does not need to employ the method of either EN or PN. Metabolites such as Homocysteine and Methylmalonic acid (MMA) are the factors to monitor the condition of megaloblastic anemia and assess tolerance and adequacy of consuming adequate b12 injection and folate supplement. Since most patients with folate deficiency have normal MMA or mildly elevated levels. About 50% of those with elevation of these metabolites will have normal serum vitamin B12 levels (Aslinia, F., Mazza, J., & Yale, S., 2006). This emphasizes the low sensitivity of using vitamin B12 levels, especially in the presence of other signs or symptoms.

In addition, anti-parietal cell antibodies attack and destroy parietal cells, so intrinsic factor can be made if parietal cells are destroyed while anti-intrinsic factor antibodies attack
intrinsic factor and prevent vitamin b12 from absorbing. Since both antibodies are negative, the diet order can be decided to be three meals daily, 5000 ug folate weekly, 1000 ug cyanocobalamin injection to improve its absorption by avoiding impaired utilization of intrinsic factor.

**ENERGY REQUIREMENTS:**

Based on the patient’s information available at this time, the Mifflin-St Jeor equation using actual body weight will provide the most accurate assessment of estimated energy requirement (EER) in the obese patient (BMI >30).

Pt: Wt: 165 lbs or 75 kg; Ht: 5’1” or 61” or 155 cm; age: 72 y/o.

EER = 10W + 6.25H - 5 Age -161 = (10 x 75) + (6.25 x 155) - (5 x 72) - 161 = 1197.8 kcal/day (~1200 kcal/day).

**PROTEIN REQUIREMENTS:**

For protein requirement in patients who have disease, if they receive adequate kcal, protein requirements can be met by providing 1.0 - 1.5 g protein/kg/day based on her current body weight ((Nelms, M., Sucher, K., & Lacey, K., 2014). Since MH’s current body weight is 165 lbs or 75 kg (current weight= 165 lbs / 2.2 lbs/kg = 75 kg). Thus, her protein needs are range from 75 to 112.5 g.

**DIET ORDER:**

MH has no problems with oral intake of food. Based on the Mifflin-St. Jeor equation her EER is 1200 kcal/day (Nelms et al., 2014). Her estimated protein intake is 75g to 112.5g based on 1.0-1.5 g/kg. It will be recommended that MH consume 25-35% of her total calories from fat, (TLC recommendation).
Diet Therapy:

The dietary goals for MH are appropriate and can be achieved with proper care. The estimate of her caloric intake based on her 24-hour diet recall was 1900 kcal, calculated by Supertracker from the Choosemyplate.gov website. Her EER and EPR were calculated based on her actual body weight because using her adjusted IBW resulted in estimated caloric needs that seemed too low for an individual her age. Using her actual weight also seemed appropriate because her EER was 700 kcals lower than her estimate caloric intake based on the 24-hour diet recall. Even if MH consumes a few more calories she can achieve weight loss by following the EER we recommend for her. Consuming an average of 1200-1400 kcal a day (500-700 kcal less a day from her estimated energy intake) can result in weight loss of about 45 lbs in 11 ½ months. The ideal weight we recommend for MH is 120 lbs, adjusted IBW, because striving for a 72 year individual to be 105 lbs can be more damaging if the Pt has future health problems. Weighing 120 lbs places MH in the normal range for healthy weight with a BMI of 23. This number seems more appropriate for MH.

Emphasis on continuing supplementation will be addressed, specifically vitamin B12, as instructed by her physician. It is critical that she supplement B12 by injection or with a sublingual pill because she has an altered GI function due to gastric surgery that does not support B12 absorption, (Nelms et al., 2014). The diagnosis of megaloblastic anemia can be reversed by appropriate supplementation of B12 and folate. Additionally, other laboratory values that could point to a more serious anemia are still within normal limits, (i.e. homocysteine), which show that the anemia can be reversed. Other tests like ferritin and iron values are normal but in the lower end, which indicates that MH seeked treatment just in time
before getting worse. Her laboratory values can also mean that MH stopped taking her supplements recently because when a person has gastric bypass surgery, she is told which supplements she has to take for life. Nutrition counseling to remind MH of the importance of taking supplements should be enough for her to take them again. If she has issues of remembering to take them, the food diary can help her with that, and educating her daughter and son-in-law may also help, since she lives at home with them.

