Case Study 1: Anemia in Pregnancy

1. Evaluate the patient’s admitting history and physical. Are there any signs or symptoms that support the diagnosis of anemia?

   Mrs. Morris’ admitting history and physical stated that the patient was pale and reported recent shortness of breath and recent exhaustion, which are all possible signs and symptoms of anemia. Mrs. Morris experienced some bleeding after a fall, which could also contribute to decreased iron.

2. What laboratory values or other tests support this diagnosis? List all abnormal values and explain the likely cause for each abnormal value.

   - **RBC (Red Blood Cell count) – 3.8 x 10^6/mm^3 (low)**
     - Pregnancy, bleeding and anemia can all cause a low RBC level.
   - **Hgb (Hemoglobin) – 9.1g/dL (low)**
     - Low levels of hemoglobin can occur with anemia and/or lower folate and iron levels (the patient is experiencing both).
   - **Hct (Hematocrit) – 33% (low)**
     - The patient’s hematocrit level may be low because of anemia, low RBC levels, and/or low levels of iron and folate.
   - **MCV (Mean Corpuscular Volume) – 72um^3 (low)**
     - MCV is measured to diagnose anemia. A low MCV indicates smaller cell size, which can diagnosis microcytic anemia. Anemia can cause red blood cells to become smaller.
   - **TIBC (Total Iron Binding Capacity) – 465ug/dL (high)**
     - TIBC can be high due to pregnancy and/or anemia, which indicates that there is a higher amount of circulating iron, but a low amount of stored iron.
   - **Ferritin – 10ug/dL (low)**
     - A low ferritin level is likely due to not enough iron being stored (ferritin stores iron inside cells). This can indicate iron-deficiency anemia.
   - **Folate – 2ng/dL (low)**
     - The patient has likely has low folate levels because of her poor diet and inconsistency of taking a prenatal vitamin. Folate deficiency can also be linked to anemia.

3. Mrs. Morris’s physician ordered additional lab work when her admitting CBC revealed a low hemoglobin. Why is this a concern? Are there normal changes in
hemoglobin associated with pregnancy? If so, what are they? What other hematological values, if any, normally change in pregnancy?

A low hemoglobin level is a concern because hemoglobin is a protein that carries oxygen to tissues throughout the body. A low hemoglobin level during pregnancy is a concern because the growing fetus needs sufficient oxygen for development.

During a healthy pregnancy, blood volume increases by around 1.5L to ensure the fetus is receiving proper nutrients and oxygen. With this increase in blood volume, hemoglobin levels slightly drop, and the drop can be lessened with daily intake of a prenatal vitamin. Mean cell volume (MCV) normally increases during pregnancy, but in Mrs. Morris’s case, MCV decreased.

4. There are several classifications of anemia. Define each of the following: megaloblastic anemia, pernicious anemia, normocytic anemia, microcytic anemia, sickle cell anemia, and hemolytic anemia.

Megaloblastic anemia – Anemia usually caused by a folic acid or cobalamin deficiency that results in large and immature red blood cell progenitors in the bone marrow (where red blood cells are produced). This abnormal change in RBC progenitors is caused by a change in DNA code, which affects the production and function of red and white blood cells, along with platelets.

Pernicious anemia – Anemia resulting from a vitamin B12 (cobalamin) deficiency with characteristic megaloblastic and macrocytic red blood cells. Vitamin B12 deficiency is often found in relation with a lack of proper intrinsic factor (IF), which helps absorb vitamin B12 in the body.

Normocytic anemia – Anemia with red blood cells of normal size.

Microcytic anemia – Anemia with small red blood cells and low hemoglobin levels in the bloodstream.

Sickle cell anemia – Anemia that is hereditary, and results in abnormal hemoglobin production, causing sickle-shaped cells that do not properly deliver oxygen to tissues and cells. Sickle cell anemia is caused from a “homozygous inheritance of hemoglobin S.”

Hemolytic anemia – Anemia that can result in cell breakdown due to problems in the membrane of erythrocytes. Oxidative damage resulting in hemolytic anemia can begin due to vitamin E deficiency, which is important in protecting cells against oxidative damage.

