

# INTRODUCTION

- Iron deficiency (ID) is the most common nutritional deficiency in children.
- WHO estimates that anemia affects **one quarter** of the world's population and is concentrated within pre-school age children and women.
- Iron deficiency anemia (**IDA**) is a microcytic, hypochromic, and hypoproliferative state.

# PREVALENCE

- It is estimated that **more than one third** of the population in the Region is anaemic.
- Pregnant women and young children are most at risk
  - **50%** of pregnant women and
  - **63%** of children under-5 have iron deficiency anaemia.



# IRON BALANCE

- **75%** bound in heme proteins (hemoglobin and myoglobin).
- In normal subjects - **small amount** of iron **enters** and **leaves** the body on a daily basis.
- Iron balance is achieved primarily by mechanisms affecting **intestinal absorption** and **transport**.
- In infants and children, **30%** of daily iron needs must come from **diet**.

- Intestinal iron absorption is a function of three principal factors:
  - body iron stores (transferrin and ferritin)
  - erythropoietic rate
  - bioavailability of dietary iron.
- Iron absorption also is increased when there is increased **erythropoiesis** and **reticulocytosis** or **ineffective erythropoiesis**, as in beta thalassemia.
- **Heme** dietary sources have a higher bioavailability of iron than do **non-heme** sources (30 versus 10 percent)
- **Ascorbic acid** enhances the absorption of non-animal sources of iron.
- **Tannates** (teas), bran foods rich in **phosphates**, and **phytates** (plant fiber, especially in seeds and grains) inhibit iron absorption.



### Sources of heme Iron



### Sources of non-heme Iron



# **REQUIREMENTS**

- **Breast milk contains only 0.3 to 1.0 mg/L iron, but has a high bioavailability (50 percent)**
- **Iron-containing formulas with 12 mg/L iron have only 4 to 6 percent bioavailability.**
- **Full-term: 1 mg/kg (maximum 15 mg)**
- **Children 1 to 3 years old: 7 mg/day**
- **Children 4 to 8 years old: 10 mg/day**
- **Children 9 to 13 years old: 8 mg/day**

# Causes





# Gastrointestinal disease

- Gastrointestinal **malabsorption** of iron:
  - Active celiac disease
  - Crohn's disease
  - Giardiasis
  - Resection of the proximal small intestine.
- Conditions that cause gastrointestinal **blood loss**:
  - Cow's milk protein-induced colitis
  - Inflammatory bowel disease
  - chronic use of aspirin or nonsteroidal antiinflammatory drugs, are also associated with iron deficiency.



# CLINICAL MANIFESTATIONS

- Iron deficiency anemia (IDA) is a microcytic, hypochromic, and hypoproliferative state.
- The **most common presentation** of IDA is an otherwise **asymptomatic**, well nourished infant or child who has a **mild to moderate** microcytic, hypochromic anemia
- **Much less frequent** are infants with **severe anemia**, who present with:
  - Lethargy
  - Pallor
  - Irritability
  - Cardiomegaly
  - Poor feeding
  - Tachypnea.



- A number of abnormalities of **epithelial tissues** are described in association with iron deficiency anemia. These include:

- Esophageal webbing
- Koilonychias
- Glossitis
- Angular stomatitis
- Gastric atroph





Angular Stomatitis









Dermatology OnCall



Koilonychia



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Esophageal webs

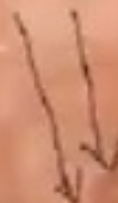


IMAGE MANAGER



- **Neurodevelopmental**
  - Impaired psychomotor and/or mental development.
  - cognitive impairment can occur in adolescents.
  - negatively impact infant social-emotional behavior
  - may contribute to the development of attention deficit hyperactivity disorder.
- **Exercise capacity**
- **Pica and pagophagia**
- **Thrombosis — cerebral vein thrombosis**

# Diagnosis



- Birth -Mean Hb = elevated, but highly variable
- 2 mos –“physiologic” anemia
  - -2 SD Hb = 9.4 g/dL
- 6 mos to 24 mos
  - -2.5 SD Hb 11.0g/dL
- American Academy of Pediatrics
  - Hb <11.0, Hct < 33% defines anemia





- For infants up to 24 months
- **The most cost effective** strategy is a therapeutic trial of iron .
- **Ferrous sulfate** this is given at **3 mg/kg** of elemental iron, given once or twice daily between meals (ie, 3 to 6 mg/kg/day total).
- If **four weeks** of this treatment produces a **hemoglobin rise** of greater than **1 gm/dL**, this confirms the diagnosis of iron deficiency.

