Notes

15

INTRODUCTION TO ANEMIA

15.1 INTRODUCTION

Anemia is a state of decreased red cell mass of blood leading to decreased oxygen carrying capacity of body. Red cell indices are useful in classifying anemia. Anemias are classified etiologically and morphologically. In this chapter we will discuss about red cell indices and also about classification of anemia.

OBJECTIVES

After reading this lesson, you will be able to:

- define anemia
- explain red cell indices
- describe Normal red cell parameters
- classify anemia

15.2 DEFINITION

Anemia is defined as the state in which the red cell mass of blood is decreased below the normal level for the age and sex of the patient. As a result of this the oxygen carrying capacity of blood is decreased. It is characterized by a decrease in hemoglobin, packed red cell volume (PCV) and red blood cell (RBC) count.

15.3 RED CELL INDICES

Red cell indices play a vital role in classification of anemia. In well equipped laboratories, these parameters are provided by the automated analyzers. Manual

counting of cells and further calculation of the indices based on them is not accurate and is obsolete. The important red cell indices are as follows:

15.3.1 Mean Corpuscular Volume or MCV

MCV is defined as the volume of the average red blood cell expressed in femtoliters.

It is calculated by the formula:

MCV (fL) = PCV (L/L) ÷ RBC (x 10^{12}/L)

The normal MCV for men and women is 92 ± 9 fL

In electronic counters the MCV is determined by pulse height analysis.

15.3.2 Mean Corpuscular Haemoglobin or MCH

MCH is the average mass of hemoglobin per red cell expressed in picograms. It is calculated by the formula:

MCH (pg) = Hb (g/L) ÷ RBC (x 10^{12}/L)

The normal MCH for men and women is 29.5 ± 2.5 pg

In electronic counters the MCH is a derived value based on the hemoglobin and the RBC count.

15.3.3 Mean Corpuscular Haemoglobin Concentration or MCHC

MCHC is the measure of the concentration of hemoglobin in a given volume of packed red cells and is expressed as g/L

MCHC (g/L) = Hb (g/L) ÷ PCV (L/L) ×1000

The normal MCHC for men and women is 330 ± 15 g/L

In electronic counters this is a derived value from Hb and PCV (or MCV and RBC).

15.3.4 Red Cell Distribution Width or RDW

The RDW is a measure of variation of red cell size or anisocytosis. In electronic counters it is derived from the pulse height analysis and can be expressed either as a coefficient of variation (CV) (%) of the RBC volume or as the standard deviation (in fL).

The normal RDW as coefficient of variation (CV) is 12.8 ± 1.2 % and as standard deviation SD is 42.5 ± 3.5 fl.

The normal red cell parameters are given in Table 1

Table 15.1: The normal red cell parameters

	PARAMETER						
	Hb (g/dL)	PCV (L/L)	RBC ($x10^{12}$/L)	MCV (fL)	MCH (pg)	MCHC (g/L)	RDW (%)
Male	14.5±1.5	0.45±0.05	5±0.5	87±5	29±2	330±15	12.8±1.2
Female	13.5±1.5	0.41±0.05	4.5±0.5	87±5	29±2	330±15	12.8±1.2
Neonate	18.0±4.0	0.6±0.15	6±1.0	100±5	34±3	330±40	12.8±1.2
Child	12.5±1.5	0.35±0.05	4.6±0.6	85±5	27±3	330±15	12.8±1.2

Table 1 – Hb – haemoglobin, PCV – packed cell volume, RBC – red blood cell, MCV – mean corpuscular volume, MCH – mean corpuscular hemoglobin. MCHC – mean corpuscular hemoglobin concentration, RDW – red cell distribution width, fL – femtoliter, pg – picogram.

15.4 CLASSIFICATION OF ANEMIA

15.4.1 Based on Morphology of Red Cells and the Red Cell indices

15.4.1.1 Normocytic Normochromic Anemia

There is a decrease in hemoglobin, PCV and RBC count.

The MCV, MCH, MCHC and RDW are normal

The blood film shows decreased RBCs which appear normal in size and colour

Examples are anemia due to acute blood loss, hemodilution, decreased erythropoietin secretion and anemia associated with impaired marrow response.

