MNT Case Study 1: “Anemia in Pregnancy”

1. Pale skin color and pale sclera are both signs that validate the diagnosis of anemia. The patient also said that she had fatigue and was short of breath, these symptoms also indicate anemia. Our patient is also pregnant. Blood volume increases during pregnancy, and this could increase her risk for developing anemia.

2. Our patient, Mrs. Morris has low values for RBC, Hgb, Hct, and MCV, all of which are indicative of iron deficiency anemia. Anemia is when the body does not have enough red blood cells to transport oxygen. This is evidenced in our patient by the low red blood cell count (RBC) as well as the low proportion of red blood cells in the body (HCT). Furthermore, hemoglobin is the iron-binding protein in the blood. Mrs. Morris has a low Hgb value, which further indicates that she has low iron in her bloodstream. Low MCV is also associated with iron deficiencies. Because the blood cell does not have iron bound, this leads to a small cell size, and thus a lower MCV value. Total Iron Binding capacity (TIBC) reflects the ability of the body’s cells to bind iron. If TIBC is low that means that the cells have enough iron and they cannot bind anymore. If TIBC is high that means that iron stores are low and that the cell needs to bind more iron. Mrs. Morris has a high TIBC value, indicating that her cells have a very low amount of iron. Ferritin indicates iron storage. Our patient has a lower than normal ferritin value, indicating that she does not have adequate iron stores. The patient’s lab panel also shows a lower than normal folate value. Folate deficiencies are associated with an increase in MCV. However, our patient has a lower than normal MCV value. Because of this, we can be sure that folate is not the cause of the anemia, but rather iron deficiency is the cause. Nonetheless, folate is a key nutrient during pregnancy, and it is possible that the pregnancy has led to decreased folate levels.[1]

3. Hemoglobin transports oxygen in the blood. This is a concern because you want Mrs. Morris to have enough hemoglobin to transport oxygen necessary for her needs as well as her growing baby’s needs. However, during pregnancy blood volume increases drastically, so it is normal for hemoglobin to decrease because of the dilution caused by increased plasma levels. This dilution caused by the increasing blood volume during pregnancy can also cause decreased values of “albumin, other serum proteins, and water-soluble vitamins” (pg. 343).[1]

4. Megaloblastic anemia is caused by impaired DNA synthesis in the cell and often leads to large RBCs that are not fully developed: folate and vitamin B12 deficiencies are common causes of megaloblastic anemia. Pernicious anemia is caused by vitamin B12 deficiency and leads to high MCV (macrocytic). Most commonly pernicious anemia is caused by a decrease in

intrinsic factor.[1] This decrease causes impaired vitamin B12 absorption leading to a Vitamin B12 deficiency. There are many causes to the decrease in intrinsic factor including autoimmune disease and a decrease in gastric parietal cells.[2] Normocytic anemia is caused by chronic disease or blood loss, and cells retain their normal size. Microcytic anemia is when the red blood cells are smaller than normal. Sickle cell anemia is a hereditary disease that causes the production of crescent shaped red blood cells, which can get stuck in small blood vessels and cause pain as well as liver and kidney problems. In hemolytic anemia, RBCs are destroyed by bursting and then are removed from the bloodstream before their normal lifespan is over.[1]

5. Iron functions as part of hemoglobin, which works to transport oxygen to tissues. Iron also aids in oxygen storage in muscle through myoglobin. Energy production (ATP) requires the use of iron in redox reductions. Iron is also important for the manufacturing of RBCs. Some enzymes in the body require the use of iron. Iron also plays an important role for the body's immune system and iron is important for brain function. During fetal development iron is important for collagen synthesis and brain development. Iron status is also important for the baby's developing organ systems. It's also important for the baby to develop adequate iron stores in utero so that he/she will have enough iron stores available until they are able to eat table food.[1]

6. There are several stages of iron deficiency. Stage 1 is early signs of low iron. Stage 1 may be evidenced by slightly higher than normal serum transferrin receptors and slightly lower than normal ferritin (below 20 ng/mL). Hemoglobin and iron serum levels remain normal. There is also a slight increase in TIBC. During stage 1, the iron depletion is probably not great enough to cause any symptoms. Stage 2 of iron deficiency is "iron depletion." During stage 2, serum transferrin receptors are high and ferritin is low, and this stage is often characterized by fatigue. Stage 3 is "iron deficiency" and it is associated with iron-deficient erythropoiesis. In this stage ferritin is low, serum iron is low, and TIBC is increased. During Stage 3 fatigue increases and there may be a decrease in one's ability to concentrate. During Stage 3, there is dysfunction, symptoms are mild to moderate, but there is not anemia. Stage 4 is complete iron deficiency anemia, and it is characterized by microcytic, hypochromic red blood cells, very high serum transferrin receptors, very low ferritin, low serum iron, high TIBC, low hemoglobin and hematocrit, and low MCV. This last stage of iron deficiency can have many symptoms including: poor muscle function, fatigue, pica, leg pain, defects in epithelial tissue, pallor, glossitis, gastritis, and if left untreated for a long period of time iron deficiency anemia can lead to cardiac failure.[1,3,4]

