Approach to pediatric anemia

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Approach to anemia

- If the well is low, either it isn’t raining enough or someone is using a lot of water
  - By analogy to pediatric anemia, either there is hypoproduction or increased destruction
  - Increased reticulocytes, immature red blood cells, are a sign of increased destruction as the body is trying to replace the destroyed cells.
    - It takes several days after a hemolytic or bleeding episode to respond
But first, is there really anemia?

- In pregnancy, the hematocrit may be decreased despite an increased red cell mass because the maternal blood volume is increased even more!
- Use normal curves to assess whether level of anemia is significant
- All infants have a normal post delivery drop in hemoglobin that starts to increase after 1-2 months
## Normal hematocrit levels by age

<table>
<thead>
<tr>
<th>Age</th>
<th>Hemoglobin (g/dl)</th>
<th>Hematocrit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-23 months</td>
<td>&lt;10</td>
<td>&lt;31</td>
</tr>
<tr>
<td>2-5 years</td>
<td>&lt;11</td>
<td>&lt;34</td>
</tr>
<tr>
<td>6-12 years</td>
<td>&lt;12</td>
<td>&lt;37</td>
</tr>
</tbody>
</table>

Table 4-1 Blood diseases of infancy and childhood Miller and Baehner 6th ed
Other questions to guide you

- Is this acute or chronic?
- Is there a family history?
- Does the child appear ill, or have signs of systemic disease?
- Are the liver and spleen large? (extramedullary sites of hematopoiesis)
- Exposure to infectious disease: HIV, malaria, dengue
Simple laboratory studies

- **Smear** (including thick smear for malaria)
  - Are the cells larger or smaller than normal?
  - Are they biconcave, target or spherocytes?
  - Are there fragments or other damage?

- **CBC including MCV (automated) & RBC #**
  - Allows calculation of Mentzer index = MCV/total RBC count x 10^6 (low = Fe def, high thalassemia)

- **Reticulocyte count**

- **Heinz body prep**
Approach to morphology

Liver disease

Large MCV

Thalassemia, Sickle cell

Small MCV

Immune hemolysis

Hereditary spherocytosis

Targets

Spherocytes
Approach by statistical frequency

- Common approach to a 1-2 year old in US with anemia was to start on iron (oral) and recheck 4-6 weeks later.
- Checking for lead exposure also routinely performed as part of regular pediatric visits, so additional lead testing not usually needed.
- In Subsaharan Africa malaria and nutritional deficiency are both common and HIV not rare, depending upon location.
Physiologic Classification

- Blood loss: Acute and chronic hemorrhage
- Blood destruction (Nathan’s rule)
  - Hemoglobinopathies
    - Structural: sickle, unstable
    - Synthetic: thalassemia
  - RBC enzyme defects: 2,3 DPG, PKU
  - Membrane defects: HS, HE, etc.
  - Immune mechanisms: auto and allo
Physiological Classification: II

- Blood destruction continued
  - Infectious agents
  - Chemical: heavy metal, oxidant
  - Physical trauma
    - Microangiopathy, thermal injury, heart valve

- Impaired production
  - Nutritional: Fe, B₁₂, folic & ascorbic acid
  - Mechanical: Osteopetrosis, Malignancy
  - Dyserythropoiesis
Morphologic classification

- **Normocytic, normochromic**
  - Acute blood loss
  - Hemolytic anemias

- **Microcytic, hypochromic**
  - Fe deficiency, thalassemia syndromes
  - Lead poisoning

- **Macrocytic, nomochromic**
  - Pernicious anemia, other B12 deficiency
  - Bone marrow failure syndromes
# Inclusions

<table>
<thead>
<tr>
<th>Inclusions</th>
<th>Appearance</th>
<th>Contains</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reticulum</td>
<td>Fine filaments</td>
<td>Ribosomes</td>
<td>Normal</td>
</tr>
<tr>
<td>Howell-Jolly bodies</td>
<td>Purple spherical</td>
<td>Nuclear fragments</td>
<td>Anemias</td>
</tr>
<tr>
<td>Basophilic stippling</td>
<td>Blue granules</td>
<td>Ribosomal aggregates</td>
<td>Anemias, Pb 5′nucleotidase def.</td>
</tr>
<tr>
<td>Heinz bodies</td>
<td>Blue granules</td>
<td>Denatured hemoglobin</td>
<td>Enzymopathies</td>
</tr>
<tr>
<td></td>
<td>Supravital stain</td>
<td></td>
<td>Unstable Hgb</td>
</tr>
<tr>
<td>Pappenheimer bodies</td>
<td>Blue (Peri’s stain)</td>
<td>Mitochondria</td>
<td>Sideroblastic anemia, thal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fe micelles</td>
<td></td>
</tr>
</tbody>
</table>
Fe deficiency anemia

Iron absorption:
- We take in 10-30mg Fe/day
- We absorb 0.5-1.0mg/day (5-10%)
- Absorption may increase to ~20% in deficiency states
- Meat iron (heme) much better absorbed than vegetable iron
- Poorest Fe absorption with grains
- Vitamin C simultaneous intake increases Fe uptake
Appearance of Iron deficiency
## Stage of Iron (Fe) deficiency

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Storage Deficiency</th>
<th>Fe limited erythropoiesis</th>
<th>Fe deficiency anemia,</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hgb (gm/dl)</strong></td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>&lt;11</td>
</tr>
<tr>
<td><strong>Transf. sat (%)</strong></td>
<td>22</td>
<td>22</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td><strong>FEP (ug/dl RBC)</strong></td>
<td>30</td>
<td>30</td>
<td>&gt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td><strong>Serum Ferritin ug/dl</strong></td>
<td>30</td>
<td>&lt;12</td>
<td>&lt;12</td>
<td>&lt;12</td>
</tr>
</tbody>
</table>
Role of bone marrow examination

- Most useful in hypoproducive anemias
- May be important to rule out malignant infiltration or identifying dyserythropoietic anemia
Research opportunity

- Point of care devices to measure hemoglobin/hematocrit
  - Many pediatric transfusions are to children with malaria. Many transfusions are ordered because the child is obviously anemic and an accurate Hemoglobin-hematocrit may take long time to obtain.
  - Might they reduce transfusion if clinicians had accurate bedside hematocrit/hemoglobin level?
  - There are at least two convenient hand held, battery run bedside devices that require no reagents
  - While the devices are not cheap, they may be grant fundable, and the disposables could potentially be reused