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NDFS 356
Nutritional Anemia Research Paper

INTRODUCTION

Anemia is a major determinant of morbidity globally It has been associated with worsened outcomes in several diseases including renal failure, heart failure, myocardial infarction, and cancer. Anemia is associated with impaired oxygen delivery, decreased exercise tolerance and a reduced quality of life in older adults (8). Adolescent girls are at increased risk of adverse pregnancy outcomes associated with anemia (4). In India, the prevalence of anemia among adolescent girls is 90% (11). More than half the residents in nursing homes are anemic, and about a third of those cases are caused by deficiencies in vitamin B12, folate, or iron (2).

DESCRIPTION

Anemia is a reduction in the total number of erythrocytes in the circulating blood or a decrease in the quality or quantity of hemoglobin (2). Most anemias are caused by a lack of nutrients required for normal erythrocyte synthesis, principally iron, vitamin B12, and folic acid (1). 16-55% of girls are already anemic by the time they become pregnant, and pregnancy is too short a period of time in which to reduce pre-existing anemia (12). Iron-deficiency anemia is estimated to cause 591,000 perinatal deaths and 115,000 maternal deaths globally (12).

Iron-deficiency anemia

Iron deficiency anemia is the most common type of anemia worldwide, affecting as many as one fifth of the world population. Children, adolescents, women of childbearing age, and the chronic poor are at greatest risk (2). Consequences of iron deficiency anemia during childhood include growth retardation, reduced school achievement, impaired motor and cognitive development, and increased morbidity (6). Iron is required to make neurotransmitters such as

dopamine, epinephrine and serotonin. Long-term effects of iron deficiency include decreased work capacity and impaired cognitive and behavioral development (2). As it may be too late to address the problem of anemia during pregnancy, worldwide attention over iron deficiency anemia in pregnancy has shifted recently from providing nutritional supplements during pregnancy to ensuring adolescent girls have adequate stores before becoming pregnant (13).

Folate-deficiency anemia

Folate is an essential vitamin for erythrocyte production and maturation, and humans require 50 to 200 mcg/day with pregnant and lactating females requiring increased amounts. At least 10% of North Americans have a folate deficiency, although this has been decreasing in the US due to the fortification of folate in food and the increased use of supplements (2).

B-12-deficiency anemia

Vitamin B12 deficiency in older adults often goes unrecognized because of the subtle nature of indications (2). Intrinsic factor is a glycoprotein in the gastric juice that is necessary for the absorption of dietary vitamin B12, and pernicious anemia, caused by a deficiency of vitamin B12, is most commonly due to a lack of IF. There are different stages of deficiency (1).

ETIOLOGY

Iron-deficiency anemia

Menstruation, frequent blood donation, endurance training, digestive conditions such as Crohn’s disease, and certain drugs can lead to iron-deficiency anemia (5). The most common cause of iron deficiency anemia in well-developed countries is pregnancy and chronic blood loss. Blood loss may result from erosive esophagitis, gastric and duodenal ulcers, colon adenomas,

and cancers. Other causes include medications that cause gastrointestinal bleeding, surgical procedures that decrease stomach acidity and absorption, insufficient dietary intake of iron, and eating disorders. Iron deficiency also occurs in individuals with lead poisoning (2).

Megaloblastic anemias, characterized by unusually large erythrocytes, are the result of defective erythrocyte DNA synthesis caused by deficiencies of B12 or folate. In this situation there is a defect in DNA synthesis but RNA synthesis continues at a normal rate, resulting in the unequal growth and development of the cytoplasm and nucleus (2).

Folate-deficiency anemia

Folate deficiency is seen particularly in alcoholics and individuals with chronic malnourishment. Alcohol interferes with folate metabolism in the liver, causing a depletion of stores. Fad diets and diets low in vegetables also may cause folate deficiency because of the absence of plant sources. Folate is required for the synthesis of thymine and purines, and manifestations become apparent when the synthesis of thymidylate is compromised (2).

B12-deficiency anemia

Eating little or no meat may cause a lack of vitamin B12. Poor vitamin B12 absorption can be caused by conditions such as Crohn's disease, an intestinal parasite infection, surgical removal of part of the stomach or intestine, or infection with HIV (5). H Pylori has been identified as a causative agent in the development of vitamin B12 deficiency. Excessive alcohol ingestion, hot tea, and smoking may lead to chronic gastritis related to B12 deficiency (2).

PATHOPHYSIOLOGY

Anemia is manifested in a reduced oxygen-carrying capacity of the blood resulting in tissue hypoxia, and symptoms vary depending on the body's ability to compensate for this hypoxia. As the reduction in red blood cells continues, symptoms become more pronounced and compensatory mechanisms from the cardiovascular, respiratory, and hematologic systems become more apparent. Anemia causes an increase in heart rate due to an increased cardiac output in an effort to maintain adequate oxygen delivery. Other symptoms include shortness of breath, dizziness, fatigue, pale skin, abdominal pain, nausea, vomiting, and anorexia (2).

