Objectives:
To define anemia
To know the practical approach to the evaluation of the anemic child
Clinical presentation and management of iron deficiency anemia in children

Definition of anemia
Anemia can be defined as a reduction in the hemoglobin concentration, hematocrit, or number of red blood cells (RBC) per cubic millimeter.
Lower limit of “normal”: 2 standard deviations below the mean for the normal population. Thus, 2.5% of the normal population will be mistakenly classified as anemic.
WHO diagnosis Hemoglobin below 11g/dl in preschool children

Normal Hematopoiesis:
In general, the hemoglobin is high at birth and falls during the initial 6 to 8 weeks of life to a physiologic nadir before it gradually increases to childhood levels.

Scenario of presentation
Common clinical presentations include:

- The child who is feeling well but is found to have a low hemoglobin concentration on a routine screening test,
- The child who is “tired” and does not eat well,
- The infant or child who is being evaluated for other chronic problems and is found to have a low hemoglobin concentration, and last,
- The child who is obviously pale, lethargic, and requires immediate assessment and evaluation.

General causes of anemia:

1. Poor production of red blood cells;
   - Nutritional deficiencies—iron, vitamin B12, folic acid.
   - Reduction in erythroid precursors— aplasia, bone marrow infiltration, leukemia.
   - Ineffective erythropoiesis: failure of apparently active erythropoiesis to produce adequate number of circulating red cells—Thalassaemias

2. Destruction of red blood cells i.e. hemolysis

3. Loss of red blood cells, i.e. bleeding
A practical approach to the evaluation of the anemic child

- Step 1: confirm anemia by using age and sex specific tables
- Step 2: evaluate the red cell indices, of these; the mean corpuscular volume (MCV) is the most useful. It enables the classification of anemia by red blood cell size as microcytic, normocytic, or macrocytic.
- Step 3: assess the white blood cell (WBC) and platelet counts. Is the anemia isolated or are other cell lines affected?
- Step 4: Microscopic examination of the peripheral blood smear can aid in further focusing the differential; assess the size, color, and shape of the red cells.

<table>
<thead>
<tr>
<th>Microcytic, Hypochromic</th>
<th>Normocytic, Normochromic</th>
<th>Macrocytic</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCV &lt; 80 fl</td>
<td>MCV 80-95 fl</td>
<td>MCV &gt; 95 fl</td>
</tr>
<tr>
<td>MCH &lt; 27 pg</td>
<td>MCH &gt; 26 pg</td>
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<tr>
<td>Iron deficiency</td>
<td>Many hemolytic anemias</td>
<td>Megaloblastic: B12, folate deficiency</td>
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<tr>
<td>Thalassemia</td>
<td>Anemia of chronic disorders (some cases)</td>
<td>Non-megaloblastic: liver diseases, Aplastic anemia</td>
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<td>Anemia of chronic diseases (some cases)</td>
<td>After acute blood loss</td>
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<tr>
<td>Lead poisoning</td>
<td>Renal diseases</td>
<td></td>
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<tr>
<td>Sideroblastic anemia (some cases)</td>
<td>BM failure e.g. post chemotherapy or infiltration</td>
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- Leucocytes & Platelets counts help to distinguish ‘pure’ anemia from ‘pancytopenia’ which suggests a more general marrow defect e.g. hypoplasia, infiltration or destruction of cells (hypersplenism).
- Reticulocytes (0.5-2.5%) count should rise & be higher the more severe the anemia.
- Impaired marrow function or lack of erythropoietin stimulus is suspected when reticulocytes count is not raised.
- Blood film is essential in all cases of anemia for morphology, number and presence of abnormal cells.
- BM examination for morphological information of different cells lines & presence of foreign cells.
Childhood Anemias/Iron Deficiency Anemia
Dr. Salma Al-Hadad

**Symptoms:**
- Due to reduced supply of oxygen—Fatigue, dyspnea on exertion, faintness, palpitations, dizziness, headache.
- In older subjects symptoms of cardiac failure, angina pectoris, or confusion.

**Signs:**
- Pallor of mucous membranes and skin creases, tachycardia, bounding pulse, cardiomegaly & systolic murmurs especially at the apex.
- In profound chronic anemia: retinal hemorrhages and papilloedema
- Other clinical observations may be suggestive of underlying etiology

**History:**
- Patient History; jaundice, Prematurity, Diet history (type/quantity of milk, Ingestion of non-food items), medications, Activity level, Acute or recent infection, Evidence of chronic infection/ disease, Evidence of endocrinopathy, Evidence of liver disease, Easy bruising/blood loss
- Maternal History (especially if anemic infant below age of 6 months); Pregnancy/delivery complications, Drug ingestion, Pica (nonfood product ingestion, e.g. clay, ice, soil), anemic during pregnancy
- Family History; Ethnicity, Anemia, Jaundice, Splenomegaly, Gallstones, Bleeding disorders, Cancer, transfusions

**Physical examination:**
While relying on physical examination alone to diagnosis anemia has often been unreliable, the physical examination can provide several clues to the etiology of anemia.
- Tachycardia suggests an acute process with poor compensation necessitating prompt intervention. A normal heart rate suggests a more chronic process.
- Jaundice points to a hemolytic process.
- Splenomegaly may be seen in inherited hemolytic anemia, malignancy, acute infection, or hypersplenism secondary to portal hypertension.
- Petechiae indicate multiple cell lineages are involved.

