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# Iron deficiency anemia

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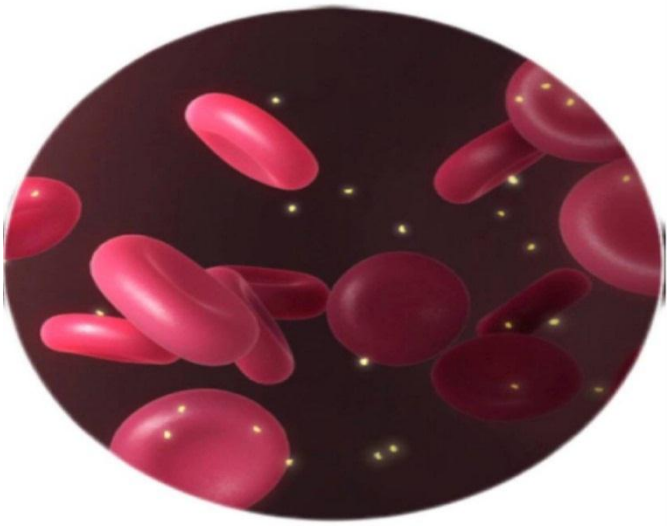

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# Content

## Abstract

Iron deficiency anemia is global health concern affecting on children, women and elderly, whilst also being a common comorbidity in multiple medical conditions. The etiology is a variable and attributed to several risk factors decreasing iron intake and absorption or increasing demand and loss, with multiple etiologies often coexisting in an individual patient. Although presenting symptoms may be nonspecific, there is emerging evidence on the detrimental effects of iron deficiency anemia on clinical outcomes across several medical conditions. Increased awareness about the consequences and the prevalence of iron deficiency anemia can aid early detection and management. Diagnosis can be easily made by measurement of the haemoglobin and serum ferritin levels, whilst in chronic inflammatory conditions, diagnosis may be more challenging and necessitates consideration of higher serum ferritin thresholds and evaluation of transferrin saturation. Oral and intravenous formulations of iron supplementation are available, several patient and disease related factors need to be considered before management decisions are made and this review provides recent updates and guidance on the diagnosis and management of iron deficiency anemia in multiple clinical settings.

## Introduction

The prevalence of iron deficiency anemia (IDA), the most common cause of anemia in the world, it is estimated that 30% of the global population suffers from IDA, & most of them live in developing countries ,approximately 9% in toddlers, 9-11% in adolescent females, and less than 1% in adolescent males **[1]**. Iron deficiency anemia occurs in approximately one third of children who are iron deficient . Children

from low socioeconomic status in the United States may be at increased risk for iron deficiency because of poor dietary intake .

The body content of iron is about 0.5 g in newborn & about 5 g in adult.About 1 mg of iron must be absorbed by GIT each day ,because of the absorption of the dietary iron in the proximal small intestine is about 10% of the eaten amount → a diet containing 8-10 mg of iron is required daily **[2],[3].**Breast-fed infants are less likely to have iron deficiency than bottle-fed infants because, although there is less iron in breast milk, this iron is more efficiently absorbed. However, infants who continue to be exclusively breast fed in the second half of the first year of life are at risk for iron deficiency.

## Definition

Iron deficiency anemia (IDA) is a condition when the body lacks sufficient iron to maintain the normal physiological functions and defined as decreased the total body iron or in some cases, serum ferritin level less than 12 mg/l in children up to 5 years and <15 mg/l in children 5 years and older. Although the serum ferritin level is useful in defining irondeficiency and this definition can be considered only if the other conditions that can affect ferritin levels (e.g inflammation or liver diseases) are absent. For the childrens less than 5 years of age with concurrent infection, serum ferritin concentrations <30 mg/l are reflective of depleted iron stores**[4]** .

Anemia is defined as a hemoglobin concentration more than 2 standard deviations below the mean reference value for age and sex matched healthy population. WHO hemoglobin thresholds used to define anemia in different age groups are **[5]** :

- children 6 months to 5 years: 11 g/dl.
- children 5–12 years: 11.5 g/d .
- children 12–15 years: 12 g/d .
- nonpregnant women: 12 g/dl.
- pregnant women: 11 g/dl and.
- men ≥15 years: 13 g/dl.