5. What is the role of iron in the body? Are there additional functions of iron during fetal development?
There are two types of iron in the body – functional and storage. Functional iron is found in “hemoglobin, myoglobin and different enzymes,” and is responsible in aiding in the delivery of oxygen throughout the body. Iron is transported throughout the circulation, in a complex with hemoglobin, to the lungs in order to pick up oxygen, travel back through circulation, and deliver oxygen to the tissues. Myoglobin delivers oxygen specifically to the muscles.

Iron is also stored in the body in the forms of “ferritin, hemosiderin and transferrin,” and is released from storage when circulating iron levels dip. If iron-deficiency is present, iron stores with decrease in order for oxygen transport to continue throughout circulation.

During pregnancy, there is a higher demand for iron due to the increase in blood volume and the added need of iron for the growing fetus. The Recommended Dietary Allowance (RDA) of iron for women increases during pregnancy from 18mg/day (non-pregnant) to 27mg/day (pregnant). Iron is needed for the growing fetus to receive oxygen through the placenta, and there are many complications that may arise if iron-deficiency is present during pregnancy, including “low birth weight, preterm delivery, inferior neonatal health and fetal growth retardation.”

6. Several stages of iron deficiency actually precede iron-deficiency anemia. Discuss these stages – including the symptoms – and identify the laboratory values that would be affected during each stage.

Iron deficiency precedes iron-deficiency anemia, and consists of 3 stages.

Stage 1: Iron Depletion
- Insufficient dietary iron intake
- Iron stores decrease to maintain serum ferritin levels
- No large physical symptoms
- Serum ferritin lab values would be low

Stage 2: Iron Deficient Erythropoiesis
- Lower hemoglobin and hematocrit levels
- Hemoglobin levels may be reduced but not beyond normal values

Stage 3: Iron Deficiency Anemia
- Low MCV and hemoglobin levels
- Increased physical symptoms, including SOB, fatigue, dizziness and pallor

7. What potential risk factor(s) for the development of iron-deficiency anemia can you identify from Mrs. Morris’s history?

Pregnancy puts Mrs. Morris at higher risk of developing iron-deficiency anemia because of the increase in blood volume and iron needs for the development of the fetus. In addition, Mrs. Morris stated that she is a picky eater in her nutrition assessment, and does not take her prenatal vitamins everyday. She may not be getting enough iron through her diet and supplementation of a prenatal vitamin.
8. What is the relationship between the health of the fetus and maternal iron status? Is there a risk for the infant if anemia continues?

The fetus depends on maternal iron status, along with other nutrients, for development. Oxygen is the primary issue with iron status, because oxygen is delivered to the fetus through the placenta by hemoglobin (from the mother). The highest amount of iron absorption by the fetus occurs after 30 weeks of gestation. At this point, if iron stores are low in the mother, “placental transferrin receptors” increase in order to take in as much iron as possible. If a mother exhibits iron deficiency, she is also increasing the risk of the baby being delivered preterm or having low birth weight. Severe anemia can also cause mortality during delivery or during the perinatal period. Fetal iron reserves can also be compromised with prolonged maternal deficiency.

9. Discuss the specific nutritional requirements during pregnancy. Be sure to address all macro- and micronutrients that are altered during pregnancy.

The Recommended Dietary Allowances (RDAs) for pregnancy, according to Krause’s Food and the Nutrition Care Process, are:

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<tr>
<th>Vitamin/Mineral</th>
<th>14-18y</th>
<th>19-30y</th>
<th>31-50y</th>
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<tr>
<td>Vitamin A</td>
<td>750µg/d</td>
<td>750µg/d</td>
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<tr>
<td>Vitamin C</td>
<td>80mg/d</td>
<td>85mg/d</td>
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<td>Vitamin D</td>
<td>15µg/d</td>
<td>15µg/d</td>
<td>15µg/d</td>
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<td>15µg/d</td>
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<td>75µg/d</td>
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<td>Folate</td>
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<td>600µg/d</td>
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<tr>
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<td>Biotin</td>
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<td>Requirement 1</td>
<td>Requirement 2</td>
<td>Requirement 3</td>
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<td>------------</td>
<td>--------------</td>
<td>--------------</td>
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<td>Choline</td>
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<td>Fluoride</td>
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<td>Iodine</td>
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<td>Iron</td>
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<td>2mg/d</td>
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<td>Molybdenum</td>
<td>50μg/d</td>
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<td>Phosphorus</td>
<td>1250mg/d</td>
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<tr>
<td>Selenium</td>
<td>60μg/d</td>
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<td>Zinc</td>
<td>12mg/d</td>
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<td>Potassium</td>
<td>4.7g/d</td>
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<tr>
<td>Chloride</td>
<td>2.3g/d</td>
<td>2.3g/d</td>
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</table>

**Energy:** Energy requirements should increase by 340-360kcal/day in the second trimester, and 112kcal/day in the third trimester to support the growing fetus, and to promote a proper increase in body fat stores for the mother.10

**Protein:** The RDA for protein during the first trimester and half of the second trimester remains the same for women, at 0.88g/kg/d.10 During the second half of pregnancy, protein needs increase to around 1.1g/kg/d (based on the kg weight of the woman before gestation).10

**Carbohydrate:** Carbohydrate intake during pregnancy ranges from about 135g-175g/day (based on a 2000 calorie diet).10 This is an ample amount to maintain stable blood glucose levels, therefore preventing ketosis.10

**Iron:** Due to the increase in blood volume in the mother’s body, there is an increased need for iron.10 Iron needs increase from 18mg/day to 27mg/day.10 Including enough and/or additional ascorbic acid in the diet can help increase iron absorption.10
Calcium: Calcium intake needs to be of focus during pregnancy due to the increase in bone turnover that occurs with changing hormone levels. Around 30g of the calcium consumed by the mother during pregnancy is transported to the fetus. The RDA for calcium during pregnancy is 1300mg/d for women aged 14-18, and 1000mg/d for women aged 19-50.

Zinc: Zinc is important for neurological development of the fetus, and a zinc deficiency can cause an increased risk of low birth weight and additional problems from compromised vitamin A status. Zinc deficiency is rare, and usually does not require supplementation. The RDA for zinc during pregnancy is 12mg/d for women aged 14-18, and 11mg/d for women aged 19-50.

Folate: Folate is needed for neurological and DNA development of the fetus, and is one of the more common vitamins to be compromised during pregnancy. Since the fetus’ neural tube closes by day 28 of gestation (which requires sufficient folate stores from the mother), and many pregnancies are unplanned, neural tube defects can be a problem. The folate RDA for pregnant women is 600µg/d.

Vitamin B₁₂: Cobalamin (vitamin B₁₂) is a coenzyme for reactions forming methionine and tetrahydrofolate (THF). Vitamin B₁₂ is found mostly in animal products, so vegetarian or vegan mothers may be at higher risk of deficiency. A vitamin B₁₂ deficiency in the mother may also hamper cognition and motor skills of her baby. The RDA for vitamin B₁₂ during pregnancy is 2.6µg/d.

Vitamin C: Ascorbic acid (vitamin C) is extremely important in collagen synthesis and preventing oxidation and damage to the body’s cells. Ascorbic acid can also increase iron absorption in the body. The RDA for vitamin C during pregnancy is 80mg/d for women aged 14-18 and 31-50, and 85mg/d for women aged 19-30.

10. What are the best dietary sources of iron? Describe the differences between heme and nonheme iron.

There are two types of iron – heme and nonheme. Heme iron is the type found in complex with hemoglobin, myoglobin and enzymes from animal products, while nonheme iron is found in plant, some animal foods, and fortified foods and supplements. Heme iron is better absorbed (about 25%) compared to nonheme iron, where only about 5% may be absorbed. Severe iron deficiency can raise absorption up to 50%, though this is uncommon. Non-heme plant sources generally have phytates and oxalates that impair absorption. The best dietary sources of iron include “liver, seafood, kidney, heart, lean meats and poultry.” Other iron sources include egg yolks, enriched grains, leafy greens, dried fruits, and wine.

