

Hematologic Disorders

CBC Normal Adult Values

- WBC 5,000 – 10,000/mm³
- RBC 4.5 – 5.5 million/mm³ (4 – 5 females)
- Hgb 14 – 17 g/dl (12 – 16 females)
- Hct 42 – 52% (36 – 48 females)
- MCV 84 – 96 fL
- MCH 28 – 34 pg/cell
- MCHC 32 – 36 g/dl
- Platelets 140,000 – 400,000/mm³
- RDW 11.5 – 14.5%
- MPV 7.4 – 10.4 fL

WBC Differential

- Segs/Polys: 50 – 62%
- Band/Stabs 3 – 6%
- Eos 0 – 3%
- Baso 0 – 1%
- Monos 3 – 7%
- Lymphs 25 – 40%
- Metas 0 – 1%

Alterations in Erythrocyte Function

- Anemias
 - reduction in the total number of circulating erythrocytes or a decrease in the quality or quantity of hemoglobin
 - Etiology
 - Impaired Erythrocyte Production
 - Blood Loss
 - Increased Erythrocyte Destruction
 - Combination of the Above Causes

Anemias

- Classification based on Morphology
 - Size: normocytic, macrocytic, microcytic
 - Color: normochromic, hypochromic, hyperchromic
 - Other
 - Anisocytic – varied size
 - Poikilocytosis – varied shape

Measures of Morphology

- Mean Corpuscular Volume (MCV)
 - (Hct X 10)/RBC
- Mean Corpuscular Hemoglobin (MCH)
 - (Hgb X 10)/RBC
- Mean Corpuscular Hemoglobin Concentration (MCHC)
 - (Hgb/Hct) X 100

Clinical Manifestations of Anemia

- Gradual vs. Sudden
 - gradual = usually less symptomatic because of compensation
 - sudden = usually more symptomatic
- Magnitude
 - Hgb of 8 g would be more likely to be symptomatic
 - Hgb of 12 g would be less likely to be symptomatic
- Classic Signs of Anemia
 - Pallor
 - Fatigue
 - Dyspnea on Exertion (DOE)
 - Dizziness

Clinical manifestations

- Compensatory Manifestations
 - Cardiovascular (stress response) to pump the decreased amount of oxygen to the vital organs most efficiently
 - Tachycardia
 - Palpitations
 - Vasoconstriction
- Respiratory – to increase the effectiveness of breathing in order to optimize the uptake of oxygen
 - tachypnea
 - increased breathing depth
- Other
 - increased plasma volume – interstitial fluid moves into the vascular space
 - salt and water retention (because of activation of the Renin-Angiotensin-Aldosterone (RAA) system)

Macrocytic-Normochromic Anemia (Megaloblastic)

- Characterized by defective DNA synthesis that produces a pattern of ineffective erythropoiesis, resulting in unusually large stem cells in the bone marrow called megaloblasts that mature into unusually large and fragile erythrocytes that may die prematurely resulting in increased bilirubin levels.
- CBC characteristics
 - Anemia
 - Macrocytic
 - Normochromic or Hyperchromic

Megaloblast Anemias

- Pernicious Anemia – Vit B12 Deficiency
 - Pernicious means highly injurious or destructive, indicating its fatal potential if untreated
- Etiology
 - Chronic condition caused by malabsorption of vitamin B12
 - Decreased intake of Vitamin B12 (strict vegetarians)
 - Animal products
 - Meat, shellfish
 - Milk, eggs
 - Stored in liver for 3-5 years

Pernicious Anemia cont

- Etiology
 - Defective gastric secretion of Intrinsic factor (IF) from parietal cells of gastric mucosa
 - Congenital
 - Following partial or complete gastrectomy
 - Autoimmune gastric atrophy
 - Chronic atrophic gastritis
 - Heavy alcohol, hot tea, smoking
 - More common in elderly

Pernicious Anemia

- Clinical Manifestations
 - Classic signs of anemia
 - Neurologic manifestations with severe anemia (<7 g/dl)
 - Vitamin B12 is necessary for the synthesis of myelin
 - Parasthesias of feet and fingers
 - Ataxia
 - Loss of position and vibration sense
 - Spasticity
 - Sore tongue, beefy red (unknown cause)
 - Hyperbilirubinemia
 - Jaundice/icterus
 - "Lemon yellow" skin – combination of pallor and jaundice
 - Hepatosplenomegaly – enlarged liver and spleen