*IDA develops when body iron is too low to maintain normal red blood cell (RBC) production. IDA in young children (up to 5 years) is defined as the presence of ferritin level <12 mg/l and hemoglobin level <11 g/dl, in the absence of other conditions that can affect these findings **[6]**.

***The terms "iron deficiency" and "IDA" are often used in the same context. However, iron deficiency without anemia is three times as common as IDA. If iron requirements are below iron intake, total body iron reduces gradually. Hemoglobin levels are initially normal, reflecting the stage when iron deficiency exists in the absence of anemia. At that point, ferritin level and transferrin saturation are reduced. As total body iron decreases and iron stores are exhausted, hemoglobin levels drop below normal values. Thus, iron deficiency is defined as reduced body iron but hemoglobin levels are still above the cut-off value for anemia. Worsening of that condition leads to iron-deficient erythropoiesis and finally to development of IDA.

## Epidemiology

Approximately about 8% of toddlers in United States have an iron deficiency, and 2–3% have iron deficiency anemia **[7]**. As age increases, prevalence decreases until adolescence. 16% of adolescent girls have iron deficiency, and 3% have iron deficiency anemia **[8]**. Among American females aged (12–15 )years, the incidence of iron deficiency was 9% and

the incidence of iron deficiency anemia was 2% in the age group (16–19) years, the incidence was 11 and 3%, respectively **[9]**. Less than 1% of adolescent males had iron deficiency. Higher incidence of iron deficiency (IDA) was found in both male and female adolescents in some other countries **[10, 11].** The rate of iron deficiency did not decline much during the last 40 years, but there were a significant improvements in some subgroups of young children. Like in children aged (12–24) months iron deficiency rates declined from 23 to 11% between two study periods**[7].**

The prevalence of iron deficiency in the United States is higher in children who live in poorness, in low-income families, and in immigrant groups. The highest prevalence was shown in children with African-American and Hispanic origin **[7, 12]**. Other risk factors associated with higher prevalence of iron defiency anemia are low birth weight, prematurity, and childhood obesity **[7, 12, 13].** These high-risk pediatric subgroups should undergo screening.

Pinhas-Hamiel and co-workers showed that the prevalence of iron deficiency was significantly associated with increased body mass index **[14]**. Obesity was a risk factor in both males and females, but it was about three times higher in girls **[14, 15]**. It is unclear why obesity is linked to iron deficiency and IDA, but low-quality foods and increased needs comparing to body weight may be connected.

Adolescent athletes, vegetarians, adolescents with chronic illnesses, heavy menstrual blood loss (>80 ml/month), or children who are underweighted or malnourished are at higher risk for iron deficiency and IDA, and they should also have laboratory screening for anemia **[16, 17]**.

In developing countries, where diets do not contain sufficient red meat, IDA is approximately seven times more frequent than in Europe or North America. Despite the fact that there is enough dietary iron in some cases, this is the case because heme iron is absorbed better than nonheme iron. IDA was found in 2/3 of children and adolescents in Nepal and in Sudan **[18]**, and in 48.5% of Egyptian children in 2005 **[19]**. Parasites like hookworm can worsen iron deficiency due to profound gastrointestinal blood loss.

Neonates have total body iron of 250 mg (80 mg/kg), obtained from maternal sources. In the first sixth months of life, during the period when the infant gets iron-deficient milk diet, this amount decreases to 60 mg/kg. Infants fed with cow's milk are at greater risk to develop serious iron deficiency anemia because calcium from cow's milk is competing with iron for absorption. Children should get 0.5 mg more iron than is lost daily in order to maintain a normal body iron of 60 mg/kg.

The prevalence of iron deficiency exceeds 50% in countries with limited food and nutrient sources, such as most countries in Africa, Southeast Asia, and Latin America **[20]**. The prevalence of anemia ranges from 45 to 65% in children, (20)% to (60)% in female, and (10%) to (35%) in male **[21]**. Half of these cases are presumed to be caused by iron deficiency.

The prevalence of iron deficiency anemia is still high in infancy and preschool children, despite improvements in public health awareness, increased breastfeeding rate, and the presence of iron-fortified foods in diet **[22,23].** All these facts emphasize the importance of constant surveillance and early detection, prevention, and intervention toward iron deficiency in childhood, particularly in high-risk groups. Special attention

should be paid to discover and treat iron deficiency during pregnancy and the earliest periods of life, because severe iron deficiency can have a great impact on child's growth, development, and learning skills.

