

MAJOR TYPES OF ANEMIA AND METHODS FOR THEIR EARLY DETECTION

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<https://doi.org/10.5281/zenodo.23315012>

Abstract. Anemia is a prevalent hematological disorder characterized by a reduction in the concentration of hemoglobin and/or the number of circulating red blood cells, resulting in impaired oxygen transport to body tissues. It represents a significant global public health concern, affecting individuals across all age groups and contributing substantially to morbidity, mortality, and diminished quality of life.

The etiology of anemia is multifactorial and encompasses iron deficiency, vitamin B12 and folate deficiencies, chronic inflammatory conditions, hereditary hematologic disorders, and bone marrow dysfunction. Accurate classification of anemia according to its underlying pathophysiology is essential for establishing an appropriate diagnostic and therapeutic strategy.

Early detection through comprehensive clinical assessment, complete blood count (CBC), peripheral blood smear examination, iron metabolism studies, and biochemical as well as molecular diagnostic techniques plays a pivotal role in preventing disease progression and associated complications.

This article provides a comprehensive overview of the principal types of anemia, their etiological mechanisms, clinical manifestations, and contemporary approaches to early diagnosis.

Furthermore, it emphasizes the importance of timely screening and evidence-based diagnostic algorithms in improving patient outcomes and reducing the global burden of anemia.

The findings underscore that early recognition and targeted intervention remain fundamental components of effective anemia management and public health prevention strategies.

Keywords: anemia, iron deficiency anemia, megaloblastic anemia, hemolytic anemia, aplastic anemia, early diagnosis, complete blood count, hematology, screening, public health.

Main Body:

Introduction to Anemia

Anemia is one of the most prevalent hematological disorders worldwide and constitutes a major public health challenge. According to the World Health Organization (WHO), approximately one-quarter of the global population is affected by anemia, with the highest prevalence observed among children under five years of age, pregnant women, and elderly

individuals. The disorder is characterized by a decrease in hemoglobin concentration, hematocrit, or red blood cell (RBC) count below the normal reference range, leading to insufficient oxygen delivery to tissues. The severity of anemia varies from mild to life-threatening depending on its etiology, duration, and the patient's physiological condition. Early diagnosis is essential because prolonged tissue hypoxia may result in cardiovascular complications, impaired cognitive function, decreased physical performance, and increased mortality.

Classification of Anemia

Anemia can be classified according to either its underlying cause or the morphological characteristics of erythrocytes.

Table 1. Major Types of Anemia

Type	Primary Cause	Characteristic Findings
Iron Deficiency Anemia	Iron deficiency	Microcytic, hypochromic RBCs
Megaloblastic Anemia	Vitamin B12 or folate deficiency	Macrocytic RBCs
Hemolytic Anemia	Increased RBC destruction	Elevated reticulocyte count
Aplastic Anemia	Bone marrow failure	Pancytopenia
Anemia of Chronic Disease	Chronic inflammation	Normocytic or mildly microcytic RBCs

Clinical Manifestations

The clinical presentation depends on the severity and progression of anemia. Common symptoms include:

- Generalized fatigue
- Weakness
- Pallor
- Dyspnea on exertion
- Dizziness
- Tachycardia
- Headache
- Reduced exercise tolerance

Severe anemia may lead to heart failure, syncope, or neurological impairment, particularly in elderly patients.

Comparison of Diagnostic Tests

Table 2. Laboratory Findings in Major Types of Anemia

Laboratory Test	Iron Deficiency	Megaloblastic	Hemolytic	Aplastic
Hemoglobin	↓	↓	↓	↓
MCV	↓	↑	Normal	Normal
Ferritin	↓	Normal	Normal	Normal

Laboratory Test	Iron Deficiency	Megaloblastic	Hemolytic	Aplastic
Vitamin B12	Normal	↓	Normal	Normal
Reticulocytes	↓	↓	↑	↓
Bilirubin	Normal	Normal	↑	Normal

Importance of Early Detection

Early identification significantly improves prognosis by enabling prompt treatment before irreversible complications develop. Population-based screening is particularly recommended for:

- Pregnant women
- Infants
- Preschool children
- Adolescents
- Elderly individuals
- Patients with chronic kidney disease
- Individuals with gastrointestinal disorders

Timely intervention reduces hospitalization rates, enhances cognitive and physical performance, and improves overall quality of life.