Pernicious Anemia

- Evaluation
 - CBC analysis
 - Clinical manifestation analysis
 - B12 levels
 - Schilling test – Vit B12 absorption is measured by administering radioactive Vitamin B12 and measuring its excretion in the urine
 - Intrinsic factor evaluation
 - Bone marrow aspiration and analysis

Pernicious Anemia

- Treatment
 - Injection if IF deficiency is the problem
 - Orally, IF deficiency is not the problem
- Vitamin B12 administration
 - Injection if IF deficiency is the problem
 - Orally, IF deficiency is not the problem
- Dietary adjustments
- Blood transfusion
- Monitor reticulocyte count for evidence of response to therapy

Vitamin B12

- Cyanocobalamin
 - Routes: PO, Intranasally, IM, SC
 - Oral Preferred
 - Adverse effects: hypokalemia
 - PO: 1000-10,000 micrograms/day tx
6 micrograms/day dietary supplement
 - IM, SC: typically 30 micg/day x 5-10days
then 100 to 200 micg/month
 - Intranasal 500 micg/spray once a week

B12 Treatment Considerations

- Monitor B12 levels
- Monitor Hemogram and reticulocytes
- Give Folic acid with B12 for severe anemia
- Folic acid caution

Folate Deficiency

- Megaloblastic anemia
- Etiology low folic acid levels
- Sources: liver, yeast, fruits, leafy vegetables, eggs, milk
 - Absorbed in upper small intestine and is not IF dependent
 - Circulates through the liver with very little storage
 - Deficiency is most common with select groups
 - Pregnancy and lactation (increased need)
 - Fad diets with decreased intake of folate
 - Alcoholic persons (ETOH interferes with folate metabolism)
 - Chronically malnourished
 - Sprue

Folate deficiency anemia

- Clinical Manifestations
 - Classic signs of anemia
 - No neurologic manifestations
 - Manifestations related to malnourishment
 - painful ulcerations of cheeks and tongue
 - fissuring of lips and mouth
 - Gastrointestinal symptoms
 - Dysphagia
 - Flatulence
 - Watery diarrhea

Folate Deficiency Anemia

- Evaluation
 - CBC
 - Clinical Manifestations
 - Folic acid levels
 - Bone marrow aspiration and analysis

Folate deficiency anemia

- Treatment
 - Folic acid requires B12 to be converted to active form
 - In large amounts, Folic acid is converted via an alternate pathway
 - Two forms of treatment are available
 - Active form: leucovorin, folinic acid, citrovorum factor
 - Inactive form: folacin, folate, pteroylglutamic acid, folic acid
 - Inactive form is more common

Folic Acid

- Indications
 - Treatment of Folic acid deficiency anemia
 - Prophylaxis for deficiency during pregnancy
 - Initial tx of severe B12 deficiency
- Adverse effects: no known
- Routes: PO, IM, SC, IV
- Dosage: 1000 – 2000 micrograms/day
400 micrograms/day

Folic Acid

- Treatment Guidelines
 - Monitor CBC and reticulocytes
 - If malabsorption is cause, diet alone will not be sufficient
 - Oral is preferred

Microcytic-Hypochromic Anemia

- Characterized by erythrocytes that are abnormally small and contain abnormally reduced amounts of hemoglobin
- CBC characteristics
 - Anemia
 - Microcytic
 - Hypochromic

Fe Deficiency Anemia

- Pathophysiology
 - The body maintains a balance between iron that is in use as Hgb and iron that is in storage for future Hgb synthesis
 - As old RBCs are broken down, iron is recycled
 - Inadequate intake of iron-rich foods
 - Children with increased need related to growth
 - Pregnancy
 - Iron poor diet

Fe Deficiency Anemia

- Pathophysiology cont
 - Increased iron loss through bleeding,
 - Menorrhagia – excessive menstrual bleeding
 - Medications that cause GI bleeding (ASA, NSAIDS)
 - Hemorrhoids
 - Ulcerative Colitis (bloody diarrhea)
 - Chronic blood loss with gastric or duodenal ulcers
 - Neoplasms which erode into blood vessels
 - Decreased iron related to parasitic infection (i.e. hookworms metabolize iron)