## Etiology

1. Low birth weights & unusual perinatal hemorrhage.

2. Dietary deficiency : failure of breastfeeding, delayed or improper weaning, ingestion of large amounts of cow's milk, ingestion of little amounts of iron-rich diet as iron-fortified milk, meat, green vegetables e.t.c**..[1]**

• In term, IDA due to dietary loss is unusual < 6 months of age & usually occurs at 9-24 months of age (the incidence ↓ after that).

• The usual dietary pattern in infants with IDA is the consumption of a large amount of cow's milk (low iron content & blood loss from milk protein colitis) & of food not supplemented with iron**.[1]**

3. Blood loss → particularly in older children as peptic ulcer, meckel's diverticulum, intestinal polyps or hemangiomas, inflammatory bowel diseases(IBD), hookworm infestation, Trichuris trichiura, plasmodium, Helicobacter pylori , pulmonary hemosiderosis, menstruation (adolescents) about 2% of adolescent girls have IDA, chronic diarrhea, & cow's milk allergy**.[1]**

4. Intense exercise conditioning, as occurs in competitive athletics in high school, may result in iron depletion in girls; this occurs less commonly in boys**[1].**

5. Solid foods given after the 6th month should be rich especially in iron, zinc, phosphorus, magnesium, calcium and vitamin B6. According to the

world Health organization data, 98% of the iron requirement in infants aged 6–23 months should be met by solid foods**[2],[3]** . Solid foods should include products rich in meat, fish, egg and vitamin C to meet this iron need.

6. Malaria

The iron deficiency anemia and malaria coexist in most tropical regions of the world. Malaria contributes to iron deficiency anemia by causing intravascular hemolysis with subsequent loss of hemoglobin iron in the urine. This clinical feature was described in 1898 as blackwater fever**[24]**. Malaria also causes an immune response that suppresses erythropoietin **[25]** as well as direct effects on erythropoiesis **[26].** And the host may also increase hepcidin expression for protection from liver stage malaria **[27]**. Of course increased hepcidin restricts iron and might delay erythroid recovery.

7. Hookworm

Like iron deficiency anemia, hookworm infection affects several hundred million humans worldwide**[28]** . Amazingly, a recent study reported that there is a considerable overlap between malaria and hookworm in sub-Saharan Africa **[29]** . Worldwide there are two hookworm species that infect humans. Both of them are found in tropical regions based on the requirement of moist soil for survival.

8. Drugs: Glucocorticoids, salicylates, NSAIDs, proton-pump inhibitors.

## Classification of Iron Deficiency Anemia

Stage 1: Pre latent stage (depletion of iron stores)

This stage is marked by depletion or absence of iron stores alongside normal serum iron concentration, hemoglobin and hematocrit and there are reduced or absent bone marrow iron stores and reduced the serum ferritin level.

Stage 2: Latent stage (depletion of transport iron)

This stage characterized by reduced serum iron and transferrin saturation. In addition there are reduced iron stores but the hemoglobin and hematocrit values are normal.

Stage 3: Marked IDA

This stage is characterized by frank features of IDA in which there are depleted iron stores, depleted serum iron and transferrin saturation, as well as reduced the levels of hemoglobin and hematocrit associated symptoms.

- All these stages are overlapping and there are no clear cut boundaries between them and laboratory values change over time with the iron deficiency therefore, they should be evaluated meticulously.

## Pathophysiology

- Iron is an essential micronutrient in human body, it plays an important role in many metabolic processes such as oxygen transport, electron transport and DNA synthesis and iron is a component of many cellular proteins and enzymes. Heme proteins, hemoglobin and myoglobin contain about 3/4 of total body iron and the rest of body iron is stored

in ferritin and hemosiderin, and about 3% is part of enzyme systems such as catalase and cytochromes **[30]**. Iron is mostly recycled from senescent RBCs by macrophages. Only small proportion of total body iron enters and leaves the body on a daily basis. Consequently, mechanisms that affect on intestinal absorption and intracellular iron transport have a great impact on iron balance. The serum iron concentration is regulated by absorptive cells in the proximal small intestine which can regulate iron absorption to compensate for iron body loss. There are three different pathways of iron uptake in small intestine, the heme pathway and two specific pathways for ferric and ferrous iron respectively.