**NUTRITIONAL GOALS:**

Develop short-term and long-term goals for the management of the Pt’s diet. For each goal, there should be at least one objective detailing how the goal will be achieved. List the most important goals first.

The primary goal for MH is to treat and reverse her symptoms of megaloblastic anemia. Getting a second opinion on her blood work was the best first step that our Pt took. To treat her megaloblastic anemia promptly, she has been given a 1000 ug of cyanocobalamin (B12) IM and 5000 ug of folate. She has been directed to return weekly for additional injections. During these visits MH will be educated on the importance and need for her to always consume her supplements as instructed. If injections of B12 are no longer needed once megaloblastic anemia has been treated, MH can try taking vitamin B12 in a sublingual pill.

Once a plan had been established to treat megaloblastic anemia, a plan for weight loss will be implemented for MH. The goal is for MH to reach an adjusted ideal body weight of 120 lbs. To reach 120 lbs MH will consume 1200 kcal/day with a protein range of 75 to 112.5 g/day. Based on the TLC diet, (Therapeutic Lifestyle Changes), recommended intake of fat is 25-35% of total kcal/day, 300-350 kcal/day should come from fat. MH will be educated on healthier
sources of fat. Physical activity of non-strenuous exercise for at least 30 minutes a day will also be recommended to influence weight loss. Consequently, the long term goal for MH is to lose 45 lbs within one year. By consuming 1200 kcal a day, MH will be reducing her kcal intake by an average of 500 kcal day. This will result a loss of one pound a week (500 kcal/day X 7 days/week=3500 kcal/week; 3500 kcal = 1 lb). To lose 45 lbs, it will take MH about 11 ½ months to a year. A year to lose 45 lbs is appropriate for MH considering she is an elderly individual and because we do not want her to lose weight rapidly, as it may cause her more harm than good.

**ADIME NOTE:**

**Assessment:**

- Pt complains of fatigue and continued numbness, burning and tingling in her feet. Her doctor recommended
- Lost 150 lbs after gastric bypass surgery (Roux-en-Y) X 25 years ago; MH’s wt fluctuates between 150-175 lbs, but has remained stable at 165 lbs for the last 5 years.
- Family medical history: mother-ovarian cancer; Father: atherosclerosis, T2DM.
- 72 yo F; Dx: B12 and folate deficiency with megaloblastic anemia secondary to gastric bypass and malabsorption combined with probable deficient dietary intake; PMH: Gravida 1 para 1-baginal delivery age 32, vertebral compression fracture (L1-L2) secondary to osteoporosis; osteoarthritis; s/p appendectomy age 12; s/p gastric bypass 25 years ago.
- Ht: 5’1”; Wt: 165#; UBW 165#; %UBW: 100%; Adjusted IBW 120#; %IBW: 137.5% (based on adjusted IBW); BMI: 31
- MCV 130 um3 (high); MCH 34 pg (high); MCHC 38 g/dL (high); RBC distribution 17.8% (high); platelet count 135 x 103/mm3 (low); vitamin B12 11 ng/dL (low); folate 3.2 ng/dL (low); MMA 0.75 mmol/L (high); Hcy 104 ug/dL (WNL); anti-parietal cell antibodies: Neg (normal); anti-intrinsic factor antibodies: Neg (normal).

- Medications: Fosamax, Celebrex, Colace (docusate), Milk of Magnesia, Calcium and vitamin D.

- GI: Altered GI function due to gastric bypass surgery.

- IO: Intake-1570 mL/kg; Output 1862 mL/kg.

