IRON DEFICIENCY ANEMIA (IDA): A REVIEW

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DOI: https://doi.org/10.5281/zenodo.18802702

ABSTRACT

Anemia is a common hematological disorder characterized by a reduction in hemoglobin concentration and red blood cells, leading to decreased oxygen supply to body tissues. Iron deficiency anemia (IDA) is the most prevalent form and occurs due to inadequate dietary intake, poor absorption, chronic blood loss, parasitic infections, menstruation, pregnancy, and malnutrition. Insufficient iron results in impaired hemoglobin synthesis and the formation of microcytic hypochromic red blood cells, which reduces physical capacity, cognitive performance, and immunity. IDA is especially common among women during adolescence, pregnancy, and childbirth, increasing the risk of maternal and neonatal complications. Serum ferritin is considered the most sensitive indicator for early diagnosis of iron deficiency. Effective management includes dietary diversification, iron supplementation, food fortification, and nutrition education. Oral iron therapy remains the primary treatment and should be continued for several months to restore iron stores. Early detection and appropriate intervention can significantly reduce morbidity and improve quality of life. This study highlights the causes, clinical features, diagnosis, and preventive strateg ies of iron deficiency anemia.

KEYWORDS: Anemia, Iron deficiency anemia, Hemoglobin, Micronutrient deficiency, Iron supplementation.

INTRODUCTION

Iron Deficiency Anemia (IDA) is the most common nutritional deficiency disorder worldwide and remains a major public health concern. It results from inadequate iron availability, leading to impaired hemoglobin synthesis and reduced oxygen transport to body tissues.

Hemoglobin, an iron-containing protein in red blood cells, is essential for maintaining normal physiological functions. Globally, IDA affects nearly one-quarter of the world's population, with the highest prevalence among preschool children, adolescents, and women of reproductive age, particularly in developing countries. In India, anemia continues to be a significant contributor to morbidity and reduced quality of life.

Iron plays a vital role in cellular respiration, energy metabolism, DNA synthesis, and cell proliferation. Deficiency leads to symptoms such as fatigue, weakness, pallor, and reduced work capacity, and may impair immune and cognitive functions. Chronic iron deficiency can result in microcytic hypochromic anemia and may worsen outcomes in patients with chronic diseases.

Despite being largely preventable and treatable, iron deficiency anemia remains underdiagnosed in many regions. This article reviews the epidemiology, pathophysiology, clinical features, and management of IDA, emphasizing the need for early diagnosis and effective prevention strategies

METHODOLOGY

This review was conducted to collect and analyze recent scientific data related to iron deficiency anemia and its management. Information was obtained through a systematic computerized search of various electronic databases, medical journals, research articles, and review papers. Updated national and international treatment guidelines were also referred to ensure the accuracy of therapeutic approaches.

Relevant keywords such as iron deficiency anemia, diagnosis, treatment, and management were used during the search process. Only peer-reviewed and reliable sources were selected for inclusion in this review. The collected data was carefully evaluated, compared, and organized to present clear and evidence-based information.

Definition: Anaemia is a common hematological disorder characterized by a reduction in hemoglobin concentration and red blood cell mass, leading to diminished oxygen- carrying capacity of the blood and impaired tissue oxygenation. According to the World Health Organization, anaemia is defined as a hemoglobin concentration of less than 120 g/L in women and less than 130 g/L in men. This definition also includes pseudo-anaemic states such as pregnancy, cardiac failure, and hyperproteinaemia, in which hemoglobin levels are reduced due to plasma volume expansion rather than a true decrease in erythrocyte mass. Conversely, hemoconcentration resulting from plasma volume contraction may mask underlying anaemia. Iron deficiency remains the most prevalent cause of anaemia worldwide, followed by anaemia of chronic disease, acute blood loss, and haemolytic disorders.