- Enterocytes absorb heme iron and nonheme iron noncompetitively. Dietary iron contains both chemical forms of iron and heme iron is mainly found as ferrous iron (Fe2+), while most part of nonheme dietary iron is ferric iron (Fe3+). When heme enters the enterocyte, it is degraded by heme oxygenase with release of iron and it passes the basolateral membrane of the enterocyte and competes with nonheme iron to bind transferrin in plasma. The way of nonheme iron transport in the body is still not known and the concentration of iron in enterocytes depends on the body needs for iron. Individuals who are iron deficient have small amount of iron in enterocytes, while those who have sufficient body iron have higher amounts of iron in the absorptive intestinal cells. Iron in the enterocyte regulates absorption by either up regulation of receptors or saturation of an iron binding protein or both. Iron that is delivered to other non intestinal cells in the body is bound to transferrin. There are two pathways through which transferrin iron can be delivered into non intestinal cells: classical transferrin receptor pathway and pathway independent of the transferrin receptor.

- In adults only 5% of the total body iron requirements are from different food sources. This amount is the same as iron loss which is mainly from the gastrointestinal tract and the majority (95%) of iron comes from breakdown of old RBCs. In children approximately 30% of iron comes from diet probably due to fast growth in the pediatric age **[30][31]**.
- There are three major factors that can influence intestinal iron absorption: iron stores in ferritin and transferrin, erythropoietic rate and bioavailability of iron in foods. When the iron stores decrease, receptors in the intestinal mucosa increase in order to raise the iron uptake and iron absorption also increases when there is increased or ineffective erythropoiesis.

## Risk factor

1) Prematurity.
2) Low birth weight.
3) Breast fed > 4 months without supplemental iron.
4) Lower socioeconomic status.
5) Excessive cow's milk consumption.
6) Menorrhagia.
7) Adolescent athletes.
8) Obesity.
9) Acid blockers.

## Clinical manifestations

### Symptoms

1) Most children with iron deficiency are asymptomatic & are identified by investigations.

2) Pallor is the most important sign of IDA but is not usually visible until the Hb falls to 7-8 g/dL (pallor of the palms, palmar creases, nail beds, or conjunctivae).
3) In mild to moderate IDA (Hb: 6-10 g/dL), compensatory mechanisms, including increased levels of 2,3-DPG & a shift of the oxygen dissociation curve, may be so effective that few symptoms of anemia aside from mild irritability are noted.
4) When Hb level falls to <5 g/Dl, irritability, anorexia & lethargy develop, & systolic flow murmurs are often heard. As Hb continues to fall, tachycardia & high output cardiac failure can occur.
5) Iron deficiency has nonhematologic systemic effects. The most important effects are impaired intellectual & motor function that can occur early in iron deficiency before anemia develops. There is evidence that these changes might not be completely reversible after treatment with iron, increasing the importance of prevention.
6) IDA may lead to decreased cell mediated immunity & impaired neutrophil activity.
7) Gastrointestinal dysfunction.
8) Thrombosis,Both iron deficiency and overload have been associated with an increased thrombotic risk in experimental and clinical studies. It has been reported that IDA is associated with cerebral vein thrombosis **[32]**
**9)** Beeturia is defined as pink or red urine after the ingestion of beets. It is most common in individuals with iron deficiency **[33].** This manifestation is caused by increased intestinal absorption and increased excretion of the red pigment betalain (betanin). The pigment is decolorized by ferric ions, and urine excretion of betalain is increased in iron deficiency**.[1]**

**Sign**

1- Musculoskeletal disorder and weight gain

- Effort capacity is decreased.
- Exercise ability is limited.
- Cow's milk consumption leads to excess fat deposits, weight gain, and poor muscle tone.

2- Cardiovascular signs

- Increased cardiac output.
- Tachycardia.
- Cardiomegaly.
- Congestive cardiac failure.
- Hemic murmur (soft systolic, intense near base and changing with position).

3- Immune system dysfunction

- Decreased resistance against infections.
- T lymphocyte and polymorphonuclear leukocyte dysfunction.