- Physical Assessment: Temp: 98.5; BP: 130/78 (prehypertension); Pulse: 94; Resp rate: 27; Heart: RRR, unremarkable; Head: WNL; Eyes: PERRLA; Ears: Clear; Nose: Moist mucous membranes; Throat: Moist mucous membranes; Genitalia: Deferred; Neurologic: Alert and oriented; Extremities: WNL; Chest/lungs: Respirations rapid, but clear to auscultation and percussion; Peripheral vascular: Diminished pulses bilaterally; Abdomen: Hypoactive bowel sounds x4. Skin: Pale, clammy, diaphoretic.

- EER: 1200 Kcal/day (based on Mifflin St. Jeor); EPR: 75 to 112.5 g/day (based on 1.0 - 1.5 g/kg/day); fluid requirement: 1800-2000 mL (based on MD Rx).

- Current diet: Frequently eats fruits and vegetables—some grains. Rarely eats meat but does like chicken, eggs and dairy products

**Diagnosis:**

1. Obesity class 1 R/T excessive caloric intake and physical inactivity AEB BMI of 31, 24 hour recall (700 kcal above EER) and reported inactivity.
2. Impaired nutrient utilization of vitamin B12  
R/T malabsorption due to altered GI function and poor dietary intake  
AEB abnormal vitamin B12 <100 ng/dL and elevated MMA lab values >0.56 mmol/L.

3. Impaired nutrient utilization of folate  
R/T vitamin B12 deficiency  
AEB abnormal vitamin B12 <100 ng/dL and abnormal folate levels <5 ng/dL.

**Intervention:**

- **Nutrition Prescription:** Recommended nutrient and energy intake for weight loss and supplementation of vitamin B12 and folate to reverse megaloblastic anemia: 1200 kcal a day, 75 to 112.5 g of PRO; 1000 ug cyanocobalamin IM (B12); 5000 ug folate weekly.

- Average caloric intake will be no more than 117% (1400 kcal/day), a reduction of 500-700 kcal a day, which will average a loss of 1 lb a week; taking about 11 ½ months for her to reach her adjusted IBW of 120 lbs.

- Once Pt feels capable, it will be recommended that she do at least 30 minutes of a physical activity, such as, walking.

- Pt will get weekly injections of 1000 ug cyanocobalamin until laboratory values normalized, and intake of a sublingual B12 vitamin will be emphasized to once a month when lab values are normal.

- Pt will receive folate supplements of 5000 ug weekly, until laboratory values of folate and vitamin B12 are normal.

- Nutrition counseling will be provided to educate the patient on healthier food choices, more nutrient dense foods, and the importance of always taking her supplements.

- Pt will be asked to maintain a food diary.
Monitoring and Evaluation:

- Weekly visits will check that altered laboratory values are normalizing.
- Pt will no longer complain of fatigue, numbness, burning or tingling in her feet and hands.
- Food diary will be evaluated with Pt to check for understanding of dietary recommendations.
- Weight will also be monitored for any changes.

When megaloblastic anemia has been reversed, patient will have two follow-up visits with the RD, one after a month and the second one three months later. During these visits laboratory values and weight will be checked, and patient will be asked to explain why supplementation is required for her.
REFERENCES & IN-TEXT CITATIONS:


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Vitamin B12 and Folate Deficiencies. (n.d.). Retrieved May 7, 2015, from
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CASE STUDY QUESTIONS

1. Vitamin B12 has the responsibility to form proper red blood cells, to aid in neurological function, and DNA synthesis. Vitamin B12 is also a cofactor for methionine synthase and L-methylmalonyl-CoA mutase.

2. Folate acts as a coenzyme in single-carbon transfers in the synthesis of nucleic acids and metabolism of amino acids. It is a very important vitamin in the conversion of homocysteine to methionine in the synthesis of S-adenosylmethionine, a methyl donor. Another reaction that is dependent on folate is the methylation of deoxyuridylate to thymidylate in the formation of DNA which is required for proper cell division. If there is deficiency in folate, it can lead to megaloblastic anemia.