7. Our patient is 31-years old, although she is currently pregnant; she has probably experienced monthly menstruation prior to her pregnancy, so it is possible that she had decreased iron stores entering into the pregnancy. Also, pregnancy in and of itself puts Mrs. Morris at greater risk for developing iron deficiency anemia. Blood volume drastically increases during pregnancy, and it is not uncommon for anemia to occur because of the increase in overall blood volume. However, iron needs are also increased during pregnancy. Based on Mrs. Morris' 24-hr diet recall and her account of what she normally eats, she also has a diet that is low in iron, and this also increases her risk for developing iron-deficiency anemia.[1]

8. Iron deficiency anemia in the mother is associated with early delivery and low birth weight.[5,6] However, if iron deficiency anemia is left untreated for long enough it can lead to serious complications that could eventually lead to cardiac failure in the mother[1], which would definitely have a negative impact on the child. Also, in iron deficiency anemia, the mother's hemoglobin levels would be decreased, thus her ability to transport oxygen in the blood would be decreased, and it's possible that this could impact the amount of oxygen transferred to the baby. Also, iron deficiency in the mother may impact brain development in the growing fetus.[6] Nonetheless, most of the time anemia in pregnancy does not cause adverse outcomes for the baby if it is diagnosed and treated early on.

9. Energy needs during pregnancy increase due to physical changes in the mother and growth of the baby. The RDI for energy needs increases by about 350 kcal/day in the pregnant woman during the second trimester, and more than 450 kcal/day during the third trimester. Protein needs during pregnancy also increase by about 25 g/day, meaning the pregnant woman needs about 71 g of protein per day. This additional protein is needed for tissue growth in both the mother and the child. Iron needs also increase from 18 mg/day to 27 mg/day during pregnancy. The additional iron is needed for the baby and placenta, to increase the amount of RBCs in the mother, and to account for mother's blood loss during birth. The DRI for calcium during pregnancy is the same for non-pregnant women: 1000 mg/day. Although, the recommendation is not different, calcium is still very important, and is needed for proper development of the baby's skeleton. Often this needed calcium is released from the mother's bone, so it is still very important that the pregnant woman consumes enough calcium. Zinc needs in the pregnant woman increase from 8 mg/day to 11 mg day. This additional zinc is needed for immunity and cell growth and development in both the mother and child. Folate needs increase from 400 mcg/day to 600 mcg/day. Folate is mostly needed during pregnancy to prevent neural tube defects, but folate is also important for the overall development of the baby. Vitamin B12 needs are only

slightly increased during pregnancy from 2.4 mcg/day to 2.6 mcg/day. Vitamin C needs in pregnancy increase from 75 mg/day to 85 mg/day. This increase of vitamin C is likely needed for the increased collagen synthesis that occurs during pregnancy.[6]

10. Heme iron comes from hemoglobin, myoglobin, and some enzymes, thus heme iron comes from animal foods. Conversely, non-heme iron comes predominately from plant-based sources. Heme iron is absorbed much better than non-heme iron, although most dietary sources of iron are found in the form of nonheme iron. Sources of heme iron include liver, red meat, chicken, and some seafood. Sources of non-heme iron include soybeans, spinach, and fortified grains.[1]

11. "Heme iron is absorbed across the brush border of intestinal cells" (pg. 106). Nonheme iron must get across the brush border via DMT1 transport. Ferric iron (Fe 3+) in the intestine is converted to ferrous iron (Fe 2+) by Dcytb. Ferrous iron then enters the cell through DMT1. Once in the cell, this ferrous iron can be converted back to ferric iron and stored as ferritin in the cell or it can leave the cell via ferroportin. If iron leaves the cell via ferroportin, it is converted back to ferric iron and is bound to transferrin for transportation in the blood. Nonheme iron and heme iron both bind to apoferritin and form ferritin. Ferritin then transports iron to the basolateral membrane where it is absorbed via active transport. Many things can influence iron absorption. Specifically, vitamin C and lactic acid enhance iron absorption. However, calcium, zinc, and magnesium compete for DMT1 transport, and thus inhibit iron absorption. Phytates can also inhibit iron absorption. Because heme iron bypasses the use of the DMT 1 transporter it is absorbed much more efficiently. About 15% of heme iron is absorbed, whereas only about 5% of nonheme iron is absorbed.[1,7]