4- Gastrointestinal system signs

- Splenomegaly.
- Loss of appetite.
- Dysphagia.
- Pica :Pica, the desire to ingest non-nutritive substances(can result in ingestion of lead- containing substances leading to plumbism) & pagophagia, the desire to ingest ice, are other symptoms of IDA.

4- Neurological signs

- Iron deficiency decreases the expression of dopamine receptors and leads to dysfunctional neurotransmitters.
- Papilledema.
- Sleep disturbance.
- Attention deficit.
- Behavioral disorder .

**[1],[34]**

## Differential diagnosis

- β-thalassemia trait : It is a mild microcytic anemia which occurs in the people of Mediterranean area, Africa, & Asia. It is characterized by ↑ HbA2 &/or ↑ HbF. Serum iron , TIBC, & serum ferritin are normal. There are ↑ RBC counts (↓ in IDA), normal RDW ( ↑ in IDA).
- α-thalassemia trait : (↑ in blacks, Chinese, & south-east Asia).
- Hemoglobinopathies as Hb-H , Hb E, & Hb C disease.
- Anemia of chronic diseases & infections : It is usually normocytic anemia but may be slightly microcytic ( about 20%). There are ↓ serum iron, ↓ serum TIBC, & normal or ↑serum ferritin.
- Lead poisoning : There are ↑ FEP (free erythrocyte protoporphyrin), coarse basophilic stippling of the RBCS, & ↑ blood lead level.
- Sideroblastic anemia : They are acquired or hereditary disorders of heme synthesis →dimorphic anemia ( hypochromic microcytic & normal RBCS) & mostly occur in adulthood. **[1]**

## Laboratory findings

In progressive IDA, a sequence of biochemical & hematological events occur as follows :

1. Disappearance of bone marrow hemosiderin, & ↓ serum ferritin followed by :
2. ↓ serum iron, ↑ serum total iron binding capacity (TIBC or serum transferrin), & ↓ transferrin saturation followed by :
3. ↓ MCV, ↓ MCH ( hypochromic microcytic RBCS) followed by :
4. RBC count decreases and blood smear reveals hypochromic, microcytic red cells with substantial variation in cell size (anisocytosis which can be revealed as increasing RBC distribution width (RDW)).

- Reticulocyte % may be normal or moderately ↑ , but absolute reticulocyte count shows insufficient response to anemia.
- Elliptocyte or cigar-shaped RBC are often seen.
- Detection of increased transferrin receptor & decreased reticulocyte hemoglobin
- concentration provides supporting diagnostic information when these studies are available.
- Platelets count may show thrombocytosis , but in severe cases, there may be thrombocytopenia.
- Bone marrow examination → hypercellular with erythroid hyperplasia.
- Occult blood in stool is seen in about 1/3 of cases.
- In most instances, a CBC demonstrating a microcytic anemia with high RDW, reduced RBC, normal WBC, & normal or elevated platelet count is sufficient for a presumptive diagnosis. Other laboratory studies as reduced ferritin, reduced serum iron & increased TIBC, are not usually necessary for diagnosis unless severe anemia

requires more rapid diagnosis, other complicating clinical factors are present, or the anemia does not respond to iron therapy. **[1], [35],[36]**

**The following investigations are significant in making a diagnosis:**

| | |
|---|---|
| **Complete Blood Count (CBC)** | • Hemoglobin and Hematocrit would be low according to age<br>• RDW (Red cell Distribution Width; 14<br>• RBC: Low<br>• MCV (mean corpuscular volume): Low according to age<br>• MCHC (mean corpuscular hemoglobin concentration: 30 %<br>• Thrombocytosis<br>• Rarely Thrombocytopenia and leucopenia |
| **Peripheral Smear** | • Microcytosis<br>• Hypochromia<br>• Anisochromia<br>• Anisocytosis<br>• Pencil cells |
| **Iron Studies** | • Serum iron: < 30 mcg/dL (diagnostic)<br>• Serum ferritin: < 12 ng/mL<br>• TIBC (total iron binding capacity): > 480 mcg/dL<br>• Transferrin saturation (Iron/TBC x 100): < 16 % |

| TEST | IRON DEFICIENCY ANEMIA |
|---|---|
| Serum iron | Low |
| Serum iron-binding capacity | High |
| Serum ferritin | Low |
| Marrow iron stores | Low or absent |
| Marrow sideroblasts | Decreased or absent |
| Free erythrocyte protoporphyrin | High |
| Hemoglobin $A_2$ or F | Normal |
| Red blood cell distribution width[5] | High |

