Classification and Diagnosis of Anemiain Children

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defintion

Anemia can be defined as a reduction in hemoglobin concentration, or number of red blood cells per cubic millimeter.

The lower limit of the normal range is set at two standard deviations below the mean for age and sex for the normal population.

Birth	۱۶/۵	۱۳/۵
۲ weeks	۱۶/۵	۱۲/۵
۲week_۳months	۱۱/۵_۱۶/۵	۹(Term) ۷(Preterm)
۳-۶ months	۱۱/۵	۹/۵
۶month_۲years	۱۲	۱۰/۵
۲-۱۲ years	۱۳/۵	۱۱/۵
۱۲-۱۸ years Female	۱۴	۱۲
۱۲_۱۸years Male	۱۴/۵	۱۳

Classification

The best approach for providing an understanding of the multiple disorders capable of producing anemia is to separate the causes of anemia into two categories

Classification

Disorders of effective red cell production, in which the net rate of red cell production is depressed. This can be due to disorders of erythrocyte maturation, in which erythropoiesis is largely ineffectual.

Classification

Disorders in which rapid erythrocytedestruction or red cell loss is primarily responsible for the anemia.

DISORDERS OF RED CELL PRODUCTION

١. **Marrow failure**
٢. **Impaired erythropoietin production or Erythroid maturation**

Marrow failure

a. Aplastic anemia(Congenital,Acquired)

b. Pure red cell aplasia(Congenital DBA,Acquired TEC)

c. Marrow replacement(Malignancies,Non Malignant)

Impaired erythropoietin production

Chronic renal disease

Hypothyroidism

Chronic inflammation

Protein malnutrition

DISORDERS OF ERYTHROID MATURATION

Iron deficiency
Sideroblastic anemias
Vitamin B_{12} & Folic acid deficiency

Hemolytic or Blood loss

١. **Congenital hemolytic anemia**(Hemoglobin ,enzyme ,membrane)

٢. **Acquired hemolytic anemias**

a. Antibody mediated

b. Microangiopathic hemolytic anemias

c. Secondary to acute infections

٣. **Acute blood loss**

٤. **Splenic pooling**

Classification

Anemias may also be classified on the basis of red cell size and then further subdivided according RBC morphology.

Classification

classification anemias are subdivided microcytic,normoytic, macrocytic

MICROCYTIC ANEMIAS

Iron deficiency

Thalassemia syndromes

Sideroblastic anemias

congenital hemolytic anemias with unstablehemoglobin(EE,CC)

lead poisoning

MACROCYTIC ANEMIAS

megaloblastic bone marrow

a. Vitamin B$_{12}$ deficiency

b. Folic acid deficiency

MACROCYTIC ANEMIAS

Non megaloblastic bone marrow

a.Aplastic anemia

b. Diamond-Blackfan syndrom

c. Hypothyroidism

d. Liver disease

f. Dyserythropoietic anemias

NORMOCYTIC ANEMIA

Congenital hemolytic anemia (Hemoglobin, enzyme , membrane)

Acquiredhemolyticanemia(Antibodymediated,Microangiopathic)

Acute blood loss

Splenic pooling

Infection

Connective tissue disorder

Bone marrow infiltration

Aplastic anemia

Evaluation

The first step in diagnosis of anemia is to establish whether the abnormality is isolated to a single cell line (red blood cells only) or whether it is part of a multiple cell line abnormality

Abnormalities of other lines

١-bone marrow involvement

٢-an immunologic disorder

٣-sequestration(hypersplenism)

Usual initial studies

-Hemoglobin and hematocrit determination

-Erythrocyte count and red cell indices, including MCV and RDW

-Reticulocyte count

-Study of peripheral blood smear(PBS)

Mean corpuscular volume (MCV)

Average volume of red cells

Mean corpuscular volume (MCV)

HCT/RBC

Mean corpuscular hemoglobin (MCH)

The test used to determine the quantity of hemoglobin in the blood .This test is used to determine the average amount of hemoglobin per red blood cell in the body.

