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Specific Aspects of Children's Anemia

Sobirova Nargiza Ravshanbek kizi
Assistant of the department "Pediatrics for the Faculty of Medicine"

Abstract. This article presents the main classification and differential diagnostic schemes of anemia. The emphasis in diagnosis is on laboratory tests that form the basis of differential diagnosis and differentiated treatment of anemia in children.

Keywords: anemia, differential diagnosis, diagnostic algorithm, method, classification.

Introduction

Anemia is defined as a state of hypoxemia associated with a decrease in the number of circulating red blood cells and/or their ability to meet tissue oxygen needs. Since the body undergoes constant intensive formation of red blood cells and their simultaneous breakdown, anemia is understood as a condition characterized by an imbalance of red blood cells, that is, a decrease in the intensity of formation or increased destruction of red blood cells, or a combination of both factors.

Materials And Methods

The main marker of anemia is the concentration of hemoglobin (Hb), which ensures the delivery of oxygen to tissues; additional markers are the affinity of hemoglobin for oxygen, intravascular volume of oxygen consumption, heart rate, specific cardiac volume and arterial oxygenation. The boundary separating normal and pathological conditions is considered to be a hemoglobin value of <110 g/l. The number of red blood cells is a less informative indicator of anemia and does not always correlate with the degree of decrease in hemoglobin. According to the degree of severity, there are: grade I anemia (mild), Hb - 110–90 g/l; anemia of the second degree (moderate), Hb - 90–70 g/l; anemia of the third degree (severe), Hb < 70 g/l.

Results And Discussion

Anemias are diverse in etiology, pathogenesis and clinical and hematological characteristics. They can be either an independent disease or a syndrome associated with various diseases. If a patient has signs of anemia, the first step is to determine whether it is the result of an abnormality in only one cell line (eg, red blood cells) or multiple cell lines (eg, red blood cells, white blood cells, and platelets). Changes in two or three cell lines usually indicate involvement of the bone marrow in the pathological process (aplastic anemia, leukemia, etc.), diseases of the immune system (connective tissue pathology, acquired immunodeficiency syndrome, etc.), immunological destruction of cells on the periphery (immune neutropenia, idiopathic thrombocytopenic purpura - ITP, immune hemolytic anemia, etc.), as well as on cell sequestration (for example, hypersplenism). In table 1 shows the etiological classification of anemia and diagnostic criteria for each of them. Currently, when classifying anemia, pediatricians adhere to the pathogenetic principle.

Table 1. Etiological classification and main criteria for diagnosing anemia in children

Etiological classification	Diagnostic criteria
I. Violation of red blood cell formation A. Deficiency of macroelements and vitamins	
1. Iron deficiency	Hypochromic microcytic erythrocytes, MCV, MCH and MCHC levels, high RDW levels, decreased serum ferritin levels, high FEP levels, guaiac fecal occult blood test positive
2. Folate deficiency	Macrocytic erythrocytes, high MCV and RDW, megaloblastic bone marrow, low serum and erythrocyte folate