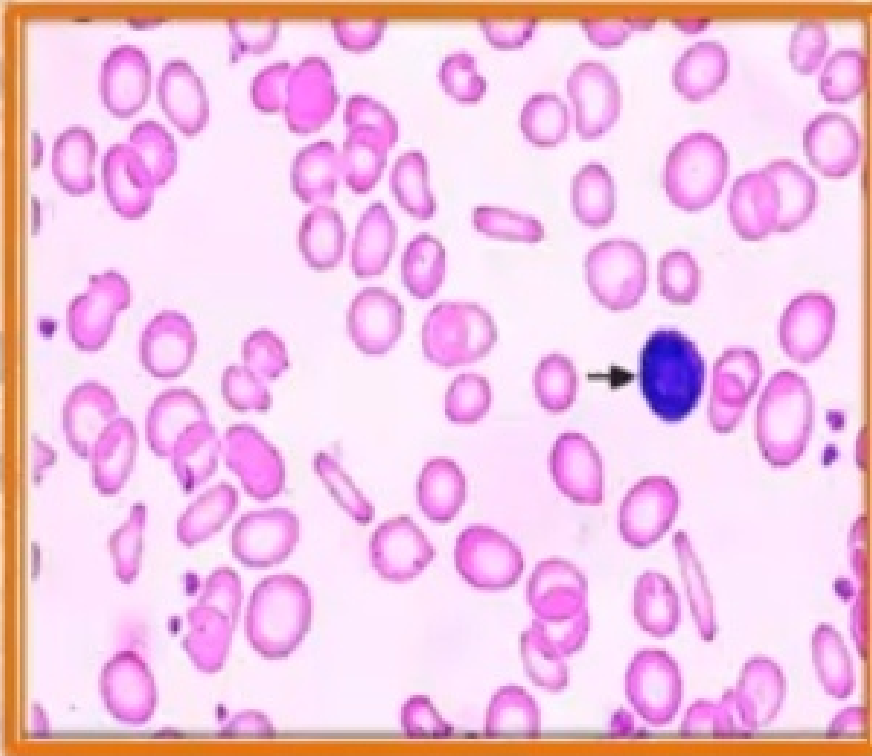
- **2 years and adolescence**, we suggest slightly more evaluation.
- This is because IDA is somewhat **less common** in otherwise-healthy children than in infants.
- Therefore, in addition to evaluating CBC (with indices for MCV and RDW), we suggest performing **a reticulocyte count** and reviewing a blood smear, and screening several stools for occult blood.

	Normal	Fe deficiency without anemia	Fe deficiency with mild anemia	Severe Fe deficiency with severe anemia
Marrow reticulo-endothelial iron	2+ to 3+	None	None	None
Serum iron (SI), $\mu\text{g/dL}$	60 to 150	60 to 150	<60	<40
Total iron binding capacity (transferrin, TIBC), $\mu\text{g/dL}$	300 to 360	300 to 390	350 to 400	>410
Transferrin saturation (SI/TIBC), percent	20 to 50	30	<15	<10
Hemoglobin, g/dL	Normal	Normal	9 to 12	6 to 7
Red cell morphology	Normal	Normal	Normal or slight hypochromia	Hypochromia and microcytosis
Plasma or serum ferritin, ng/mL	40 to 200	<40	<20	<10
Erythrocyte protoporphyrin, ng/mL RBC	30 to 70	30 to 70	>100	100 to 200
Other tissue changes	None	None	None	Nail and epithelial changes

