

CHAPTER 23 — ALTERATIONS OF HEMATOLOGIC FUNCTION

High-Yield Nursing Study Guide (Patho → Clinical → Diagnostics → Treatment)

1. OVERVIEW OF HEMATOLOGIC ALTERATIONS

Hematologic dysfunction involves one or more of the following:

A. Erythrocyte (RBC) Problems

- Too few RBCs → Anemia
- Too many RBCs → Polycythemia
- Normal number, abnormal structure → hemoglobinopathies (SCA, thalassemia)

B. Leukocyte (WBC) Problems

- **Leukocytosis** (infections, stress, inflammation)
- **Leukopenia** (immunosuppression, bone marrow failure)
- **Leukemia & other cancers** (bone marrow infiltration)

C. Platelet / Coagulation Problems

- Too few platelets → bleeding risk
- Too many platelets → thrombosis risk
- Coagulation disorders → ↑ bleeding OR ↑ clotting

2. ANEMIA — CLASSIFICATION, PATHO, MANIFESTATIONS

A. Definition

A decrease in total RBC number, or decrease in hemoglobin quality or quantity, resulting in reduced oxygen-carrying capacity → tissue hypoxia.

Causes

1. Impaired RBC production
2. Blood loss (acute or chronic)
3. Increased RBC destruction (hemolysis)
4. *Combination of the above*

B. Morphologic Classification (VERY HIGH-YIELD)

Type	MCV	MCHC	Example Conditions
Macrocytic–Normochromic	High	Normal	B12 deficiency, Folate deficiency, Alcoholism
Microcytic–Hypochromic	Low	Low	Iron deficiency, Thalassemia, Sideroblastic anemia
Normocytic–Normochromic	Normal	Normal	Acute blood loss, Aplastic anemia, Hemolytic anemia, Chronic inflammation

👉 "-cytic" = cell size, "-chromic" = hemoglobin content

👉 Anisocytosis = variable size, Poikilocytosis = abnormal shapes

C. Pathophysiology of Anemia

Reduced oxygen-carrying capacity → **hypoxemia** → **tissue hypoxia** → compensations:

Compensatory Mechanisms

Cardiovascular

- ↑ HR, ↑ stroke volume
- Hyperdynamic circulation
- Possible murmurs, heart failure

Respiratory

- ↑ RR, ↑ depth
- Dyspnea on exertion → dyspnea at rest

Hematologic

- ↑ EPO → ↑ reticulocytes if bone marrow is functional

Renal

- RAAS activation → salt + water retention → ↑ plasma volume → hemodilution
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D. Clinical Manifestations of Anemia

General symptoms (all anemia types)

- Fatigue, weakness
- Dyspnea
- Palpitations, tachycardia

- Dizziness, syncope
- Pale skin, mucous membranes
- Headache, irritability
- Low-grade fever

Severe or Acute

- Shock
- Vasoconstriction
- Organ ischemia

Skin/Hair/Nails

- Pallor
- Jaundice (if hemolytic anemia)
- Brittle hair, early graying
- Poor wound healing

GI

- Nausea, anorexia, abdominal pain

Neuro (B12 deficiency)

- Paresthesias
- Ataxia
- Loss of vibration/position sense
- Cognitive changes

- Neuro damage may be **irreversible**
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3. ANEMIAS DUE TO BLOOD LOSS

A. Acute Blood Loss (Posthemorrhagic Anemia)

Normocytic–Normochromic (NNA)

Causes

- Trauma
- GI bleed
- Ruptured aneurysm

Patho

- Loss of intravascular volume
- Hemodilution occurs within 24 hrs
- Neutrophils & platelets increase temporarily
- EPO increases → reticulocytosis (if iron stores adequate)

Clinical

- Hypotension
- Tachycardia
- Shock
- Cool, clammy skin

Treatment

- Stop the bleeding
 - Restore volume (NS, LR, blood products)
 - Transfusion PRN
 - Iron replacement if large RBC loss
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B. Chronic Blood Loss

Leads to **iron deficiency anemia** because RBCs lost faster than replaced.

Common causes

- Menstrual losses
- GI bleeding (ulcer, malignancy)

Treatment

- Find & stop source of bleeding
 - Iron replacement
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4. ANEMIAS OF DIMINISHED ERYTHROPOIESIS (LOW PRODUCTION)

A. Megaloblastic Anemias (Macrocytic-Normochromic)

Due to **impaired DNA synthesis** → large abnormal RBCs (megaloblasts)

Types

1. **Pernicious anemia (Vitamin B12 deficiency)**
 2. **Folate deficiency anemia**
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1. Pernicious Anemia (B12 deficiency)

Causes

- Autoimmune destruction of **intrinsic factor (IF)**
- Gastrectomy
- Long-term PPI or metformin use
- Ileal disease/resection
- Tapeworm
- Vegan diet (low B12)

Pathophysiology

- B12 cannot be absorbed → impaired DNA synthesis
- RBC precursors die prematurely → decreased RBC count
- **MMA & homocysteine** ↑ (diagnostic!)