Mean corpuscular hemoglobin (MCH)

Hb/RBC

mean corpuscular hemoglobin concentration (MCHC)

Hb/Hct (a measure of cellular hydration status)
Hemoglobin concentration

Red Cell Distribution width (RDW)

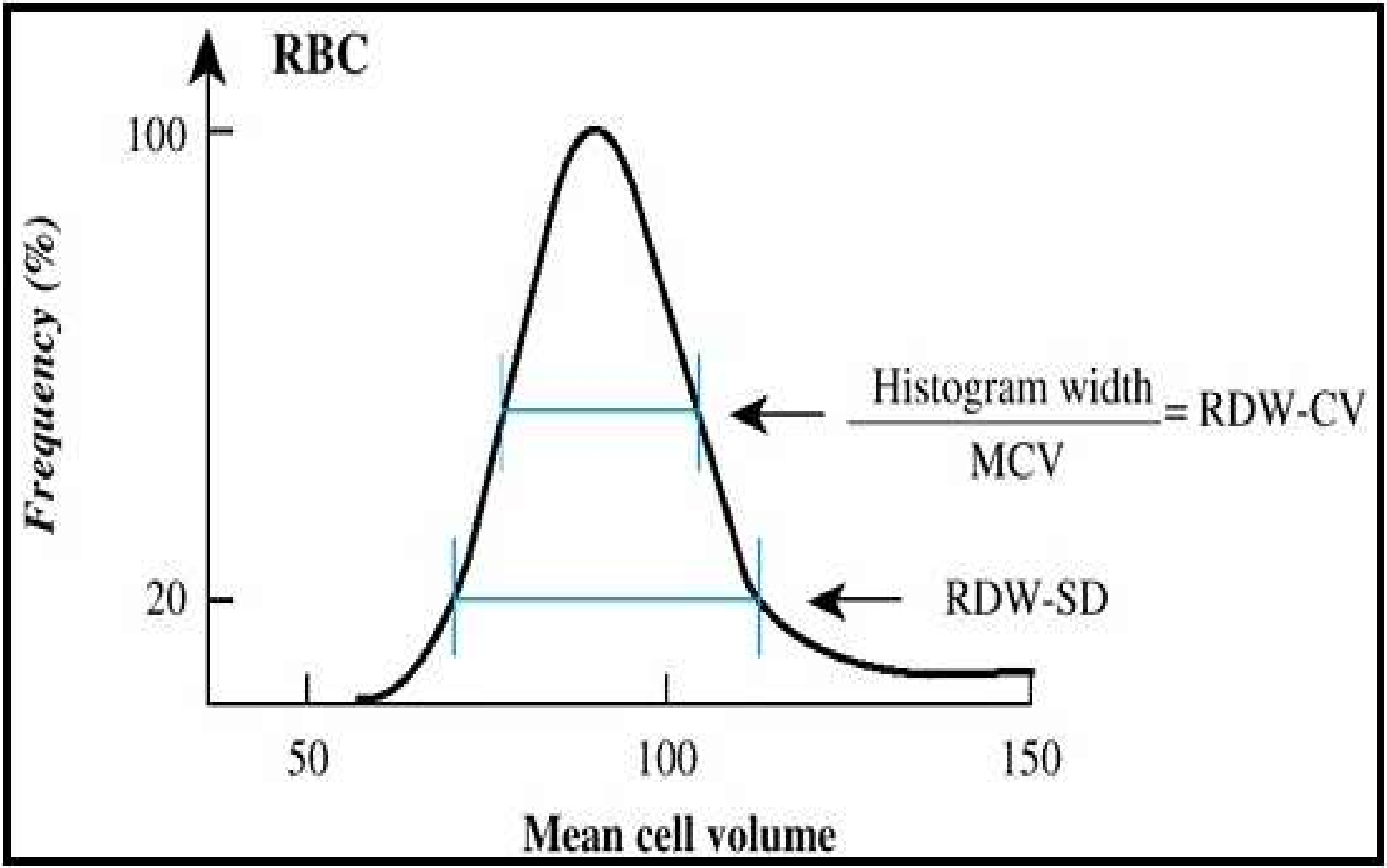
RDW =SD/MCV x ١٠٠. The RDW is an index of the variation in red cell size and thus can be used to detect anisocytosis.

Red Cell Distribution width (RDW)

The RDW-SD is an actual measure of size. It is derived by finding the width in fluid Liters at the ٢٠% height of the distribution histogram.

Red Cell Distribution width (RDW)

The RDW-CV is determined by taking the standard deviation of RDW-SD and the mean corpuscular volume (MCV) number.