12. Mrs. Morris' pre-pregnancy BMI was 22.5. Mrs. Morris' percent usual body weight is 105.2%.
    BMI = kg/m^2 Weight in kg = 61.36 kg Height in m = 1.651 BMI=$61.36/(1.6151)^2$=22.51
    %UBW = Actual Wt/Usual Wt X 100 = 142/135 X 100 = 105.185%

13. Mrs. Morris is in her 23rd week of gestation and has gained 7 pounds. According to the desirable weight gain chart on pg. 352 of *Krause's and the Nutrition Care Process*, this is in the lower range of what should be gained by females who were overweight before pregnancy. Because Mrs. Morris was normal weight before pregnancy, she should have gained between 11 and 16 pounds at the 23rd week of gestation. According to the current recommendations, Mrs. Morris has only gained about half of what is recommended for this stage of pregnancy. It is recommended that women who enter pregnancy at a normal

weight gain between 25 and 35 pounds. During her first pregnancy, Mrs. Morris gained 15 pounds, and she gained about 20 pounds during her second pregnancy. Both of these previous pregnancies did not have weight gains WNL (25-35 pounds).[1]

14. Females need 1.1g/kg/day based on their weight before pregnancy.[1] According to this formula, Mrs. Morris would need about 67.5 g of protein per day. This calculated value is very close to the 71 g of protein per day recommended in question 9. To calculate energy requirements we used the Mifflin-St. Jeor equation. The Mifflin-St. Jeor equation was a good fit because it is validated for normal weight adults. We then added 350 kcal/day to account for her pregnancy needs.[1] Based on this, Mrs. Morris needs 1679.51 kcal/day.

    Weight in kg X 1.1g/kg/day protein = 61.36 X 1.1 = 67.49g/day protein
    REE (female) = 10W + 6.25H - 5A - 161 = 10(61.36) + 6.25(165.1) - 5(31) - 161 = 1329.475 + 350 = 1679.475 kcal/day

15. According to Mrs. Morris' 24-hr recall nutrient analysis using NutritionistPro[8], our patient consumed 1759.199 kcal and 56.4 g of protein. This means that Mrs. Morris was below her calculated protein needs by 11.1 grams, and over her calorie needs by 79.689. Overall, Mrs. Morris was very close to her calculated calorie needs, but would need to incorporate more protein in her diet to meet the calculated protein needs. (Print-out of NutritionistPro Nutrition Summary is included after the reference page).

16. According to the analysis of Mrs. Morris' 24-hr recall using NutritionistPro[8], Mrs. Morris consumed 20.687 mg of iron. The recommendation (from question 9) is 27 mg/day during pregnancy. This means that Mrs. Morris is not meeting the recommendation for iron needs during pregnancy, and this could be contributing to her anemia.

17. The pertinent nutrition problem is iron deficiency. The corresponding nutrition diagnosis is "Inadequate mineral intake: iron" (NI-5.10.1)

18. Inadequate mineral intake (iron) R/T hypochromic microcytic anemia AEB abnormal lab values: Hgb of 9.1 g/dL, Hct of 33%, TIBC of 464 μg/dL, RBC of 3.8 $10^6/mm^3$, and ferritin of 10 μg/dL.

19. Ferrous sulfate can cause nausea, diarrhea, constipation, dark stool, heartburn, and upset stomach. Drug-nutrient interactions can occur if iron is taken with meals instead of on an empty stomach. [9] Taking iron with meals greatly reduces the absorbability of the iron due to interactions with phosphate, oxalate, and phytate found in foods. Vitamin C (ascorbic acid) enhances iron absorption.[1] Also, iron supplementation may negatively impact the absorption of other drugs.[9] To maximize the benefit of iron supplementation, we would suggest increasing vitamin C consumption to help enhance iron absorption. Some good food sources of vitamin C are citrus (specifically oranges), bell peppers, spinach, and strawberries.[1] We would suggest trying to limit whole grain products that contain a lot of phosphate, oxalate, and phytate. We would encourage Mrs. Morris to take the ferrous sulfate on an empty stomach three times daily to maximize absorption, if she begins to experience severe gastric irritation then take the medication with meals. [9]