Clinical Manifestations

- Classic: **smooth beefy-red tongue (glossitis)**
- Weakness, fatigue
- Weight loss

- Paresthesias, ataxia, loss of vibration sense
- Mood changes, depression
- “Lemon-yellow” skin (pallor + jaundice)
- Hepatosplenomegaly possible

Diagnostics

- Low B12
- Anti–intrinsic factor antibodies
- High MMA, high homocysteine
- CBC: macrocytosis, low reticulocytes

Treatment

- **Lifelong B12 replacement**
 - IM: 1000 mcg daily/every other day × 1–2 wks
 - Then weekly × 1–2 months
 - Then monthly for life
 - High-dose oral B12 possible
 - Monitor for **gastric cancer risk**
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2. Folate Deficiency Anemia

Causes

- Poor diet (elderly, alcoholism, malnutrition)

- Malabsorption (Crohn, UC)
- Pregnancy, lactation
- Medications: methotrexate, trimethoprim, phenytoin

Clinical Manifestations

- Similar to B12 deficiency **BUT NO NEURO SYMPTOMS**
- Mouth ulcers, glossitis
- Stomatitis, cheilosis
- Diarrhea

Diagnostics

- Low serum folate
- High MCV
- Normal MMA

Treatment

- Oral folate supplementation
- Correct diet
- Symptoms resolve in 1–2 weeks

5. MICROCYTIC–HYPOCHROMIC ANEMIAS

A. Iron Deficiency Anemia (IDA)

Most common anemia worldwide.

Causes

- Chronic blood loss
- Poor intake
- Pregnancy
- Malabsorption
- GI pathology
- ↑ Hepcidin (inflammation) → ↓ iron absorption

Pathophysiology

Low iron → ↓ hemoglobin synthesis → microcytic, pale RBCs.

Clinical Manifestations

Early: Fatigue, weakness, dyspnea

Late:

- Pale conjunctiva, palms
- Koilonychia (spoon nails)
- Glossitis (smooth tongue)
- Cheilosis
- Dysphagia (Plummer-Vinson syndrome)
- Neuromuscular changes
- Cognitive impairment (especially in children)

Diagnostics

- ↓ Hgb/Hct
- ↓ MCV, ↓ MCHC
- ↓ ferritin
- ↓ serum iron
- ↑ TIBC
- ↓ transferrin saturation

Treatment

- Identify and stop blood loss
 - Oral iron therapy
 - Treat for months until ferritin normal
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B. Sideroblastic Anemia

Defect in heme synthesis → ring sideroblasts in marrow

Causes

- Congenital
 - Toxins/alcohol
 - Medications
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C. Thalassemias

Genetic defect → impaired α or β -globin chain production
(covered more in pediatric hematology)

6. ANEMIA OF INFLAMMATION (CHRONIC DISEASE)

Normocytic at first → then microcytic if long-standing

Causes

- Infection
- Autoimmune disease
- Cancer
- CKD
- HF
- Chronic pulmonary disease

Pathophysiology

- ↑ IL-6 → ↑ hepcidin
- Hepcidin blocks iron release & absorption
- ↓ EPO production
- Shortened RBC lifespan

Clinical Manifestations

- Fatigue
- Weakness
- Cognitive changes

- Dyspnea
- Chest pain

Diagnostics

- Low serum iron
- Low TIBC
- High ferritin (KEY)
- Normal or low reticulocytes

Treatment

- Treat underlying condition
- Consider EPO in CKD
- Iron only if proven deficiency

7. APLASTIC ANEMIA (Bone Marrow Failure)

Definition

Pancytopenia: ↓ **RBCs**, ↓ **WBCs**, ↓ **platelets**

Causes

Acquired (most common):

- Autoimmune destruction of stem cells
- Medications (chloramphenicol, chemotherapy, antimetabolites)

- Benzene exposure
- Radiation
- Viral infections (EBV, CMV, hepatitis)

Inherited:

- Fanconi anemia

Clinical Manifestations

- Fatigue, pallor
- Frequent infections
- Bleeding, petechiae
- Fever

Diagnostics

- Pancytopenia
- Hypocellular bone marrow

Treatment

- Remove offending toxin
 - Immunosuppression (ATG, cyclosporine, steroids)
 - Stem cell transplant in younger patients
 - Supportive transfusions
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8. HEMOLYTIC ANEMIAS (Increased RBC Destruction)

Normocytic–Normochromic

Causes

Intrinsic (RBC defect)

- Membrane defects
- Enzyme deficiencies (G6PD)
- Hemoglobinopathies (sickle cell)

Extrinsic (outside RBC)

- Autoimmune hemolysis
- Infections (malaria, babesiosis)
- Mechanical (prosthetic valves, microangiopathy)
- Drugs (oxidative stress)
- Transfusion reactions

Clinical Manifestations

- Fatigue, dyspnea
- Jaundice
- Dark urine (hemoglobinuria)
- Splenomegaly/hepatomegaly
- Tachycardia

Diagnostics

- ↑ reticulocyte count
- ↑ LDH
- ↑ unconjugated bilirubin
- ↓ haptoglobin
- Positive or negative Coombs test (immune vs nonimmune)

Treatment

- Treat cause
- Transfusion PRN
- Steroids for autoimmune forms
- Avoid triggers (G6PD)
- Possible EPO or BMT in severe disease

9. QUICK HIGH-YIELD COMPARISON CHART

Anemia Type	MCV	Key Labs	Unique Signs	Treatment
Iron Deficiency	↓	↓ Fe, ↓ ferritin, ↑ TIBC	Spoon nails, pica, glossitis	Oral iron
B12 Deficiency (PA)	↑	↑ MMA, ↑ homocysteine	Neuro symptoms, beefy red tongue, lemon-yellow skin	Lifelong B12
Folate Deficiency	↑	Normal MMA	No neuro signs, mouth ulcers	Oral folate

Anemia of Inflammation	Normal → ↓	Low Fe, low TIBC , high ferritin	Chronic disease background	Treat underlying
Aplastic Anemia	Normal	Pancytopenia	Infections + bleeding	Immunosuppression, BMT
Hemolytic Anemia	Normal	↑ retics, ↑ LDH, ↓ haptoglobin	Jaundice, dark urine	Treat cause