11. Explain the digestion and absorption of dietary iron.

Non-heme Iron digestion begins when it meets the acidic gastric secretions in the duodenum which help reduce it from the ferric (3+) to ferrous (2+) form, which is more easily
absorbed. Non-heme ferrous iron is brought into intestinal enterocytes via DMT-1 (Divalent Metal Transporter-1) which can also transport other, possibly competing, divalent metal ions like calcium, zinc, and copper. If needed in the body, iron will be transported via Ferroportin and then bound to Transferrin, an iron-binding protein in the blood.

Absorption of heme iron begins after food has entered the duodenum (the main site of iron absorption), and heme-iron is able to enter the brush border of the small intestine through vesicle formation. Then, once in the cytosol, the ferrous heme-iron is removed for the ferroporphyrin complex, and free iron molecules are released. These free iron molecules join with apoferritin to make ferritin in the same way that non-heme iron does. Iron is either stored in the enterocyte or actively transported out and bound to transferrin in the blood where it is delivered to tissues.


Prepregnancy BMI:
- Weight = 135lb x (1kg/2.2lbs) = 61.36kg
- Height = 65in x (2.54cm/1in) = 165.1
- BMI = 61.36/(1.651^2) = 22.5 (normal)

Since Mrs. Morris’ BMI is classified as normal, her Total Weight Gain Range: 25lbs – 35lbs.

%UBW = CBW/UBW x 100
= 142/135 x 100 = 105.2%

13. Check Mrs. Morris’ prepregnancy weight. Plot her weight gain on the maternal weight gain curve. Is her weight gain adequate? How does her weight gain compare to the current recommendations? Was the weight gain from her previous pregnancies WNL?
Her weight gain for 23rd week of gestation is not adequate or WNL of recommended weight gain for pregnant women within BMI 18.5-24.9. Her weight gain for the 23rd week of gestation is below the recommended amount of 11 – 15lbs. The client stated that she gained 15lbs with her first pregnancy and 20lbs with her second. Neither of these weights is within normal limits (25lbs to 35lbs).

14. Determine Mrs. Morris’ energy and protein requirements. Explain the rationale for the method you used to calculate these requirements.

Protein needs:
- 0.88/g/kg/d – first half of pregnancy
- 1.1/g/kg/d or 71g/d – second half

\[1.1/g/kg/d \times 61.36kg \text{ (prepregnant weight)} = 67.5g/d\]

Mrs. Morris is in her second half of pregnancy at 23 weeks, so she should have an intake of 1.1/g/kg/d.

Caloric needs:

\[\text{REE (female)} = 10W + 6.25H – 5A – 161\]
\[= 10(61.36) + 6.25(159.25) – 5(31) – 161\]
\[= 1680.8 + (340 \text{ to } 360)\]
\[= 2020.8 \text{ kcals/d} – 2040.8 \text{ kcals/d}\]

Fluid needs:

3 L/day

I used the Mifflin-St. Jeor equation because it is for Adults (19-78). I used the activity factor of 1.3, because even though the case study does not mention her activity levels with two smaller children around the house she is active keeping up after them. I added a range of 340 to 360 kcals/d because this is the additional amount of calories recommended for pregnant women.

15. Using her 24-hour recall, compare her dietary intake to the energy and protein requirements that you calculated in Question 14.

Energy from 24 hour recall: 1382kcal
Energy requirements calculated: 2020 – 2040kcal/d

Protein from 24 hour recall: 40g
Protein requirements calculated: 67 – 71g/d

Mrs. Morris is not eating enough calories or protein for her stage of life needs. From her 24 hour food recall she is experiencing a gap of 638 – 658 kcal/d and 27 - 31g/d of protein in her diet.
16. Again using her 24-hour recall, assess the patient’s daily iron intake. How does it compare to the recommendations for this patient (which you provided in question #9)?
Recommendations Pregnancy 31-50 y.o\(^{10}\): 27mg/d
Iron:\(^{16}\) 19mg

Mrs. Morris is not consuming enough foods with iron to meet her recommendation. There is a gap of \(~8\text{mg}\) of iron in her diet.