Other Laboratory Tests

❖ Stool testing

For the presence of hemoglobin is useful in establishing gastrointestinal bleeding as etiology of iron deficiency anemia. Usually chemical testing that detects more than 20 mL of blood loss daily from the upper GI tract is employed. More sensitive tests are available however, they produce a high incidence of false positive results in people who eat meat and severe iron deficiency anemia can occur in patients with a persistent loss of less than 20 mL/d.

To detect blood loss the patient can be placed on a strict vegetarian diet for 3-5 days and the stool can be tested for hemoglobin with a benzidine method or red blood cells (RBCs) can be radiolabeled with radiochromium and retransfused. Stools are collected and the radioactivity is quantified in a gamma detector and compared to the radioactivity in a measured quantity of the patient's blood. An immunologic method of detecting human species specific hemoglobin in stool is under development and could increase specificity and sensitivity.

❖ Incubated osmotic fragility

Is useful and microspherocytosis may produce a low normal or slightly abnormal MCV however, the MCHC usually is elevated rather than decreased, and the peripheral smear shows a lack of central pallor rather than hypochromia and spherocytosis can normally be separated from iron deficiency anemia by peripheral blood smear.

❖ Tissue lead concentrations

Measure tissue lead concentrations. Chronic lead poisoning may produce a mild microcytosis. The anemia probably is related to the anemia of chronic disorders. The incidence of lead poisoning is greater in individuals who are iron deficient than in healthy subjects because increased absorption of lead occurs in individuals who are iron deficient. Paint in old houses has been a source of lead poisoning in children and painters.

❖ Bone marrow aspiration

Can be diagnostic of iron deficiency. The absence of stainable iron in a bone marrow aspirate that contains spicules and a simultaneous control specimen containing stainable iron permit establishment of a diagnosis of iron deficiency without other laboratory tests.

A bone marrow aspirate stained for iron (Perls stain) can be diagnostic of iron deficiency, provided that spicules are present in the smear and that a control specimen containing iron is performed at the same time. Although this test has largely been displaced in the diagnosis of iron deficiency by serum iron, TIBC, and serum ferritin testing, the absence of stainable iron in a bone marrow aspirate is the criterion standard for the diagnosis of iron deficiency.

This test is diagnostic in identifying the sideroblastic anemias by showing ringed sideroblasts in the aspirate stained with Perls stain. Occasionally, it is useful in separating patients with the anemia of chronic disorders or alpha-thalassemia from patients with iron deficiency, and it is useful in identifying patients with both iron deficiency and the anemia of chronic disorders.

❖ Histologic Findings

The absence of stainable iron in body tissues, including the bone marrow and liver is the most useful histologic finding in individuals who are iron deficient. Nonspecific abnormalities of epithelial tissues are reported in iron deficiency and these include gastric atrophy and clubbing of the small intestinal villi, while they suggest that iron deficiency is a pantropic disorder they have little clinical diagnostic value.**[37]**

## Treatment

The regular response of IDA to an adequate amount of the iron is a critical diagnostic and therapeutic feature.

1. Oral administration :

a) simple ferrous salts, most often ferrous sulfate provide inexpensive and effective therapy. A daily total dose of 3-6 mg/kg of elemental iron in 3 divided doses is adequate, ferrous sulfate has 20% elemental iron and is ideally given between meals with juice for 8 wks after the blood values normalize to reestablish iron stores. Intolerance to oral iron is rare in young children but older children and adolescents may have a GIT complications.

b) Ferrous gluconate, which contains 12% elemental iron and is available in 250mg doses.

- However, potential adverse effects could occur in the form of nausea, vomiting, diarrhea, constipation, and epigastric pain and even the recommended dose can cause adverse effects in which case readjustment of dose becomes essential.