Iron deficiency is the most frequent cause of anaemia, closely followed by anaemia of chronic disease (Figure 1)
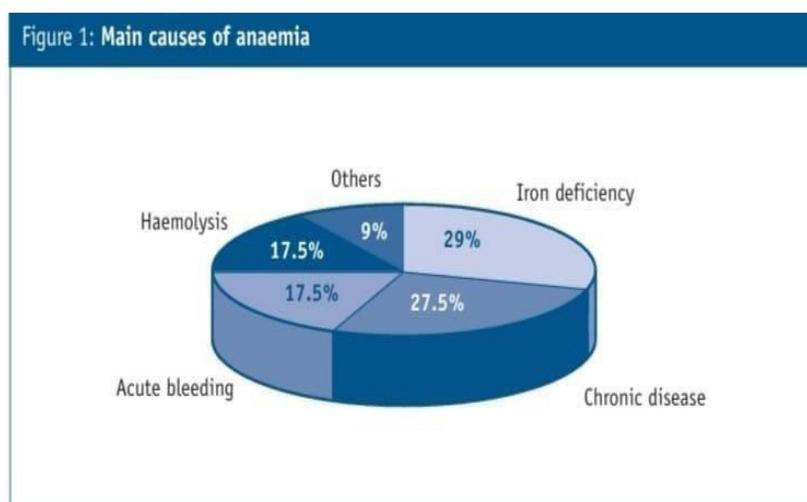

Figure 1: Main causes of anaemia

Fig. 1.[5]

Pathophysiology

Table 1: Classification of anaemias	
Hyporegenerative	**Regenerative**
Aplastic anaemia	Haemolysis
Pure red cell aplasia	Immune
Myelodysplastic syndrome	Non-immune
Deficiency states	• Congenital: membrane, SS, thalassaemia, enzymopathies, unstable Hb
• Iron	• Acquired: PNH, drugs (Pb, Zn and Cu poisoning), microangiopathy, hypersplenism
• Vitamins	
Marrow infiltration/fibrosis	Haemorrhage (bleeding)
Inflammatory anaemia (anaemia of chronic disease)	
Erythropoietin underproduction	

Hyporegenerative anaemia is defined as a reticulocyte count of $< 50 \times 10^9/L$; regenerative anaemia is defined as a reticulocyte count of $> 100 \times 10^9/L$. PNH: Paroxysmal nocturnal haemoglobinuria; SS: homozygous sickle cell disease. For reticulocyte count between 50 and $100 \times 10^9/L$, see Section 3: Practical approach to the anaemic patient.

Fig 2.

Risk factors

Anaemiacan be classified based on reticulocyte count into hyporegenerative and regenerative types, which reflects the bone marrow's response to reduced red blood cells.

Hyporegenerative anaemia occurs when reticulocyte count is low ($< 50 \times 10^9/L$), indicating decreased RBC production, and includes conditions such as aplastic anaemia, pure red cell aplasia, myelodysplastic syndrome, iron and vitamin deficiencies, marrow infiltration or fibrosis, anaemia of chronic disease, and reduced erythropoietin production. In this group, mean corpuscular volume (MCV) remains important for further diagnosis. Regenerative anaemia is characterized by a high reticulocyte count ($> 100 \times 10^9/L$), showing increased RBC production in response to loss or destruction, and is mainly caused by haemolysis (immune or non-immune, congenital or acquired) and haemorrhage.

Thus, reticulocyte count provides a simple and reliable basis for classifying anaemia and identifying its underlying cause.

Causes

- **Chronic Blood Loss**

Continuous blood loss from the gastrointestinal tract (ulcers, tumors, gastritis), menstrual disorders, gynecological diseases, and parasitic infections leads to gradual depletion of body iron stores.

- **Increased Physiological Demand**

During pregnancy, infancy, adolescence, and rapid growth periods, the requirement for iron increases for hemoglobin synthesis and tissue development. Failure to meet this demand causes deficiency.

- **Inadequate Dietary Intake**

Low intake of iron-rich foods such as meat, liver, eggs, pulses, and green leafy vegetables results in insufficient iron supply to the body.

- **Impaired Intestinal Absorption**

Diseases of the small intestine (celiac disease, Crohn's disease), chronic diarrhea, or intestinal surgery reduce iron absorption from food.

- **Malabsorption Syndromes**

Disorders affecting digestion and absorption, such as tropical sprue and chronic pancreatitis, interfere with effective iron uptake.