17. Identify the pertinent nutrition problems and the corresponding nutrition diagnoses.

- Low iron intake – Inadequate mineral intake of iron (NI – 5.10.12)
- High phytate and iron consumption - Impaired nutrient utilization (NC - 2.1)
- Low weight gain for pregnancy - Inadequate energy intake – (NI – 1.2)

18. Write a PES statement for each nutrition problem.

1. Inadequate energy intake (NI - 1.2) r/t low weight gain for pregnancy AEB poor (7lb) weight gain at 23\(^{rd}\) week of gestation compared to the normal limits \(\sim 10 – 15\text{lb}\) and calorie deficit of 638 – 658 kcal/d.
2. Inadequate mineral intake of iron (NI - 5.10.12) r/t increased iron needs AEB 24 hour food recall, low Hgb 9.1g/dL, increased TIBC 465\(\mu\)g/dL, decreased ferritin 10\(\mu\)g/dL and pale skin.
3. Impaired nutrient utilization (NC - 2.1) r/t phytate consumption paired with iron containing foods AEB 24 hour food recall, low Hgb 9.1g/dL, increased TIBC 465\(\mu\)g/dL and decreased ferritin 10\(\mu\)g/dL.

19. Mrs. Morris was discharged on 40 mg of ferrous sulfate three times daily. Are there potential side effects from this medication? Are there any drug-nutrient interactions? What instructions might you give her to maximize the benefit of her iron supplementation?

- Side effects of ferrous sulfate are N/V, dyspepsia, bloating, constipation, diarrhea, dark stools, false + guaiac test for occult fecal blood, and dark urine.\(^{17}\)
- Drug nutrient interactions: high phytate foods, fiber supplement, tea, coffee, caffeine, red grape juice/wine, soy, dairy products, or egg.\(^{17}\) In addition, a high dose of iron may decrease zinc absorption.\(^{17}\)
- Take with orange juice or source of vitamin C to maximize absorption with each meal. Because she is a smoker, she has increased needs of vitamin C as well. Make sure that appropriate iron bioavailability in foods consumed is present.\(^{10}\) Do not drink tea or coffee near the time of taking the iron supplement because of tannin iron interaction which decreases availability.\(^{10}\) To avoid high phytate foods such as whole grains, bran, and soy, take ferrous sulfate before bed.
Also, be aware that the prenatal vitamin will also supplement iron. It may be best to switch to a prenatal vitamin that does not contain iron, so Mrs. Morris is not at risk for iron toxicity of 45mg/d.\(^\text{18}\)

20. Mrs. Morris says she does not take her prenatal vitamin regularly. What nutrients does this vitamin provide? What recommendations would you make to her regarding her difficulty taking the vitamin supplement?

A prenatal vitamin provides: iron, folic acid, calcium, vitamin C, vitamin A, vitamin E, vitamin B\(_1\), vitamin B\(_2\), vitamin B\(_3\), vitamin B\(_6\), Vitamin B\(_{12}\), zinc, copper, iodine, vitamin B\(_5\), vitamin D, magnesium, and manganese.\(^\text{10}\)

I would recommend strategies for making taking the vitamin easier. Take it at the same time daily with a meal to reduce GI distress, there are chewable varieties if this is more appealing to client, use a pill box, keep the vitamins insight to visually remember to take them utilize an electronic daily reminders on cell phone, ask someone responsible in your family to encourage you to take your vitamin, take vitamin right before bedtime.

I would also recommend to her to eat foods high in all of these nutrients. The best way is to follow the myplate guidelines to eat a healthy, balanced diet.

21. List factors that you would monitor to assess her pregnancy, nutritional, and iron status.

Factors that I would monitor would include oral intake, amount of iron bioavailability in food, phytate intake with meals, weight gain, protein intake, hematology levels including hemoglobin, and general appearance.
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Group 1: Apples
Kimberly Goin, Lindsey Kummer, Tessa Englund, Lindsey Wallace