Fe Deficiency Anemia

- Clinical Manifestations
 - Classic signs of anemia
 - Structural and functional changes in epithelial tissue as a result of impaired capillary circulation (usually not present unless the anemia is severe, < 7 g/dl)
 - nails – brittle, thin, coarsely ridged, spoon-shaped (koilonychia)
 - Tongue – sore, red, burning caused by atrophy of the papillae (glossitis)
 - Sore, dry skin at the corners of the mouth called "angular stomatitis"
 - Difficulty swallowing related to a mucous web at the level of the hypopharynx and epiglottis (consisting of mucous & inflammatory cells)

Fe Deficiency Anemia

- Clinical manifestations
 - Deficient iron containing enzymes
 - gastritis
 - headache
 - Neuromuscular changes probably related to hypoxia (gait problems are rare)
 - numbness
 - tingling
 - Confusion, disorientation, memory loss (elderly)
 - Pica

Fe Deficiency Anemia

- Evaluation
 - CBC analysis
 - Clinical manifestation analysis
 - Serum Iron profile
 - Plasma Iron (Fe)
 - Total Iron Binding Capacity (TIBC)
 - Transferrin – carrier protein for iron
 - Ferritin – storage form of iron
 - Free Erythrocyte Protoporphyrin (FEP) – indicator of heme synthesis within erythrocytes
 - Bone Marrow aspiration and analysis

Fe Deficiency Anemia

- Treatments
 - eliminate causes of blood loss
 - administer iron
 - offer dietary counseling
 - blood transfusion
 - monitor reticulocyte count for evidence of response to therapy

Iron Therapy

- Oral Iron Preparations
 - Iron Salts
 - Ferrous Sulfate (DOC)
 - Ferrous Fumarate
 - Ferrous Gluconate
 - Carbonyl Iron
 - Parenteral Iron
 - Iron Dextran
 - Sodium-ferric Gluconate Complex and Iron Sucrose

Ferrous Sulfate

- Least expensive
- Standard by which other therapies are judged
- Indications
 - Tx of Iron Deficiency Anemia
 - Prophylaxis
- Adverse Effects
 - GI side effects
 - Staining of teeth (liquid forms)

Ferrous Sulfate

- Toxicity
 - Rare from therapeutic dosing
 - Mostly accidental or intentional overdosing
 - Adult fatality rare
 - Child mortality common
 - NVD, shock, then acidosis, gastric necrosis, hepatic failure, pulmonary edema, vasomotor collapse
 - Early dx saves lives :Fe levels and gastric x-ray

Ferrous Sulfate

- Drug Interactions
 - Antacids decrease iron absorption
 - Tetracyclines decrease absorption of both
 - Ascorbic acid increases absorption and side effects
- Formulations IR and SR
- Dosage and administration
 - Elemental Iron is key
 - Relationship to meals

Carbonyl Irons

- Pure elemental Iron

Parenteral Iron

- Iron Dextran anaphylaxis precautions
- Other
 - Sodium-Ferric Gluconate
 - Iron Sucrose

Microcytic Hypochromic Anemia

- Sideroblastic Anemia –
 - group of hereditary and acquired microcytic hypochromic anemias characterized by inefficient iron uptake resulting in dysfunctional hemoglobin synthesis

Normocytic-Normochromic Anemia

- Characterized by erythrocytes that are relatively normal in size and hemoglobin content, but insufficient in number
- CBC characteristics
 - Anemia
 - Normocytic
 - Normochromic

Aplastic Anemia

- Pathophysiology
 - Caused by bone marrow failure (hypoplasia or aplasia)
 - Pancytopenia is common (RBC, WBC, & platelet counts are all low)
 - Pure red cell aplasia (PRCA) is an associated condition - only red cells are affected

Aplastic Anemia

- Etiology
 - Acquired
 - Primary - Idiopathic
 - 50% of all confirmed cases
 - 80% of Aplastic anemia occurring over age 50
 - Secondary
 - Chemicals
 - Benzene
 - Chloramphenicol
 - Chemotherapy for cancer treatment
 - Ionizing radiation
 - Hereditary – Fanconi anemia – rare genetic anemia
 - Has been observed to be a precursor to leukemia for some persons (preleukemic condition)

Aplastic Anemia

- Clinical manifestations
 - Classic signs of anemia
 - If WBCs are low – expect infection
 - If platelets are low – expect bleeding
- Evaluation
 - CBC
 - Bone Marrow Biopsy analysis

Aplastic Anemia

- Treatment
 - Treat underlying disorder
 - Prevent further exposure to causal agent
 - Blood transfusions
 - Bone Marrow Transplant