Iron-deficiency anemia

Depleted iron stores result in reduced hemoglobin synthesis. Anemia occurs when the demand for iron exceeds the supply and develops through 3 stages. First, the body's stores are depleted but erythropoiesis proceeds normally with hemoglobin content remaining normal. Second, iron transportation is diminished, resulting in iron deficiency erythropoiesis. Third, the small hemoglobin-deficient cells enter the circulation in sufficient numbers to replace the normal mature erythrocytes. When stores are depleted *and* there is diminished hemoglobin production, manifestations appear (2).

Folate-deficiency anemia

Folate deficiency results in megaloblastic cells with clumped nuclear chromatin due to impaired DNA synthesis. Anemia may result from the death of erythroblasts in erythropoiesis. Folate deficiency in pregnant women is associated with neural tube defects of the fetus. Folate is required for reducing homocysteine levels, a risk factor in the development of atherosclerosis. A deficiency of folate also is implicated in the development of cancers, specifically colorectal (2).

B12-deficiency anemia

Pernicious anemia, the most common type of megaloblastic anemia, is caused by vitamin B12 deficiency. The primary condition is an absence of intrinsic factor, which is required for B12 absorption. Nearly all vitamin B12 deficiencies in older adults are caused by a failure of IF-related absorption. Pernicious anemia most commonly affects individuals older than the age of 50 and is often associated with chronic gastritis. Chronic gastric atrophy is associated with low pepsinogen, achlorhydria, and gastric carcinoids. The gastric sub mucosa becomes infiltrated with inflammatory cells, causing parietal and zymogenic cell destruction. Pernicious anemia is also associated with other autoimmune conditions such as Addison's disease, type 1 diabetes, thyroiditis, and Graves ' disease (2).

MEDICAL DIAGNOSIS

Iron-deficiency anemia

There are a few tests a doctor may run to diagnose iron deficiency anemia. First, red blood cell size and color because with iron deficiency anemia they are smaller and paler in color than normal. Second, hematocrit, the percentage of red blood cells in the blood. Normal levels fall around 35-45 for women and 38-50 for men. Third: Hemoglobin. Lower than normal levels indicate anemia, the normal range is 13.5-17.5 g/dL of blood for men and 12-15.5 g/dL for women. Fourth: Ferritin, a protein that helps to store iron in the body. Low levels indicate low iron stores. Additional tests that may be ordered are an endoscopy, colonoscopy, and ultrasound to look for internal bleeding (7). Serum ferritin, an iron storage protein, and serum transferrin, an iron transport protein, are commonly used as indicators of iron status in populations (6). Hemoglobin by itself is unsuitable as a diagnostic tool because it is affected only late in the

disease, it cannot distinguish iron deficiency from other anemias, and hemoglobin values in normal individuals vary widely (1).

B-12 and Folate deficiency anemia

The amount of folate or B12 in the blood might be tested, as well as the number and appearance of red blood cells. Those with anemia have fewer red blood cells and these cells appear large and underdeveloped when there is a lack of B12 and folate. The numbers of white blood cells and platelets also might be decreased if advanced. Additional tests for B-12 deficiency include an antibodies test, methylmalonic acid test, and schilling test (assessing intrinsic factor) (8).

MEDICAL THERAPY

Iron-deficiency anemia

The foremost treatment for iron deficiency anemia involves oral administration of iron. Ferrous iron is better absorbed than ferric, and chelated iron is less affected by inhibitors and causes less GI disturbances than nonchelated iron. The patient is to take iron on an empty stomach unless gastric irritation occurs, in which they are told to take with meals. (1)

Scott et al. (10) studied 12,000 children from six African countries and found that approximately 1.8 million deaths in children aged 28 days-5 years could be avoided each year by increasing Hb in these children by 1g/dL.

Folate-deficiency anemia

To replenish folate stores, 1 mg of folate is taken orally every day for 2 to 3 weeks. Maintaining these stores requires a minimum of 50 to 100 mcg of folic acid daily (1).

B-12-deficiency anemia

An injection of 100 mcg or more of vitamin B12 once per week is administered. The frequency is reduced until remission can be maintained with monthly injections. A response to treatment is shown by improved appetite, alertness, and cooperation and by marked reticulocytosis within hours of an injection (1).

In an article from the Cochrane library, De-Regil et al. analyzed 33 trials involving children from birth to 12 years of age and found that intermittent iron supplementation is effective to improve hemoglobin and reduce anemia in children when compared with a placebo or no intervention, but it is less effective than daily supplementation to prevent or control anemia (6).

TOOLS IN NUTRITION ASSESSMENT

Iron-deficiency anemia

Hemoglobin by itself is unsuitable as a diagnostic tool. Ferritin, iron and transferrin are the most useful. Quantity of serum/plasma ferritin, quantity of serum/plasma iron, quantity of total circulating transferrin, percent saturation of circulating transferrin, percent saturation of ferritin with iron, and quantity of STFR are all biochemical measures of iron deficiency (1).