3. Vitamin B12 that is bound to protein in food is released by the activity of hydrochloric acid and gastric protease in the stomach. When free form vitamin B12 is consumed, it combines with intrinsic factor and the resulting complex undergoes absorption within the distal ileum by receptor-mediated endocytosis.

4. Once consumed, folates are hydrolyzed to monoglutamate form in the gut before they are absorbed by active transport across the intestinal mucosa. When folate is consumed as a supplement, passive diffusion occurs. Before it enters the bloodstream, folate in monoglutamate form is reduced to tetrahydrofolate and then converted to methyl or formyl forms. The unmetabolized form of folic acid can be found in the blood.

5. Vitamin B12 and folate are required to make normal red blood cells (RBCs), repair tissues and cells, synthesize DNA (the genetic material in cells). B12 and folate are nutrients that cannot be produced in the body and must be supplied by the diet. Individuals deficient in
both B12 and folate will require replenishment of both. B12 is important for normal nerve cell function. If an individual with a B12 deficiency only takes folic acid supplements, the macrocytic anemia may be resolved but the underlying neuropathy caused by the B12 deficiency will persist.

6. The most common B12 deficiencies are due to a vegan or vegetarian diet, a diagnosis of pernicious anemia, and those who have lower levels of stomach acidity. Folate deficiencies are uncommon in the U.S except for women of childbearing age and non-Hispanic black women.

7. A potential cause of Mrs. Hicks’s deficiencies may be due to changes in the gastric anatomy caused by the gastric bypass surgery (Roux-en-Y) she had 25 years ago. The procedure removes a portion of the stomach and bypasses a part of the small intestine where most vitamin absorption occurs; production of intrinsic factor is decreased also causing poor vitamin absorption. Once a person has this type of surgery, they must take nutritional supplements for the rest of their life. Since our patient is deficient in vitamin B12, it may be possible that she stopped taking her supplements because her surgery was 25 years ago and health problems associated with vitamin B12 deficiency would have been seen at that time. If she stopped taking supplements, it must have been recently because other laboratory tests indicative of megaloblastic anemia are still within the normal values. Another cause for her deficiencies may be due to poor dietary intake of vitamin B12 and folate. Symptoms of megaloblastic anemia include skin paleness, fatigue, tingling and numbness in extremities (paresthesia).

8. Abnormal laboratory values are listed and explained below.
   - Mean cell volume (130; normal 80-96)
o Megaloblastic anemia is characterized by large abnormal cells. The increase in large cells causes the volume to increase which results in the abnormal mean cell volume.

- Mean cell Hgb (34; normal 26-32)
- Mean cell Hgb content (38; normal 31.5-36)
  o Both MCH and MCHC reflect the hemoglobin content of red blood cells. Hemoglobin is found in red blood cells and is responsible for the transport of oxygen. Due to the megaloblastic anemia there are less red blood cells but are larger which means hemoglobin is found more concentrated in the large immature cells.
- RBC distribution (17.8; normal 11.6-16.5)
  o This value may be above normal due to the large cells that are seen in megaloblastic anemia. The distribution of red blood cells shows as higher levels because the large red blood cells take up more space.
  o The Red Blood Count (RBC) test for our patient was 4.2 X10^6 mm3 which is at the lower limit of the normal range of 4.2-5.4 for females. If this test is below the normal range, it indicates nutrition deficiencies of some minerals and vitamins, which include vitamin B12 and folic acid.
- Platelet count (135; normal 140-440)
  o Platelets help blood clot.
  o Platelet count is not a direct test that can be used to diagnose megaloblastic anemia.
  o The low levels of B12 and folate can affect the components of blood, causing platelets to be low and affect its ability to help blood clot.
The PT test (prothrombin time) indicates the time it takes for blood to clot. The normal range is 12.4-14.4 sec, and our patients’ result was 14.4, just within the upper limit, indicating that her blood is taking longer to clot and it supports the below normal platelet count.