RBC
100
20
Frequency (%)
Histogram width
MCV
= RDW-CV
RDW-SD
50
100
150
Mean cell volume

MICROCYTIC ANEMIAS

Iron deficiency
Thalassemia syndromes
Chronic lead poisoning
Sideroblastic anemias
Chronic inflammation
Some congenital hemolytic anemias with unstable hemoglobin

MCV Low RDW Normal

Heterozygous thalassemia

Chronic disease

MCV Low RDW High

Iron deficiency

Differentiation of Thalassemia from IDA

MCV/RBC <١٣
>١٣

(MCV) ٢ x MCH <١٥٣٠
>١٥٣٠

MCV - RBC -(٥ x Hb) - ٨٫٤ Negative
Positive

Suspected iron deficiency

Serum ferritin levels

Suspected Thalassemia

Hemoglobin electrophoresis

MACROCYTIC ANEMIA

megaloblastic bone marrow

a. Vitamin B_{12} deficiency

b. Folic acid deficiency

MACROCYTIC ANEMIA

Non megaloblastic bone marrow

a.Aplastic anemia

b. Diamond-Blackfan syndrom

c. Hypothyroidism

d. Liver disease

f. Dyserythropoietic anemias

MCV High RDW Normal

a.Aplastic anemia

b. Diamond-Blackfan syndrom

c. Hypothyroidism

d. Liver disease

f. Dyserythropoietic anemias

MCV High RDW High

Folate deficiency

Vitamin B_{12} deficiency

Suspected vitamin B١٢ or folic acid deficiency

Bone marrow

Serum vitamin B١٢ level

Serum folate level

Normocytic

High Retic

Low or Normal Retic

Normocytic(High Retic)

Acute blood loss
Hemolysis

Normocytic(High Retic)

Acute blood loss(Normal Bil,LDH)
Hemolysis(High Bil,LDH)

Suspected hemolytic anemia

Blood smear (schistocytes, spherocytes, target cells)

Serum bilirubin level

Urinary urobilinogen, Hemoglobinuria

Intravascular Hemolysis

Hemoglobin defects
Membrane defects
Enzymes defect

Evidence of corpuscular hemolyticanemia(Hemoglobn defects)

Blood smear: sickle cells, target cells

Sickling test

Hemoglobin electrophoresis

Evidence of corpuscular hemolyticanemia(Membrane defects)

Blood smear: spherocytes, ovalocytes, pyknocytes, stomatocytes

Osmotic fragility test (fresh and incubated)

Autohemolysis test

Evidence of corpuscuslar hemolytic anemia (Enzymes defect)

Heinz-body preparation

Specific enzyme assay

PBS(Blistercells,Schistocytes,Bite Cell)

Markers of Intravascular Hemolysis

١. Increased unconjugated bilirubin
٢. Increased lactic acid dehydrogenase
٣. Hemoglobinuria

Extravascular Hemolysis

Immune
Nonimmune

Immune

Idiopathic(WarmAb,Coldantibody)
Secondary(Infection,Drugs,Tumors, Immunologic disorders)

Nonimmune

Microangiopathic hemolytic anemia(TTP,HUS, burns, march Hemoglobinuria)

Miscellaneous: Wilson disease, osteopetrosis, hypersplenismia:

Markers of Extravascular Hemolysis

١. Increased unconjugated bilirubin
٢. Increased lactic acid dehydrogenase
٣. Increased urinary urobilinogen

Evidence of type of extracorpuscular hemolytic anemia

Direct antiglobulin test: IgG (gamma), C٣ (complement)

ANA,Anti ds,RF, Viral serology

Normocytic(Low Retic)

Infection
Connective tissue disorder
Bone marrow infiltration
Hypersplenism
Aplastic anemia

Normocytic(Low Retic) (Low PLT,WBC)

-Bone marrow depression(Malignant, nonMalignant)

-Aplastic anemia(Congenital,Acquired)

Normocytic(Low Retic) (Normal PLT,WBC)

-Pure red cell aplasia

-Transient erythroblastopenia of childhood (TEC)

-Infection

Normocytic(Low Retic) (HighWBC)

Infection

Suspected aplastic anemia or leukemia

Bone marrow (aspiration and biopsy)
immunologic markers
chromosome analysis
Viral serology