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3. Vitamin B12 deficiency	Macrocytic red blood cells, high MCV and RDW, megaloblastic bone marrow, low serum B12, reduced gastric acidity; positive Schilling test
4. Vitamin C deficiency	Clinical signs of vitamin deficiency (scurvy)
5. Protein deficiency	Kwashiorkor (syndrome of depigmentation and subcutaneous tissue edema)
6. Vitamin B6 deficiency	Hypochromic red blood cells, sideroblastic bone marrow, high serum ferritin
7. Thyroxine deficiency	Cretinism, low T4, high thyroid-stimulating hormone
B. Bone marrow pathology	
1. Pathology of one cell line: a. Megakaryocytopenia • amegakaryocytic thrombocytopenic purpura	Bruises and hemorrhages on the skin of the extremities, absence of megakaryocytes, bleeding from the mucous membranes, early age
b. Red blood cell precursor defects: • congenital erythrocyte aplasia (Diamond–Blackfan anemia) • acquired erythrocyte aplasia (transient erythroblastopenia of children)	Absence of erythroid precursors in bone marrow examination Absence of erythroid precursors (intermittent)
c. Leukocyte precursor defects2: • congenital neutropenia • pathology of all cell lines (aplastic anemia, characterized by pancytopenia and hypocellular bone marrow)	Neutropenia, recurrent infections
2. a. Constitutional: • Fanconi anemia • family without anomalies • congenital dyskeratosis	Multiple congenital pathologies, fragility of chromosomes Heredity, absence of congenital anomalies Detection of pathology from the skin and mucous membranes
b. Purchased: • idiopathic • secondary	Reason not established As a result of exposure to drugs, radiation, household toxins, infections; associated with an immunological disease
3. Bone marrow infiltration: a. primary (leukemia, etc.) b. secondary (neuroblastoma, lymphoma, etc.)	Bone marrow: morphology, cytochemistry, immunological markers, cytogenetics of cells infiltrating the bone marrow Bone marrow, cerebrospinal fluid, visualization of the skeleton, thoracic organs and abdominal cavity. Biological markers, immunocytology, cytogenetics

The division into groups is very arbitrary, since there is often a combination of different mechanisms of anemization, and one nosological form does not fit into the strict framework of the group. In such cases, anemia is classified according to the leading mechanism of its development.

Diagnosis of anemia in children requires mandatory laboratory testing. At the same time, a blood smear is fundamentally important and informative for the diagnosis of anemia. It indicates the nature of anemia:

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hypochromic, microcytic, normo- or macrocytic, and also reveals specific morphological changes (spherocytes, sickle cells, target cells, etc.). Mean cell volume (MCV) indicates the size of the red cells: for example, microcytosis (<80 fL), macrocytosis (>95 fL) or normocytosis (80–95 fL).

The reticulocyte level is determined to determine the degree of anemia; The reticulocyte index is the most accurate indicator of erythropoiesis. In patients with bleeding or hemolysis, the reticulocyte index is ~3%, while in patients with anemia due to decreased red blood cell production it is less than 3% (usually <1.5%).

MCV and RDW are indicators determined during blood testing on an automatic analyzer, helping to establish the morphology and nature of anemia. Based on these indices, another classification of anemia was developed. In more complex cases, a bone marrow puncture is performed with staining of the drug to determine iron reserves and identify signs of sideroblastic anemia. Bone marrow studies can determine normal, megalo, or sideroblastic morphology.

Table 2. Classification of anemia based on MCV and RDW indicators

Indexes	Low MCV level	Normal MCV level	High MCV level
RDW normal	Microcytic homogeneous	Normocytic homogeneous	Macrocytic homogeneous
	Heterozygous thalassemia	Norm Chronic diseases Chronic disease Chronic liver pathology Nonanemic hemoglobinopathy (eg, AS, AC) Chemotherapy Chronic myelocytic leukemia Hemorrhage Hereditary spherocytosis	Aplastic anemia Preleukemia
RDW high	Microcytic heterogeneous	Normocytic heterogeneous	Macrocytic heterogeneous
	Iron deficiency S β-thalassemia Hemoglobin H Red blood cell fragmentation	Early stages of iron or folate deficiency Mixed deficiencies Hemoglobinopathies (eg, SS, SC) Myelofibrosis Sideroblastic anemia	Folate deficiency Vitamin B12 deficiency Immune hemolytic anemia Cold agglutinins

Conclusion

Anemic conditions and diseases in children are widespread in the population. Anemia occupies a leading place in the structure of nosologies and visits to the pediatrician, giving way to infections. The algorithm for diagnosing anemia is simple and possible at the primary health care level of providing care to children. Differential diagnosis of anemia and its treatment are carried out at a specialized stage; a number of anemias require highly specialized technologies, including hematopoietic cell transplantation and gene therapy. Further articles in the new section of the journal will present standards and clinical recommendations for the management of all types of anemia in children.

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