Anemia Outline

• Background facts about blood
• Anemia: general information
• Anemia: specific types

Normal blood cells

Complete Blood Count (CBC)

RBC

Hemoglobin

Hematocrit
**Complete Blood Count (CBC)**

- **MCV** (Microcytic, Normocytic, Macrocytic)
- **MCHC** (Hypochromic, Normochromic)

**Additional Red Blood Cell Properties**

- **Size variation**
  - Anisocytosis
  - Poikilocytosis

**Symptoms of Anemia**

- Pale skin, mucous membranes
- Jaundice (if hemolytic)
- Tachycardia
- Breathlessness
- Dizziness
- Fatigue

**Anemia Outline**

- Background facts about blood
- Anemia: general information

An (without) -emia (blood):

a reduction below normal in hemoglobin or red blood cell number.
Anemia Outline

- Background facts about blood
- Anemia: general information
- Anemia: specific types

Three Ways to Get Anemic

Lose blood

Destroy too much blood
- Extracorpuscular reasons
- Intracorpuscular reasons

Make too little blood
- Too few building blocks
- Too few erythroblasts
- Not enough room

Three Ways to Get Anemic

Lose blood

Anemia of Blood Loss

Things you must know
- Cause: traumatic, acute blood loss
- At first, hemoglobin is normal!
- After 2-3 days, see reticulocytes
- Chronic blood loss is different (it causes iron deficiency anemia).

Reticulocytes

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Hemolytic Anemias

- Intracorpussular vs. extracorpussular
- Chronic vs. acute
- Signs of destruction: ↑ bilirubin, ↑ LDH, ↓ haptoglobin
- Signs of production: ↑ reticulocytes, nucleated red cells in blood

Three Ways to Get Anemic

Lose blood
Destroy too much blood
  • Extracorpussular reasons

Microangiopathic Hemolytic Anemia

Things You Must Know

- Physical trauma to red cells
- Schistocytes
- Find out why!
Autoimmune Hemolytic Anemia

Things You Must Know

- Warm AIHA
  - IgG
  - Spleen
  - Spherocytes
- Cold AIHA
  - IgM, complement
  - Intravascular hemolysis
  - Agglutination

Causes of MAHA

- Artificial heart valve
- Malignancy
- Obstetric complications
- Sepsis
- Trauma
Cold AIHA

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Cold AIHA

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patient red cells + AHG = agglutination

Direct antiglobulin test (DAT)

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• Intracorpuscular reasons

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Hemoglobinopathy (qualitative defect in hemoglobin)

• Single amino acid substitution in beta chain of hemoglobin
• Can be heterozygous or homozygous

Sickle cells are nasty:
• Fragile (burst easily)
• Get stuck in vessels

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Hemoglobin

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Point mutation in β chain gene

abnormal β chains
(substitution of valine for glutamate)

Hgb S
Nasty!

Aggregates and polymerizes on deoxygenation
Red cell becomes sickle shaped
Sickles clog up vessels...
...plus, they are fragile

Sickle cell anemia

Sickle cell anemia: foot lesion

Sickle cell anemia: spleen

Clinical Findings in Sickle Cell Anemia

- Blacks (8% are heterozygous)
- Severity of disease is variable
- Chronic hemolysis, vaso-occlusive disease, and ↑ infections (autosplenectomy)
- Treatment: prevent triggers, vaccinate, transfuse

Thalassemia

Things You Must Know

- Quantitative defect in hemoglobin
- Can’t make enough α or β chains
- Variable disease severity
- Hypochromic, microcytic anemia with increased RBC and target cells
Hemoglobin chain development:

- Hgb F = α₂γ₂
- Hgb A₂ = α₂δ₂
- Hgb A = α₂β₂

Thalassemia:

Hereditary Spherocytosis:

- Tons of spherocytes
- Spectrin defect
- Splenectomy is curative

Hereditary spherocytosis:

Things You Must Know:
**Splenomegaly in hereditary spherocytosis**

**Glucose-6-Phosphate Dehydrogenase Deficiency**

**Things You Must Know**
- $\downarrow$ G6PD $\rightarrow$ $\uparrow$ peroxides $\rightarrow$ cell lysis
- Oxidant exposure
- Bite cells (removal of Heinz bodies)
- Self-limiting

**Clinical Findings in G6PD Deficiency**

- Some patients asymptomatic
- Others have episodic hemolysis
- Triggers: broad beans (favism), drugs (antibiotics, aspirin)
- Spontaneous resolution

**Why Do G6PD-Deficient Red Cells Die?**

- They can’t reduce nasties
- Nasties attack hemoglobin bonds
- Heme breaks away from globin
- Globin denatures, sticks to red cell membrane ("Heinz body")
- Spleen bites out Heinz bodies
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Iron-Deficiency Anemia

Things You Must Know
  • Most important cause: GI bleeding
  • Microcytic, hypochromic anemia
  • Must find out why patient is iron deficient!
Koilonychia in iron-deficiency anemia

Causes of Iron Deficiency
- Decreased iron intake
  - bad diet
  - bad absorption
- Increased iron loss
  - GI bleed
  - menses
  - hemorrhage
- Increased iron requirement
  - pregnancy

Anemia of Chronic Disease

Things You Must Know
- Infections, inflammation, malignancy
- Iron metabolism disturbed
- Normochromic, normocytic anemia
- Anemia usually mild

Megaloblastic Anemia

Things You Must Know
- Defective DNA synthesis
- Nuclear/cytoplasmic asynchrony
- ↓ B12/folate
- Macrocytic anemia with oval macrocytes and hypersegmented neutrophils

FH4
methylene FH4
methyl FH4
FH2

dUMP → dTMP → DNA

需 B12 to make DNA!

Megaloblastic Anemia

retarded DNA synthesis
unimpaired RNA synthesis

BIG cells!
immature nucleus
mature cytoplasm
Megaloblastic anemia

Atrophic glossitis in megaloblastic anemia

What else is B₁₂ good for?

homocysteine → methionine
↑↑ homocysteine ↓↓ methionine
endothelial damage → myelin damage
atherosclerosis → subacute combined degeneration
thrombosis

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Aplastic Anemia

Things You Must Know

  • Pancytopenia
  • Empty marrow
  • Most are idiopathic
Blood smear in aplastic anemia

Empty bone marrow in aplastic anemia

Empty bone marrow in aplastic anemia

Causes of Aplastic Anemia

- Idiopathic
- Drugs
- Viruses
- Pregnancy
- Fanconi anemia

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Bone marrow full of fibrosis