Post-Hemorrhagic Anemia

- Pathophysiology
 - Caused by acute blood loss
 - Immediate effects are those of volume depletion
 - Fluid Volume Deficit
 - Hypovolemic Shock
 - The stress response attempts to compensate for the volume loss

Post Hemorrhagic Anemia

- Clinical Manifestations
 - Sympathetic Nervous system (SNS) stimulation
 - If greater than 50% blood loss
 - Shock
 - Lactic Acidosis
 - Death
 - Classic Signs of anemia
 - If the blood loss becomes chronic – loss of iron recycling results in the development of iron deficiency anemia – with clinical manifestations as described above

Post Hemorrhagic Anemia

- Evaluation
 - CBC analysis
 - Vital signs assessment & Physical examination
 - History driven
 - Look for bleeding if not obvious

Post Hemorrhagic Anemia

- Treatment
 - Stop the bleeding
 - Administer fluids
 - Blood transfusion

Hemolytic Anemia

- Pathophysiology
 - Premature, accelerated destruction of RBCs
 - Erythropoiesis is normal and often accelerates in an attempt to compensate for the increased destruction
 - Elevated Bilirubin levels often occur as a consequence of the increased destruction
 - Jaundice
 - Icterus (scleral icterus)

Hemolytic Anemia

- Etiology
 - Acquired
 - Immune Mediated
 - Traumatic
 - Infectious
 - Toxic
 - Physical
 - Hypophosphatemic

Hemolytic Anemia

- Etiology cont.
 - Hereditary
 - Structural Defects
 - Enzyme Deficiencies
 - Defects of Globin synthesis or structure
 - Sickle cell anemia
 - Thalassemia

Hemolytic Anemia

- Clinical Manifestations
 - Classic Signs of Anemia
 - Jaundice
 - Splenomegaly
- Evaluation
 - CBC analysis
 - Bone Marrow studies
 - Clinical Manifestation analysis
 - Other tests for immune status or Hgb examination etc. depending on the cause of the hemolysis

Hemolytic Anemia

- Treatment
 - Remove the cause
 - Treat the underlying disorder
 - Blood transfusions
 - Splenectomy if that is a site where hemolysis is occurring
 - Corticosteroids to treat immune mediated hemolysis
 - Administration of folate, iron, erythropoietin

Anemia of Chronic Disease (ACD)

- Pathophysiology
 - Most common anemia in the hospitalized patient
 - Three pathogenic mechanisms cause ACD
 - Decreased erythrocyte lifespan
 - Failure of mechanisms of compensatory erythropoiesis
 - Disturbances of the iron cycle

Anemia of Chronic Disease (ACD)

- Etiology
 - Chronic Infections
 - HIV
 - Hepatitis C
 - Chronic inflammatory diseases
 - RA
 - SLE
 - IBD
 - Malignancies

Anemia of Chronic Disease (ACD)

- Clinical Manifestations
 - Classic signs of anemia
 - Usually normocytic-normochromic but may be microcytic-hypochromic if iron cycle is severely affected
 - Manifestations of Iron deficiency anemia if microcytic-hypochromic

Anemia of Chronic Disease (ACD)

- Evaluation
 - CBC analysis
 - Screening for malignancies if chronic infection or inflammation is not present
- Treatment
 - Treat the underlying disorder
 - Administer Erythropoietin
 - Blood transfusion

Hemoglobin Blood Products

- Packed Red Blood Cells (PRBCs)
 - No plasma; easier to store
 - Less likelihood of fluid overload
- Whole Blood
 - Contains clotting factors and proteins
- Both
 - Used to replace blood losses
 - Contains hemoglobin
 - Can transmit viruses
 - Carry oxygen to cells
 - Contain citrates – may affect calcium levels

PRBCs and Whole Blood

- Poor shelf life, expensive (testing), availability varies
- Must be typed and cross-matched (time consuming)
- Many patients have developed antibodies against all blood groups (patients with prior blood transfusions), and PRBCs and whole blood must be "washed" to remove antigens
- Can transmit viruses and other pathogens
- Adverse (allergic) reactions common
 - RN must follow strict protocols when transfusing
 - Nursing students are not allowed to transfuse PRBCs and whole blood !!!

Other Blood Products

- Fresh Frozen Plasma (FFP)
- Albumin
- Platelets
- Clotting Factors