- Vitamin B12 (11; normal 24.4-100)
  - Levels of vitamin B12 are below the normal level due to poor intake of foods containing vitamin B12; changes to the GI tract due to gastric surgery and age may be causing the malabsorption of vitamin B12; reduced intrinsic factor also interferes with vitamin B12 absorption.

- Folate (3.2; normal 5-25)
  - Folate levels are below normal range because MH’s dietary intake is low in folate-containing foods. Also, when vitamin B12 levels are low, folate consumed may be trapped and unavailable in the active form for the body to utilize.

- MMA (.75; normal .08-.56)
  - When there is a deficiency of vitamin B12, methylmalonic acid (MMA) accumulates in the body because it needs the presence of vitamin B12 for its metabolism.

Laboratory values that support megaloblastic anemia include MMA, MCV, MCH, MCHC, vitamin B12 and folate levels. The primary test in this list that identifies the Pt as having megaloblastic anemia is methylmalonic acid (MMA).

9. The following tests were assessed as a component of diagnosing Mrs. Hicks to differentiate the type of anemia she should be treated for; megaloblastic anemia or pernicious anemia given that both are caused by a deficiency of vitamin B12.
a. anti-intrinsic factor antibodies

- Vitamin B12 deficiency can be caused by an autoimmune response, which causes the body to make antibodies (proteins) that damage the body’s tissues or cells. An autoimmune response can make antibodies against intrinsic factor, known as anti-intrinsic factor antibodies, that attack and destroy the intrinsic factor affecting vitamin B12 absorption.

- This test differentiates a person having pernicious anemia or megaloblastic anemia.

b. Anti-parietal cell antibodies

- These antibodies are produced in pernicious anemia and attack and destroy parietal cells. These cells make intrinsic factor and if parietal cells are destroyed, there is no intrinsic factor made or available for the metabolism/absorption of vitamin B12.

- This test can also differentiate between the patient having pernicious anemia or megaloblastic anemia.

c. methylmalonic acid

- This test confirms vitamin B12 deficiency because methylmalonic acid needs vitamin B12 to change into a component of the Krebs cycle (series of chemical reactions in energy metabolism). Vitamin B12 is the only coenzyme that can catalyze reactions of MMA. Levels of MMA rise when B12 is unavailable.
d. homocysteine

- Vitamin B12 is needed to complete the pathway that forms DNA. When no vitamin B12 is available, homocysteine (the intermediate metabolite) levels are elevated.
- Our patient had a normal lab value for homocysteine, which shows that deficiency in vitamin B12 was recent.

e. Schilling test

- This test is used to determine whether the body absorbs vitamin B12 normally. Also, it can be used to see if B12 deficiency is caused by problems in the stomach preventing it from producing intrinsic factor. The Schilling test can also determine if there is bacterial growth or problems with the pancreas causing low levels of B12.

10. Pernicious anemia is associated with vitamin B12 and it is specific to gastrointestinal dysfunction, it is also most commonly diagnosed when there is an autoimmune disorder that causes a deficiency in intrinsic factor. With pernicious anemia, the characteristics of blood cells may or may not be megaloblastic or microcytic. Specific laboratory tests can determine if a patient has a vitamin B12 deficiency anemia due to a lack of intrinsic factor. Megaloblastic anemia may occur as a result of inadequate intake of B12, due to gastrointestinal disorders, surgeries that remove parts of the stomach or small intestine, and a long term use of antacids.
The treatment for pernicious or megaloblastic anemia is essentially the same, patients may need to take supplements by injection or sublingual (which go directly into the blood) for the rest of their lives. Knowing the type of anemia can help determine if other diseases should be tested for that may be causing vitamin B12 deficiency.

