

# Vitamin B12 deficiency Anaemia

## Vitamin B12 Deficiency – Pernicious Anemia

Definition of disease: Vitamin B12 Deficiency is a reduced rate of RBC production in the bone marrow when critical nutritional components are lacking (Bruyere, 2009).

Detailed pathophysiology at cellular, tissue, organ and systems levels: Cobalamines come from the family of Vitamin B12 and is a cofactor for intra-cellular biochemical reactions. When it is methylcobalamin it serves as a cofactor for methionine synthetase and converts homocysteine to methionine. As adenosylcobalamin it facilitates the conversion of methylmalonic acid to succinyl-coenzyme A. Vitamin B12 also promotes thymidine synthase function; normal development of the nucleus is different cell types and DNA synthesis. Once ingested, vitamin B12 binds to intrinsic factor (IF). B12-IF is absorbed in the terminal ileum and is transported through the blood and stored in the liver. If B12 is not bound to IF, it cannot be absorbed. There are three plasma transport proteins that have been identified to transport B12. They are Transcobalamines I, II and III. Transcobalamine II is the protein responsible for transporting vitamin B12 into cells for use. Vitamin B12 deficiency occurs if anything interferes with the ingestion, separation, absorption, plasma transport, or transfer of B12 into cells (Bruyere, 2009). Defective DNA synthesis results in a disparity between the development of cytoplasm and nucleus which create megaloblastic cells. Megaloblastic cells have an immature and smaller nucleus than that of normoblasts. With every cell division, the disparity becomes more obvious. These abnormal RBC developments cause premature cell death and phagocytosis in the bone marrow. This is called megaloblastic anemia (Bruyere, 2009). White blood cells are also affected by the defective DNA synthesis. They also undergo premature cell death in bone marrow. Thrombocytopenia and leucopenia occur in varying degrees. Other cells with high turnover rate are also affected by these abnormalities which may explain the redness and increased pain in the tongue and diarrhea (Bruyere, 2009). Caucasian patients with B12 deficiency present with a lemon-yellow skin color. This occurs due to excess bilirubin that is circulating in the blood stream. This excess bilirubin is the increased breakdown of hemoglobin (Bruyere, 2009). Deficiencies in B12 causes abnormal methylation of the protein that makes up myelin. The result of myelin degeneration includes neurologic complications, paresthesias of the hands and feet, loss of vibratory sensations in the arms and legs and ultimately, ataxia (Bruyere, 2009). The absence of intrinsic factor is the principal abnormality in vitamin B12 deficiency. This is believed to have an autoimmune cause. This is thought because antibodies to gastric parietal cells are seen in the serum and gastric juice of patients with vitamin B12 deficiency. Vitamin B12 deficiency is characterized by intestinal metaplasia which is the infiltration of lymphocytes in the walls of the stomach that is associated with the degeneration of parietal cells and their replacement with mucus secreting goblet cells. There are also antibodies in the gastric juice that bind with B12 at its IF binding site, which prevents the formation of B12-IF complexes (Bruyere, 2009).

Genetics: Transcobalamine II (which is the protein responsible for transporting vitamin B12 into cells for use) deficiencies can be transmitted in families. This is usually an autosomal recessive condition (Bruyere, 2009).

Epidemiology: - Individuals older than 30 - Northern European descent (primarily Scandinavian, English and Irish) - More likely in females (black females having earlier onset) (McCance, Huether, Brashers & Rote, 2014)

Disease described: Vitamin B12 deficiency is a complication of an abnormality in body function, not a disease. A patient with vitamin B12 deficiency has an abnormally low number of circulating red blood cells or a low concentration of total hemoglobin, maybe both. RBCs are abnormally large, oval instead of biconcave and have flimsy cell membranes. These RBCs have a shorter lifespan and are measured in weeks not months.

Signs and symptoms: - Fatigue - Shortness of breath - Dizziness - Pale or yellowish skin - Irregular heartbeats - Numbness or tingling in hands and feet - Weight loss - Muscle weakness - Personality changes - Unsteady movements - Mental confusion/forgetfulness (Mayoclinic.org)

Diagnosis: The serum level of vitamin B12 is <100 pg/mL (Bruyere, 2009).

Treatment: Replacement of vitamin B12 (cobalamine). Injections of vitamin B12 are given weekly at first then monthly for the remainder of the patient's life.

## References:

Bruyere, H. (2009). 100 case studies in pathophysiology DVD. In D. Troy & M. L. Brittain (Eds.), Case study 53: Diabetes mellitus, type 1. Baltimore, MD: Lipincott Williams & Wilkins.

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McCance, K. L., Huether, S., Brashers, V. L., & Rote, N. S. (2014). Pathophysiology: The biologic basis for disease in adult and children. In K. McCance, S. Huether, V.L. Brashers & N. Rote (Eds.), Chapter 22 Alterations of hormonal regulation, pp. 735-739. St. Louis, MO: Elsevier.