**Severity of clinical symptoms depends on:**
1. Severity of anemia
2. Speed of onset; gradual onset is better tolerated
3. Age and cardiovascular status of patient; young tolerates anemia better than elderly.
4. Degree of reduction in O2 carrying capacity e.g. Hb-S gives better tissue oxygenation than Hb-A and the low Hb in sickle cell anemia therefore is better tolerated.
Microcytic anemia

Microcytic anemias reflect a **quantitative defect** in the production of hemoglobin during erythrocyte maturation. This may be due to a defect in heme synthesis (due to inadequate quantity of substrate or an inability to use substrate) or to a defect in globin synthesis (due to an inherited hemoglobinopathy).

In pediatrics, the differential diagnosis is generally limited to one of four diagnoses:

1. Iron deficiency,
2. Lead poisoning,
3. Anemia of inflammation, or
4. Thalassemia (or other more rare hemoglobinopathies).

*Sideroblastic anemias also cause microcytosis but are rare in children.*

Iron deficiency anemia (IDA):

**Causes of IDA:**

1. Poor intake:
   - Inadequate dietary iron (unusual before 6 months but becomes common at 9-24 month of age) by consumption of large amounts of cow’s milk and of foods not supplemented with iron. A **milk intake greater than 16 oz/24 h**; The high satiation value of milk and the milk-induced delay in gastric emptying time interferes with the ingestion of adequate amounts of iron-containing foods.
   - Malnutrition

2. Increased demands: low birth weight (low body iron stores then rapid growth)

3. Blood loss: by
   - A lesion of the GIT, such as a peptic ulcer, Meckel’s diverticulum, a polyp, or by inflammatory bowel disease.
   - Hookworm infestation is an important cause of iron deficiency, e.g. *Ancylosotma duodenale*
   - Any site outside GIT, *e.g.* nose, trauma, lung, kidney

4. Malabsorption: e.g. celiac disease, partial gastrectomy
Clinical features of IDA

1. General symptoms and signs of anemia
2. Symptoms and signs specific to iron deficiency: Patients with long-standing deficiency may develop changes due to a reduction in the iron-containing enzymes in the epithelium and gastrointestinal tract:
   - Nail flattening and koilonychia (concave nail),
   - Sore tongues and papillary atrophy,
   - Angular stomatitis (painful cracks appear at the angle of the mouth).
   - Iron deficiency in young children can contribute to psychomotor delay and behavioral problems.
3. Symptoms and signs due to the underlying cause of iron deficiency

Diagnosis of IDA:
The diagnosis may be suspected on the basis of the history and examination but laboratory investigations are required for confirmation.

The blood counts:
- Low Hb
- Low MCV, MCH, and MCHC
- Blood film: microcytic hypochromic red cells

Confirmatory tests:
- Low serum iron
- Increased total iron binding capacity
- Serum ferritin is probably the most useful of these tests.
- In occasional difficult cases (e.g. where the patient has recently been transfused) a bone marrow aspirate is helpful in showing absence of iron stores.

Treatment of IDA; Principles
- Use oral iron
- Replace iron deficit in total (Iron medication should be continued for 8 wk after blood values are normal)
- Establish and treat the cause (e.g. GI blood loss).
- The therapeutic dose should be calculated in terms of elemental iron
- A daily total of 6 mg/kg of elemental iron in three divided doses provides an optimal amount of iron for the stimulated bone marrow to use
✓ The regular response of iron-deficiency anemia to adequate amounts of iron is an important diagnostic and therapeutic feature.

**Response:**
The reticulocyte count should rise in five to ten days and the serum hemoglobin should increase by 1 gm/dl/week thereafter. Poor compliance, poor absorption, an incorrect diagnosis, or ongoing blood loss can account for an inadequate response.

**Failure to respond to oral iron therapy due to:**
1. Wrong diagnosis (i.e. other cause of anemia)
2. Inadequate dose
3. Non-compliance (The child does not receive the prescribed medication)
4. Malabsorption
5. Continued bleeding (When there is continuing unrecognized blood loss, such as intestinal or pulmonary loss, or with menstrual periods).
6. When iron is given in a form that is poorly absorbed
7. Severe infection

**Parenteral therapy; iron dextran**
A parenteral iron preparation (iron dextran) is an effective form of iron

**Indications**
✓ Poor compliance
✓ Intolerance of oral iron
✓ Severe bowel disease
✓ Chronic hemorrhage
✓ Acute diarrhea disorder

The rise in haemoglobin concentration is not faster than with oral iron therapy.

**Prevention**
– Breast feeding until 5-6 mo, beyond 6 mo add Fe supplementation
– Fe-fortified formula for first 12 mo
– Fe-fortified cereal early with solid foods
– Avoid cow’s milk until 9-12 mo

**HOME MESSAGE**
• Not a diagnosis, but an expression of an underlying disorder
• Anemia is a sign, not a disease.
• Anemias are a dynamic process.
• It’s never normal to be anemic.
• The diagnosis of iron deficiency anemia mandates further work-up