- **Frequent Blood Donation or Repeated Blood Loss** Regular blood donation, repeated phlebotomy, or unnoticed minor bleeding leads to continuous iron loss exceeding replacement.

- **Chronic Diseases and Malignancies**

Long-standing infections, inflammatory disorders, and cancers cause slow blood loss and altered iron metabolism, contributing to iron deficiency.

Clinical Features

Iron deficiency anemia presents with general symptoms like fatigue, pallor, and reduced exercise capacity, which vary based on the condition's severity. Chronic cases often feature unique behaviors like pica (craving chalk or clay), pagophagia (craving ice), or a strange attraction to the smell of gasoline. Physical signs include a smooth, burning tongue (glossitis), cracks at the mouth corners (cheilosis), and brittle, spoon- shaped nails known as koilonychia. Rarely, patients may experience difficulty swallowing due to esophageal webs or notice a bluish tint to the whites of their eyes

Category	Clinical Feature
Common	Fatigue, Pallor, Dyspnea on exertion
Oral	Glossitis, Angular stomatitis, Esophageal webs
Dermal	Brittle nails, Koilonychia (Spoon nails)
Behavioral	Pica, Pagophagia, Olfactory cravings

Fig. 3.

Diagnosis: Iron deficiency anaemia is best diagnosed through an integrated evaluation of haematological indices and biochemical markers of iron metabolism, supplemented by investigations to identify underlying causes. Initial laboratory assessment typically reveals reduced haemoglobin concentration, decreased erythrocyte count, and characteristic microcytic, hypochromic red blood cells with lowered MCV, MCH, and MCHC values. Among biochemical tests, serum ferritin serves as the most sensitive and early indicator of depleted iron stores; markedly reduced levels strongly suggest absent or severely diminished body iron reserves. Additional supportive findings include decreased serum iron concentration, reduced transferrin saturation (commonly <10%), and elevated total iron-binding capacity, reflecting increased iron transport demand. Measurement of soluble transferrin receptors and elevated red cell protoporphyrin levels further enhance early detection by indicating impaired haem synthesis. Once laboratory evidence confirms iron deficiency, targeted diagnostic procedures such as endoscopy or colonoscopy may be employed to detect occult gastrointestinal blood loss, while pelvic ultrasonography may be indicated in women to evaluate

excessive menstrual bleeding or structural uterine pathology. Thus, accurate diagnosis of iron deficiency anaemia requires a systematic approach that combines morphological blood analysis, specific biochemical indicators of iron status, and etiological investigations to guide definitive management.
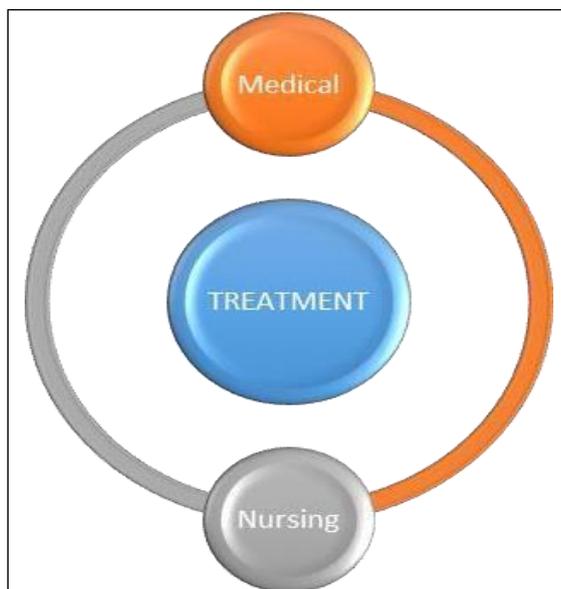

Fig. 4.

Table - 1.