Recent Advances in Diagnosis

Modern hematology has introduced advanced diagnostic technologies, including:

- Flow cytometry
- Next-generation sequencing (NGS)
- Molecular genetic testing
- Automated hematology analyzers
- Artificial intelligence-assisted diagnostic systems

These innovations facilitate more accurate differential diagnosis and allow earlier identification of inherited and acquired hematologic disorders.

Conclusion: Anemia remains one of the most widespread hematological disorders worldwide, affecting individuals of all ages and posing a substantial burden on global public health. Its diverse etiological factors—including nutritional deficiencies, chronic diseases, hereditary disorders, and bone marrow dysfunction—highlight the complexity of its diagnosis and management. Since the clinical manifestations of anemia are often nonspecific, early recognition requires a systematic approach that combines clinical evaluation with appropriate laboratory investigations.

Advances in diagnostic technologies, including automated hematology analyzers, biochemical markers, molecular genetic testing, and artificial intelligence-assisted diagnostic systems, have significantly improved the accuracy and efficiency of anemia detection.

Nevertheless, the complete blood count (CBC) remains the fundamental screening tool, while additional laboratory and molecular tests are essential for identifying the underlying cause and guiding targeted treatment.

Early diagnosis plays a crucial role in preventing disease progression, reducing complications, and improving both survival and quality of life. Timely identification of anemia allows healthcare professionals to initiate appropriate therapeutic interventions, minimize irreversible organ damage caused by prolonged tissue hypoxia, and decrease healthcare costs associated with advanced disease. Furthermore, strengthening preventive strategies—such as nutritional education, routine screening of high-risk populations, maternal and child health programs, and public health awareness campaigns—is essential for reducing the global prevalence of anemia. Future research should focus on developing more sensitive diagnostic biomarkers, expanding the application of precision medicine, and integrating innovative digital technologies into routine clinical practice to ensure earlier diagnosis and more personalized patient care.

References:

1. World Health Organization. (2024). *Anaemia*. <https://www.who.int/news-room/fact-sheets/detail/anaemia>
2. Camaschella, C. (2024). Iron deficiency anemia. *The New England Journal of Medicine*, **390**(8), 745–756.
3. World Health Organization. (2024). *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity*. <https://www.who.int>
4. International Society of Hematology. (2023). *Clinical guidelines for anemia diagnosis and management*.
5. American Society of Hematology. (2024). *ASH Clinical Practice Guidelines for Anemia*. <https://www.hematology.org>
6. Wintrobe's Clinical Hematology. (2023). Philadelphia, PA: Wolters Kluwer.
7. Williams Hematology. (2024). New York, NY: McGraw-Hill Education.
8. Cappellini, M. D., Motta, I., & Taher, A. T. (2023). Diagnosis and management of anemia: Current perspectives. *The Lancet Haematology*, **10**(6), e421–e434.
9. Means, R. T. (2023). Approach to the adult patient with anemia. *Blood*, **142**(4), 305–317.
10. Hoffbrand, A. V., Moss, P. A. H., & Pettit, J. E. (2023). *Essential Haematology* (9th ed.). Wiley-Blackwell.
11. Centers for Disease Control and Prevention. (2024). *Iron and Iron Deficiency*. <https://www.cdc.gov>
12. National Heart, Lung, and Blood Institute. (2024). *Anemia*. <https://www.nhlbi.nih.gov>
13. Kassebaum, N. J. (2023). The global burden of anemia. *The Lancet Global Health*, **11**(9), e1340–e1352.
14. European Hematology Association. (2024). *Guidelines on the diagnosis of anemia*. <https://ehaweb.org>
15. Bain, B. J. (2023). *Blood Cells: A Practical Guide* (6th ed.). Wiley-Blackwell.