11. Fosamax is a prescribed medication used to treat osteoporosis in women after menopause. The absorption of fosamax is insignificantly reduced if taken with food, and it decreases to 60% if taken with coffee or orange juice.
   - Pt should be aware of the interaction between Fosamax and calcium. No calcium supplements (nor MVI multivitamin infusion) should be taken for 2 hours before or after taking this medication. An interaction between these two may cause nausea, abdominal pain, and loose bowel movements
   - Fosamax is a bisphosphonate and it binds to the surfaces of the bones and slow down the osteoclasts (these cells allow for bone tissue resorption/bone remodeling which is supposed to decrease bone density? an increased rate of bone remodeling = net bone loss)

12. The best sources of vitamin B12 can be found in animal products such as, meat and meat products, poultry, fish, shellfish (especially clams and oysters), and eggs (yolk). Best sources for folate are dark green leafy vegetables, nuts, beans, peas, dairy products, poultry and meat, eggs, seafood, and grains. The top ranked food sources are asparagus, cooked spinach, cooked peas and lentils.

13. Calcium intake should meet the RDA amount of 1200mg/d for people over the age of 70 y/o. The National Osteoporosis Foundation (NOF) recommends 800-1000 IU per day for
adults 50 y/o and above, which is higher than the RDA of 800 IU/d. The amounts of vitamin D supplements should be recommended based on the ability to increase serum 25 (OH)D level to approximately 30 ng/mL (75 nmol/L). Once the goal serum level has been reached, the supplement amount should be modified. Further maintenance of these levels include a therapy of 1500 – 2000 IU/day.

14. BMI for MH: 5’1” or 61”, 165 lbs

- Convert inches to meter: 5’1” = 61 inches x 0.0254 m/inches = 1.55 m
- Convert lbs to kg: 165 lbs / 2.2 lb/kg = 75.0 kg
- BMI = weight (kg) / height² (m²) = 75.0 kg / (1.55 m x 1.55 m) = 31 kg/m²

MH’s usual body weight and current weight is 165 lbs, so % usual body weight = (current weight / usual body weight) x 100% = (165 lbs / 165 lbs) x 100% = 100%

15. Pt consumes a lot of dairy products throughout the day that are helpful with her consumption of calcium. They are not low in fat and per the TLC diet and our weight loss goals, due to a BMI of 31, we would recommend lower fat options. The factors revealed by her nutrition assessment are that she has a low intake of vitamin B12 food sources, low intake of folate food sources, and a BMI that puts her into the category of class 1 obesity.

16. According to MH’s BMI of 31 kg/m², the Mifflin-St Jeor equation using actual body weight will provide the most accurate assessment of estimated energy requirement (EER) in the obese patient (BMI > 30). MH’s estimated energy requirement is determined to be 1197.8 calorie per day (EER = 10W + 6.25H - 5 Age - 161 = (10 x 75) + (6.25 x 155) - (5 x 72) - 161 = 1197.8 kcal/day). For protein requirement in patients who have diseases, their protein needs range from 1.0 - 1.5 g protein/kg/day based on her current body weight (Nelms et
al., 2014). Since MH’s current body weight is 165 lbs or 75 kg (current weight = 165 lbs / 2.2 lbs/kg = 75 kg). Thus, her protein needs range from 75 to 112.5 g.

17. Her 24 hour recall showed a very low intake of dark green leafy vegetables that are a good source of folate. The only meat she consumes is chicken and it may be helpful to suggest to consume more of other animal products, such as egg yolks or seafood to contribute to her vitamin B12 deficiency.

The DRI for folate is 400 ug/day and 2.4 ug/day for vitamin B12. Her estimated folate intake obtained from USDA MyPlate Supertracker is 400 ug, which is the recommended intake. This probably means that she may be getting additional folate from fortified sources, since her dietary intake seems low. It also shows that the pt has a malabsorption of folate because her lab value for folate was low.

Mrs. Hicks’ intake of vitamin B12 is estimated to be 1.3 ug a day, which is below the recommended intake. In the case of vitamin B12 there is a combined deficiency due to her dietary intake and because of an altered GI function from gastric bypass surgery.