Factors involving in poor response to oral iron include the following:

- Poor tolerance.
- The insufficient time span of treatment.
- Malabsorption.
- Persistent bleeding.
- Inadequate iron absorption due to concurrent phytates and phosphates.
- Inadequate dose (<3–6 mg/kg/day).
- Poor compliance.iron

3.preparation : is indicative in the following conditions:

a. Oral iron administration failed to manage IDA.
b. Patient is intolerant of oral iron therapy.
c. Patient is unable to take the oral medication.
d. malabsorption is present or when compliance is poor because the oral therapy is otherwise as fast, as effective, much less expensive and less toxic. When necessary parenteral iron sucrose and ferric gluconate complexes have a lower risk of serious reactions than iron dextran.

4. Dietary counseling is usually necessary. Excessive intake of milk, particularly bovine milk, should be limited. Iron deficiency in adolescent girls secondary to abnormal uterine blood flow loss is treated with iron and hormone therapy**.[38]**

5. Follow up: If anemia is mild the only additional study is to repeat the blood count 4 wk after initiating therapy at which Hb has usually risen by at least 1-2 g/Dl and has often normalized. If the anemia is more severe and earlier confirmation of the diagnosis can be made by the appearance of reticulocytosis usually within 48-96 hr of treatment. The Hb will then begin to increase 0.1-0.4 g/dL per day depending on severity of anemia.

6. When the anemia responds poorly or not at all to iron therapy, there are multiple considerations like poor compliance, incorrect dose or medication, malabsorption, ongoing blood loss, concurrent infection or inflammatory disorder, concurrent vitamin B 12 or folate deficiency or diagnosis other than IDA.

7. Blood transfusion is rarely necessary. It should only be used when congestive heart failure is imminent or if anemia is severe with evidence of substantial ongoing blood loss usually with Iron deficiency is best prevented to avoid both its systemic manifestations & the anemia**.[1][38]**

## Prevention

- Iron deficiency is best prevented to avoid both its systemic manifestations & the anemia.
- Breastfeeding should be encouraged, with the addition of iron-fortified cereals after 4-6 mo of age.
- Infants who are not breast–fed should only receive iron fortified formula (12 mg of iron per liter) for the first year, & thereafter bovine milk should be limited to < 20-24 oz daily. This approach encourages the ingestion of foods richer in iron & prevents blood loss due to bovine milk-induced enteropathy.
- When these preventive measures fail, routine screening helps prevent the development of severe anemia. Routine screening using Hb or

Hematocrit is done at 12 mo of age, or earlier if at 4 mo of age the child is assessed to be at high risk for iron deficiency.

- Adolescent females who are menstruating should have a diet enriched with iron-containing foods.
- A vitamin with iron may also be used**.[1]**

## Prognosis

Iron deficiency is easily treated disorder with excellent outcome. However, it may be caused by underlying condition with poor prognosis such as neoplasm, similarly the prognosis may be altered by a comorbid condition like a coronary artery diseases, promptly and adequately treat patient with iron deficiency anemia who is symptomatic with such comorbid conditions.

## Conclusion

- iron deficiency anemia is most common nutritional deficiency in the world and affecting more than a quarter of global population. Iron plays an essential role in many physiological functions, including oxygen binding and transport, cell growth and differentiation, gene regulation, enzyme reactions, and the neurotransmitter synthesis. Iron deficiency develops in stages. In first stage, iron requirement exceeds intake and causing depletion of bone marrow iron stores. As stores decrease absorption of dietary iron increases compensatory. During later stages deficiency impairs erythropoiesis and ultimately causing anemia.
- Iron deficiency and IDA have many systemic effects, and the most concerning are diminished mental, motor, and behavioral functioning that might not be completely reversible after treatment with iron,

therefore, intervention should focus on primary prevention which includes breastfeeding, fortification of foods with iron and use of iron rich formulas when breastmilk is insufficient, and avoiding cow's milk before 1 year of age. Routine laboratory screening is recommended for all children 9–12 months of the age. Risk assessment consisting of focused dietary history presents the most valuable screening tool and additional laboratory screening is recommended for children with a risk factor for iron deficiency and IDA.

- Treatment starts with establishing the diagnosis and the main therapeutic principles are detection of the condition that causes iron deficiency, correction of underlying etiology, iron supplementation, dietary modifications, and education of families. Oral iron is the first line therapy giving in appropriate dose and scheduling. Adequate follow up assessment for response is also important and if the appropriate response is missing, further evaluation should be obtained to rule out the conditions that might simulate or complicate IDA.

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