Folate-deficiency anemia

Folate-deficiency anemia is manifested by very low serum folate (<3 ng/mL) and RBC folate levels of less than 140-160 mg/mL. Red cell folate level measures actual body folate stores and thus is the superior measurement. To determine folate deficiency apart from vitamin B12 deficiency, levels of serum folate, RCF, serum vitamin B12, and vitamin B12 bound to TCII can

be measured simultaneously using a radioassay kit. There will also be an elevated level of formiminoglutamic acid in the urine with a folate deficiency (1).

B12-deficiency anemia

Vitamin B12 stores are depleted after several years without intake. A low TCII value (<40 pg/mL) is a sign of early B12 deficiency. Tests that may be helpful are IF antibody, the Schilling test, the dU suppression test, and tests to determine homocysteine and methionine levels (1).

MEDICAL NUTRITION THERAPY

Iron-deficiency anemia

The chief objective in medical nutrition therapy for iron deficiency anemia would noticeably be to increase the amount of iron in the diet. Beef, dried fruits, dried peas and beans, nuts, green leafy vegetables, and fortified whole-grain breads, muffins, cereals, and nutrition bars are foods that contain good amounts of iron. Heme iron is found in meat, fish, and poultry and is much better absorbed than nonheme. Individuals with iron-deficiency anemia absorb greater amounts of dietary iron compared to those without iron deficiency. Tea and coffee can reduce iron absorption by 50% if taken with meals, so it is recommended to decrease their consumption. (1)

Lynch and Cook (3) stated that the total intake of dietary iron is less important from a nutritional standpoint than the availability of that iron. This includes vitamin C. They found that ascorbic acid is a powerful enhancer of nonheme iron absorption and can reverse the inhibiting effect of such substances as tea and calcium/phosphate. Its influence may be less pronounced in meals with meat, fish, or poultry, but the enhancement of iron absorption from vegetable meals is

directly proportional to the quantity of ascorbic acid present. Ascorbic acid facilitates iron absorption (3).

Folate-deficiency anemia

The patient should eat at least one fresh, uncooked fruit or vegetable or drink a glass of fruit juice daily. Fresh fruits and vegetables are best sources of folate because folate can be destroyed by heat. Grains are required to be fortified by folic acid by the Food and Drug Administration. Women who are or who may become pregnant are recommended to consume 600 mcg/day through supplements in addition to consuming foods containing folate. (1)

B-12-deficiency anemia

Foods rich in vitamin B-12 should be increased in the diet. These include meats, (especially beef and pork) eggs, milk, and milk products. Metformin decreases B12 absorption, but increased calcium intake reverses the malabsorption. People older than 50 years of age are recommended to consume B12 in fortified cereals or supplements. The RDA for adults is 2.4 mcg daily. (1)

PROGNOSIS

In a study reviewed by Martinsson et al. (9) it was found that all diagnostic definitions of anemia were associated with a higher total mortality compared to no anemia. Anemia was associated with an increased risk of cardiovascular and cancer mortality, the two leading causes of death in the US. Deaths from GI disease, renal disease and infectious disease were also higher in subjects with anemia. It was stated that anemia, despite not being directly related to the pathophysiology of CAD, might be associated with other factors such as inflammation. Erythrocyte volume predicted mortality independently of hemoglobin with the highest mortality

observed for macrocytic anemia, which is less prevalent. The results highlighted the importance of careful evaluation and follow-up of individuals with anemia, even with a lenient definition (9).

ALTERNATIVE THERAPY

One alternate therapy studied by Vyas et al. (4) was the effectiveness of leaf concentrate for treating anemia in adolescent girls in urban India. This was done in attempts to develop low-cost, locally produced supplements to ensure the sustainability of efforts to prevent anemia. One group received daily Iron and Folic acid and the other received daily leaf concentrate. Hb concentration, mean cell volume, serum Fe, serum ferritin and total Fe-binding capacity were measured before and after intervention. They found that "daily servings of leaf concentrate, containing 5mg Fe and 13 micrograms folic acid, are as effective as daily supplements containing 60 mg Fe and 500 micrograms folic acid for treating anemia in adolescent girls." It may be due to the improved bioavailability of Fe in leaf concentrate or the effects of its other components. They concluded that leaf concentrate is a viable and more palatable alternative to iron and folic adolescent in these types of communities (4).

CONCLUSION

Anemia is a deficiency in the size or number of RBCs or their amount of hemoglobin and limits the exchange of oxygen and carbon dioxide between the blood and the tissue cells (1). Other anemias result from conditions such as hemorrhage, genetic abnormalities, chronic disease states, or drug toxicity and have varying degrees of nutritional consequence (1). It continues to be a problem globally, contributing to worsened outcomes in several diseases, causing adverse pregnancy outcomes, and resulting in increased overall mortality.

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