18. Low levels of folate and vitamin B12 that contribute to her megaloblastic anemia; Gastric bypass (Roux-en-Y) may lead to malabsorption; inadequate intake of calcium and vitamin D that increase osteoporosis

19. The PES statements for Mrs. Hick are the following:

1. Obesity class 1 R/T excessive caloric intake and physical inactivity AEB BMI of 31, 24 hour recall (700 kcal above EER) and reported inactivity.
2. Impaired nutrient utilization of vitamin B12 R/T malabsorption due to altered GI function and poor dietary intake AEB abnormal vitamin B12 <100 ng/dL and elevated MMA lab values >0.56 mmol/L.

3. Impaired nutrient utilization of folate R/T vitamin B12 deficiency AEB abnormal vitamin B12 <100 ng/dL and abnormal folate levels <5 ng/dL.

20. Nutrition recommendations for Mrs. Hicks based on her nutrition problems are as follows:

1. Will recommend MH to consume 1200 kcal a day (EER based on Mifflin-St. Jeor) and no more than 117% of her EER (1400 kcal).

2. Protein recommendations for MH range from 75 to 112.5 g, (based on 1.0-1.5 g for a patient with a disease).

3. Pt will get weekly injections of 1000 ug cyanocobalamin until laboratory values are normalized, and intake of a sublingual B12 vitamin will be emphasized once those lab values have shown a reversal of megaloblastic anemia.

4. Be physically active at least 30 minutes a day by enjoying non strenuous exercise, such as walking, to encourage weight loss and muscle maintenance.

5. Repeat laboratory values to see if MH needs additional B12 injection weekly and folate supplementation daily.

6. Nutrition counseling will be provided to educate the patient on healthier food choices, more nutrient dense foods, and the importance of always taking her supplements.

21. Mrs. Hick was given a B12 injection because this form of supplementation allows vitamin B12 to go directly into the blood making it readily available for the body to consume what it needs. In an injection form, B12 bypasses the stomach and intestine where it may not be
properly absorbed because of altered GI function caused by gastric bypass surgery (Roux-en-Y). This surgery removes a portion of the stomach and bypasses the small intestine where absorption of vitamin B12 occurs. The removal of stomach also decreases intrinsic factor production, which is necessary for vitamin B12 absorption. A B12 injection does not need intrinsic factor because it does not go through the stomach. Even if the patient is consuming enough B12 with her diet, she will be deficient because of the Roux-en-Y surgery, (Nelms et al., 2014).

22. For megaloblastic anemia, metabolites such as Homocysteine and Methylmalonic acid (MMA) are the factors to monitor and assess tolerance and adequacy of B12 injection and folate supplement. Since most patients with folate deficiency have normal MMA or mildly elevated levels. About 50% of those with elevation of these metabolites will have normal serum vitamin B12 levels (Aslinia, F., Mazza, J. J., & Yale, S., 2006). This emphasizes the low sensitivity of using vitamin B12 levels, especially in the presence of other signs or symptoms.

23. ADIME Note

**Assessment:**

- Pt complains of fatigue and continued numbness, burning and tingling in her feet. Her doctor recommended
- Lost 150 lbs after gastric bypass surgery (Roux-en-Y) X 25 years ago; MH’s wt fluctuates between 150-175 lbs, but has remained stable at 165 lbs for the last 5 years.
- Family medical history: mother-ovarian cancer; Father: atherosclerosis, T2DM.
• 72 yo F; Dx: B12 and folate deficiency with megaloblastic anemia secondary to gastric bypass and malabsorption combined with probable deficient dietary intake; PMH: Gravida 1 para 1-bizophrenal delivery age 32, vertebral compression fracture (L1-L2) secondary to osteoporosis; osteoarthritis; s/p appendectomy age 12; s/p gastric bypass 25 years ago.

