Anemia in children

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Common Conditions Not Referred (Hematology/Oncology). Diagnose and manage patients with hematological disorders that generally do not need referral

- Diagnose, explain, and manage the following hematologic or oncologic conditions:

  - Iron deficiency
  - Hemoglobin traits
    - Alpha and beta thalassemia
    - Sickle cell
    - Hgb E
  - Lead poisoning
  - Transient erythroblastopenia of childhood
  - Minor, common reactions to blood transfusions
  - Benign bone cyst
  - Idiopathic thrombocytopenic purpura
  - Nosebleeds
  - Bruising
What is anemia?
Definition of anemia

• Definitions vary

  • Laboratory – hemoglobin less than two standard deviations below the mean

    • Red blood cell count

    • Hemoglobin

    • Hematocrit
Definition of anemia

- Physiologic – hemoglobin too low to support O2 needs of the body
Hematopoiesis

- Production and development of blood cells

- Pleuripotent stem cell
  - continuous self-replication
  - gives rise to all blood cell lines

- Growth factors (cytokines) - promote differentiation into mature blood elements
Erythroid Maturation Sequence

Early  →  Intermediate  →  Late

Proerythroblast (Pronormoblast)  Polychromatophilic Normoblast  Reticulocyte
Basophilic Normoblast  Orthochromatophilic Normoblast  Erythrocyte
Red Blood Cell

- Hemoglobin (Hgb) -
  - direct measurement (g/dl)

- Hematocrit (Hct) -
  - packed RBC volume - manual “spun” hematocrit (%)
  - automated counters calculate based on RBC number and size
Red Blood Cell Indices

- Mean corpuscular volume (MCV) - average size of the RBCs
- Mean cell hemoglobin (MCH) - Hgb/RBC
- Mean cell hemoglobin concentration (MCHC) - Hgb/Hct
- Red blood cell distribution width (RDW) - index of size variation
What is anemia?
Factors that affect hemoglobin

- Age
- Sex
- Race
- Altitude
Normal hemoglobin indices

- Hemoglobin: 11 + 0.1 rule

- MCV: 70 + 1 rule
Evaluation of child with anemia

• History

• Symptoms
  • Weakness, malaise, fatigue
  • CNS hypoxia - headaches, faintness, visual changes
  • Skin pallor, thinning and inelasticity
  • Nail brittleness
  • Nonspecific signs and symptoms

• Diet
  • Jaundice

• Family history

• Prior normal CBC
Evaluation of child with anemia

- Physical exam
  - Pallor
  - Jaundice
  - Cardiovascular status
  - Splenomegaly
  - Lymphadenopathy
- Other diseases
Evaluation of child with anemia

• Make sure the child is not bleeding!
Morphologic classification of anemia

- Microcytic anemia
  - Iron deficiency
  - Lead poisoning
  - Thalassemia
  - Anemia of chronic disease
Morphologic classification of anemia

- Macrocytic anemia
- B12 deficiency
- Folate deficiency
- Thiamine depletion
- Aplastic anemia
- Diamond-Blackfan anemia
- Bone marrow infiltration
- Hypothyroidism
- Liver disease
Morphologic classification of anemia

- Normocytic anemia
  - Red cell membrane defects
  - Enzyme defects
  - Hemoglobinopathies
  - Renal disease
  - Antibody mediated hemolysis
  - Microangiopathic hemolysis
  - Splenic sequestration
  - Blood loss
Pathophysiologic classification

• Anemia means not enough RBCs

• Inadequate production

• Excessive destruction
What test?

- Distinguish between decreased production and increased destruction

- Reticulocyte count
Anemia due to inadequate production

- Decreased/altered nutrition
  - iron deficiency, B12 deficiency, folate deficiency, lead poisoning
- Anemia of chronic disease
- Decreased erythropoietin
- Marrow infiltration/dysfunction
  - Infection, drugs, radiation, toxins, TEC, DBA, cancer
Anemia due to excessive destruction

• Acquired
  • antibody mediated
  • toxin mediated, infections (malaria)
  • mechanical (microangiopathic, HUS, artificial valve)

• Intrinsic
  • Membrane defects: hereditary spherocytosis
  • Hemoglobinopathies: Hgb SS, thalassemias
  • Enzyme defects: G6PD, pyruvate kinase
Initial lab tests

- CBC/diff
- Reticulocyte count
- Coomb’s test (direct)
Iron deficiency

- Most common nutritional deficiency
- Required in hemoglobin synthesis
- Heme + globin chains = hemoglobin
- Occurs in RBC cytoplasm
- Hypochromic microcytic anemia
Iron metabolism

- Iron is absorbed primarily in duodenum
  - 25% of heme-bound iron (red meat)
  - 1-2% of non-heme iron
- Body losses of iron are limited
  - 1-2 mg/day by epithelial cell shedding
  - Mucosal block - maintains balance
Transferrin

• Transport protein for iron in blood

• Fully saturated transferrin = TIBC
  
  • 300 - 350 µg/dl Fe

• Normal transferrin
  
  • 1/3rd bound with iron

  • 100 - 120 µg/dl Fe (serum iron)
Iron Storage

• Ferritin – protein-iron complex

• Found in all tissues

• BM, liver (transferrin)

• Spleen (RBC breakdown)

• Hemosiderin - breakdown product of ferritin
Development of Iron Deficiency

- Depletion of stores
- ↓ serum ferritin
- ↓ serum Fe, ↑ transferrin (↑ TIBC)
- ↓ stainable BM iron
- ↓ transferrin saturation
- ↓ hemoglobin, myoglobin, Fe proteins
Iron Deficiency Anemia - Clinical Manifestations

- Anemia - nonspecific findings
- Blue sclera
- Pica
- Koilonychia
- Developmental delay
Iron Deficiency Anemia
Laboratory Findings

• Hypochromic microcytic anemia
  • (↓ RBC count, ↓ MCV)

• ↓ Serum ferritin levels

• ↓ Transferrin saturation

  • (↓ serum Fe, ↑ transferrin)
Causes of Iron Deficiency (Adult version)

• External blood loss - most common
  • Female genital tract
  • Gastrointestinal tract

• Increased demand
  • Infancy
  • pregnancy

• Intestinal malabsorption syndrome
Causes of Iron Deficiency (Pediatric version)

• Dietary deficiency
  • Milk monster
    • Decreased bioavailability
    • Increased needs
    • Possible chronic GI losses
  • Vegetarian diets
• Bleeding
Iron Deficiency – Therapy

- Oral supplementation
  - FeSO4: 6 mg/kg elemental iron
  - No milk
  - No milk
  - No milk
  - No milk
  - Fe rich foods
- Parental supplementation
  - Iron dextran
- Developmental followup