20. Prenatal vitamins typically include Vitamin A, D, E, K, B1, B2, B3, B6, B12, C, pantothenic acid, folic acid, choline, biotin, calcium, copper, iron, chromium, iodine, magnesium, zinc, selenium, magnesium, zinc, selenium, manganese.[1] We would recommend that Mrs. Morris take the prenatal vitamin with a light meal or snack. This would decrease the irritation that the vitamin causes on the lining of the stomach and assure that the stomach is not distended. Not taking the vitamin on an empty stomach may help decrease the stomach pain that Mrs. Morris has experienced when taking the prenatal vitamins in the past.

21. First, we would monitor lab work. Increased reticulocytosis would be evident around 3 days after iron supplementation, and hemoglobin should increase at about 4 days after iron supplementation.[1] Because of this, we would monitor her CBC within 5-7 days of d/c from the hospital to make sure that RBC and hemoglobin are increasing in response to the ferrous sulfate supplementation. Furthermore, we would also look at other lab values on a monthly basis for the remainder of her pregnancy. We would specifically look at ferritin to make sure that our patient's iron stores were increasing. However, we would also examine RBC, Hgb, Hct, MCV, TIBC, and folate. We want to continue to monitor her lab work to make sure that she is absorbing the additional ferrous sulfate supplement and that her biochemical markers return to normal, but we also want to make sure that the added supplement has not increased her iron stores to an excess in which she would be above the normal limit (a condition that could also cause potential problems for her and the baby). Also, we noted that Mrs. Morris is currently low on the curve for recommended maternal weight gain. However, Mrs. Morris did not gain the recommended weight in previous pregnancies, so this may be normal for her. Nonetheless, we still feel that it is important to monitor her weight throughout the remainder of her pregnancy. To do this we will review her chart to follow the weight readings that are taken at

her OBGYN appointments. We want to make sure that her weight gain does not fall below the curve that it is currently on, and would like to see her come closer to meeting the minimal weight gain recommendations for women who are of normal BMI prior to pregnancy. Lastly, to follow her nutritional status, we will review a 3-day food recall from Mrs. Morris. We will conduct this approximately one week after her d/c from the hospital to see if she is increasing iron in her diet, and also as a means of checking her nutritional balance through diet during pregnancy.

Nutrition Care Progress Note Amber Morris	***DATE & TIME***	**09/22/23**	
ASSESSMENT	**DIAGNOSIS**	**INTERVENTION**	**Monitoring & Evaluation**
Mrs. Morris is a 31 year old white female, who is in the 23rd week of pregnancy, and has been diagnosed with hypochromic, microcytic anemia PM Hx: 2 previous pregnancies delivered at 38 and 37 wks c 15 and 20 lbs wt gain respectively Ht: 5'5" Wt: 142 lbs Pre-pregnancy wt: 135 lbs Pre-pregnancy BMI: 22.51 %UBW: 105.2% Good appetite, no difficulty chewing or swallowing, NKFA Current diet order: NPO Estimated Nutrient Needs: REE: 1679.475 kcal/day Protein: 67.49g/day Fluid: 2000-2400 mL/day Current meds: prenatal vitamin (taken irregularly) S/S: fatigue, SOB, pallor Labs: RBC: 3.8 10^6/mm^3, Hgb: 9.1 g/dL, Hct: 33%, MCV: 72 µm^3, TIBC: 465 µg/dL, Ferritin: 10 µg/dL, Folate: 2 ng/dL 24-hr diet recall reveals a diet high in processed foods	Inadequate mineral intake (iron) R/T hypochromic microcytic anemia AEB abnormal lab values: Hgb of 9.1 g/dL, Hct of 33%, TIBC of 464 µg/dL, RBC of 3.8 10^6/mm^3, and ferritin of 10 µg/dL. (NI-5.10.1)	Mineral modified diet: iron (ND 1.2) • Teach pt how to incorporate more iron into daily diet • Identify good sources of iron • Differentiate between heme and nonheme sources Goal: Increase iron intake through diet	Monitor CBC within 5-7 days after d/c to make sure that Hgb and RBC is increasing Continue to monitor lab values, specifically ferritin to make sure that iron stores are increasing, as well as RBC, Hgb, Hct, MCV, and TIBC, Continue to monitor wt status throughout pregnancy Use food recalls to identify if the pt has increased iron intake through food sources
	Signature & Credential		

References

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