Tests	Normal Range	IDA
TIBC	240-450 μg/dL (men & women)	High
SI	55–160 μg/dL (men) 40–155 μg/dL (women)	Low
TS	20%-50% (Adults) >16% (Children)	<12 - 16%
SF	15–200 ng/ml (women) 20–300 ng/ml (men) 25 – 75 ng/ml (Optimal for men and women)	<15ng/ml) (in a healthy person) or <50ng/ml (in a person with an underlying source of chronic inflammation
Hb	130 g/L (men) 120 g/L (women) 110 g/L (pregnant women and preschool children)	Low

Consequences

- Reduced Oxygen Transport and Fatigue
- Deficient haemoglobin synthesis decreases the oxygen-carrying capacity of blood, leading to tissue hypoxia. This results in generalized weakness, easy fatigability, reduced physical endurance, and exertional dyspnoea.
- Cardiovascular Strain.
- To compensate for inadequate oxygen delivery, the heart increases its rate and output. Persistent compensation may lead to tachycardia, cardiac enlargement, and in severe cases, high-output heart failure.
- Cognitive and Neurological Impairment.

- Inadequate oxygen supply to the brain impairs neuronal metabolism, causing reduced concentration, irritability, headache, diminished cognitive performance, and decreased neuromuscular efficiency.
- Impaired Immune Function
- Iron deficiency disrupts immune cell activity and enzymatic processes, weakening host defence mechanisms and increasing susceptibility to infections.
- Growth and Reproductive Complications
- Chronic iron deficiency may cause delayed growth and developmental impairment in children and increases the risk of adverse pregnancy outcomes such as low birth weight and preterm delivery.

Treatment

Dietary management

- Provide patients with an iron-rich eating plan that includes heme iron (animal sources: meat, poultry, fish) and non-heme iron (plant sources: whole grains, eggs, lentils, dried beans & peas, nuts, seeds, dried fruit like apricots, dates, figs, prunes, raisins).
- Enhance non-heme iron absorption by consuming vitamin C-rich foods together with iron-rich meals (citrus fruits/juices, dried cranberries, strawberries, kiwi, melons, papaya, cauliflower, broccoli).
- Ensure patients receive at least one nutritious meal daily, preferably through community nutrition programs.

Medicines

- First-line treatment is oral ferrous iron salts (the most economical and effective option).
- Continue oral therapy for about 2 months after hemoglobin normalizes to replenish iron stores.
- Use parenteral iron only for patients who cannot absorb oral iron or who have worsening anemia despite adequate oral doses, or for those with inflammatory bowel disease (e.g., ulcerative colitis, Crohn's disease), noting that ferrous sulfate can aggravate intestinal inflammation.

Table 2: Recommended dietary allowances for Indians (ICMR).

Age/Age Group (years)		Iron (mg/day)
Man		28
Pregnant Woman		38
Lactating Woman		30
Non Pregnant Woman		30
Children		
	1-3 y	12
	4-6 y	18
	7-9 y	26
13-15 y		
	Boys	41
	Girls	28
16-18 y		
	Boys	50
	Girls	30

Table 3: Supplementation dosage recommended by NNAPP.

Age group	Dosage schedule	Duration
Children 6-60 months	2o mg elemental iron + 100 μg folic acid (one tablet of pediatric IFA or 5 ml of IFA syrup or 1 ml of IFA drops)	100 days if the child is clinically found to be anemic.
School children 6-10 years	30 mg elemental iron + 250 μg folic acid	100 days.
Adolescents 11-18 years	100 mg elemental iron + 500 μg folic acid	100 days
Pregnant women	One tablet of 100 mg elemental iron + 500 μg folic acid prophylactically If clinically anemic	Daily 2 such tablets to be given daily for 100 days
Nursing mothers	One tablet OF 100 mg elemental iron + 500 μg folic acid	100 days

CONCLUSION

Combating micronutrient malnutrition requires a food-based approach, rather than relying solely on supplements. It's crucial to address iron deficiency, particularly in pregnant women and young children, as it can impact cognitive development, growth, and overall well-being. Dietary changes should focus on increasing iron, folic acid, and vitamin C intake, as well as consuming foods that enhance iron absorption. Nutrition education, coupled with iron supplements and natural vitamin C sources, is the most effective way to restore healthy hemoglobin levels and prevent iron deficiency anemia in vulnerable populations.

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