• Ht: 5’1”; Wt: 165#; UBW 165#; %UBW: 100%; Adjusted IBW 120#; %IBW: 137.5% (based on adjusted IBW); BMI: 31

• MCV 130 um3 (high); MCH 34 pg (high); MCHC 38 g/dL (high); RBC distribution 17.8% (high); platelet count 135 x 103/mm3 (low); vitamin B12 11 ng/dL (low); folate 3.2 ng/dL (low); MMA 0.75 mmol/L (high); Hcy 104 ug/dL (WNL); anti-parietal cell antibodies: Neg (normal); anti-intrinsic factor antibodies: Neg (normal).

• Medications: Fosamax, Celebrex, Colace (docusate), Milk of Magnesia, Calcium and vitamin D.

• GI: Altered GI function due to gastric bypass surgery.

• IO: Intake-1570 mL/kg; Output 1862 mL/kg.

• Physical Assessment: Temp: 98.5; BP: 130/78 (prehypertension); Pulse: 94; Resp rate: 27; Heart: RRR, unremarkable; Head: WNL; Eyes: PERRLA; Ears: Clear; Nose: Moist mucous membranes; Throat: Moist mucous membranes; Genitalia: Deferred; Neurologic: Alert and oriented; Extremities: WNL; Chest/lungs: Respirations rapid, but clear to auscultation and percussion; Peripheral vascular: Diminished pulses bilaterally; Abdomen: Hypoactive bowel sounds x4. Skin: Pale, clammy, diaphoretic.

• EER: 1200 Kcal/day (based on Mifflin St. Jeor); EPR: 75 to 112.5 g/day (based on 1.0 - 1.5 g/kg/day); fluid requirement: 1800-2000 mL (based on MD Rx).
• Current diet: Frequently eats fruits and vegetables—some grains. Rarely eats meat but does like chicken, eggs and dairy products

**Diagnosis:**

1. Obesity class 1 R/T excessive caloric intake and physical inactivity AEB BMI of 31, 24 hour recall (700 kcal above EER) and reported inactivity.

2. Impaired nutrient utilization of vitamin B12 R/T malabsorption due to altered GI function and poor dietary intake AEB abnormal vitamin B12 <100 ng/dL and elevated MMA lab values >0.56 mmol/L.

3. Impaired nutrient utilization of folate R/T vitamin B12 deficiency AEB abnormal vitamin B12 <100 ng/dL and abnormal folate levels <5 ng/dL.

**Intervention:**

• Nutrition Prescription: Recommended nutrient and energy intake for weight loss and supplementation of vitamin B12 and folate to reverse megaloblastic anemia: 1200 kcal a day, 75 to 112.5 g of PRO; 1000 ug cyanocobalamin IM (B12); 5000 ug folate weekly.

• Average caloric intake will be no more than 117% (1400 kcal/day), a reduction of 500-700 kcal a day, which will average a loss of 1 lb a week; taking about 11 ½ months for her to reach her adjusted IBW of 120 lbs.

• Once Pt feels capable, it will be recommended that she do at least 30 minutes of a physical activity, such as, walking.

• Pt will get weekly injections of 1000 ug cyanocobalamin until laboratory values normalized, and intake of a sublingual B12 vitamin will be emphasized to once a month when lab values are normal.
• Pt will receive folate supplements of 5000 ug weekly, until laboratory values of folate and vitamin B12 are normal.

• Nutrition counseling will be provided to educate the patient on healthier food choices, more nutrient dense foods, and the importance of always taking her supplements.

• Pt will be asked to maintain a food diary.

**Monitoring and Evaluation:**

• Weekly visits will check that altered laboratory values are normalizing.

• Pt will no longer complain of fatigue, numbness, burning or tingling in her feet and hands.

• Food diary will be evaluated with Pt to check for understanding of dietary recommendations.

• Weight will also be monitored for any changes.

• When megaloblastic anemia has been reversed, patient will have two follow-up visits with the RD, one after a month and the second one three months later. During these visits laboratory values and weight will be checked, and patient will be asked to explain why supplementation is required for her.