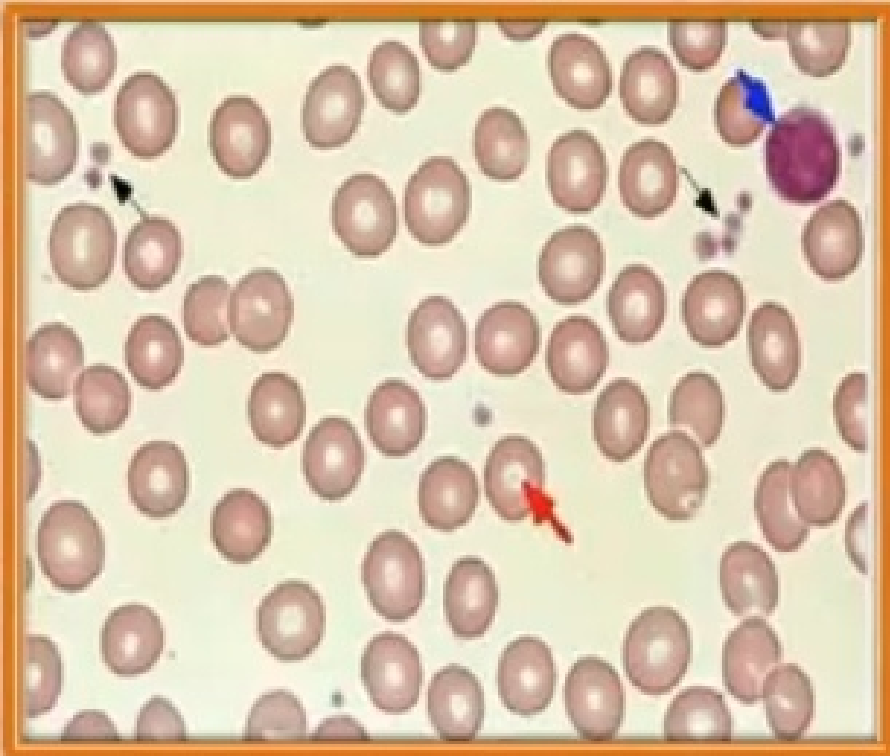


Test	Expected value in patients with iron deficiency anemia	Confounding factors
Hemoglobin	<11 g/dL	Viral infections may cause a transient decrease in hemoglobin
Mean corpuscular volume MCV	<70	Thalassemia trait
Red cell distribution width RDW	>15	Infection or inflammation, hemolysis
Erythrocyte protoporphyrin	>70-80 µg/dL	Lead poisoning
Total iron-binding capacity	>450 µg/dL	Liver disease, inflammation, or hemolysis may lower TIBC; pregnancy or hormonal contraceptives may increase TIBC
Transferrin saturation	<12-15 percent	Infection or inflammation
Serum ferritin	<12 ng/mL	Infection or inflammation; liver disease
Transferrin receptor	Increased	Increased in high turnover states
Serum iron	<30 µg/dL	Diurnal variation; iron intake; infection or inflammation

Test	Iron deficiency anemia	Alpha/beta thalassemia	Anemia of chronic disease
Hemoglobin	↓	↓	↓
MCV	↓	↓	↓ ↔
RDW	↑	↔	↑ ↔
Erythrocyte protoporphyrin	↑	↔	↑
Total iron-binding capacity	↑	↔	↓
Transferrin saturation	↓	↔	↓
Serum ferritin	↓	↔	↑
Transferrin receptor	↑	↔	↑



**Microcytic hypochromic red cells**



**Normal peripheral blood smear**



The image features a warm, orange-toned background. On the left side, a hand is shown firmly grasping a forearm, suggesting support or medical examination. The word "Treatment" is written in a large, bold, red font with a slight 3D effect, positioned in the upper right quadrant of the image.

# Treatment

# Treatment

- Oral iron therapy is started at a dose of **3 mg/kg** of elemental iron, given **once or twice daily**. It should be given **30 to 45 minutes before meals** or two hours after meals, and only with juice or water, rather than with food or milk.
- **<12 months:**
  - iron-fortified formula
  - A cow's milk-based formula
  - Unmodified cow's milk (non-formula cow's milk) should not be given to infants.
- **>12 months** of age, intake of cow's milk should be limited to less than 20 oz per day and bottle feeding should be discontinued.

- CBC is reevaluated in **4 weeks** when the child is healthy. If the hemoglobin (Hgb) has increased by **1 g/dL**, therapy is continued and a CBC is retested every 2 to 3 months until the Hgb reaches the age-adjusted normal range.
- Oral iron is continued for an additional **two months** after the **Hgb** reaches the normal range for age.





# Prevention of iron deficiency



- Encourage **breastfeeding exclusively** for 4-6 MO.
- **> 4MO** an additional source of iron should be added, first as an **iron supplement**, then **transitioning to iron-fortified infant cereals**.
- **<12 MO** who are not breastfed or are partially breastfed, use only iron-fortified formulas (12 mg of iron per liter).
- **6 MO** encourage one feeding per day of foods rich in **vitamin C**.
- **> 6 MO** pureed meats.
- Avoid feeding unmodified (nonformula) cow's milk until **age 12 months**.
- **1-5 y** should also consume an adequate amount of iron-containing foods to meet daily requirements.