15.4.2 Microcytic Hypochromic Anemia

There is decrease in hemoglobin, PCV and RBC count

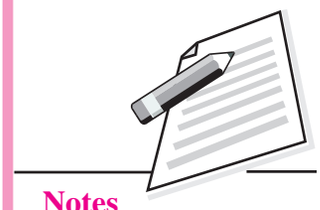
The MCV, MCH and MCHC are decreased. RDW may or may not be increased

The blood film shows small RBCs (microcytes) with increase in central pallor (hypochromic).

Examples are iron deficiency anemia, anemia of chronic disorders, disorders of globin synthesis (beta thalassemia minor), sideroblastic anemia and lead intoxication.

15.4.3 Macrocytic Anemia

There is decrease in hemoglobin, PCV and the RBC count.



The MCV and MCH are increased, MCHC is normal and the RDW is increased.

The blood film shows large number of macrocytes which are well hemoglobinised.

Macrocytic anemia is further divided into megaloblastic and nonmegaloblastic anemia.

Examples of megaloblastic anemia are folic acid or vitamin B12 deficiency, inherited disorders of DNA synthesis and drug induced disorders of DNA synthesis.

Nonmegaloblastic anemia can be due to hypothyroidism, liver disease, alcoholism and aplastic anemia.

15.4.5 Etiological Classification Based on the Cause of Anemia

15.4.5.1 Deficiency of building materials essential for the production of blood

(a) Iron deficiency anemia – red cells are unable to make normal amount of hemoglobin

(b) Vitamin B12 and folic acid deficiency –results in abnormal DNA synthesis leading to megaloblastic anemia.

(c) Anemia of protein calorie malnutrition – red cells are unable to make globin chains

15.4.5.2 Disease of the bone marrow interfering with normal haematopoiesis

(a) Aplastic and hypoplastic anemia

(b) Leukemia/lymphoma – abnormal proliferating cells infiltrating marrow

(c) Fibrosis of the marrow – primary or secondary

(d) Inflammatory conditions – tuberculosis, granuloma formation

15.4.5.3 Excessive blood loss

(a) Acute blood loss – accidents, trauma, surgery, hematemesis

(b) Chronic blood loss – gastrointestinal bleeding due to ulcers, cancer, piles, hookworm infestation, genitourinary due to repeated pregnancies, excessive periods.

15.4.5.4 Increased red cell destruction – Haemolytic anemias

These may be due to:

A. Defects inside the RBC (Intra corpuscular defects)

(a) Red cell membrane defects - example Hereditary spherocytosis, elliptocytosis

(b) Abnormalties of hemoglobin synthesis

1. Decreased globin synthesis – quantitative defect (Example Thalassemias)
2. Abnormal globin synthesis – qualitative defects (Example Sickle cell anemia)

(c) Abnormalities of red cell enzymes – G6PD deficiency

B. Defects outside the RBC (Extra corpuscular defects)

(a) Immune haemolytic anemias- alloimmune, auto immune, drug induced

(b) Parasites – eg malaria

(c) Bacterial – eg Clostridia

(d) Venoms – eg snake venoms

(e) Red cell fragmentation seen in disseminated intravascular coagulation, haemolytic uremic syndrome, march haemoglobinuria, prosthetic heart valves etc.

(f) Drug induced

INTEXT QUESTION 15.1

1. Define Anemia
2. Classify anemia according to the morphology of red cells.

   (a) ..... (b) .....

   (c) .....
3. Name the four red cell indices used to classify anemias and give their normal values.

   (a) ..... (b) .....

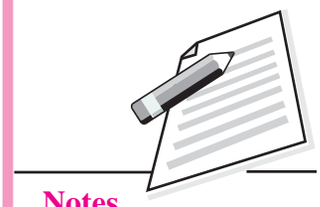
   (c) ..... (d) .....
4. Given the following red cell parameters describe the type of anemia and give one example.

   (a) Hb 10.0g/dl, PCV 32%, RBC 4.5×10^{12}/L, MCV 71fL, MCH 22.2pg, MCHC31.2%, RDW 19%.

   Type of anemia ..... Example .....

   (b) Hb 7.5g.dl, PCV 25%, RBC 2.2×10^{12}/L, MCV 114fL,MCH 34pg. MCHC 30%, RDW 26%

   Type of anemia ..... Example .....



(c) Hb 10g/dl PCV 29% RBC 5.5 × 10^{12}/L MCV 69fL MCH 20pg MCHC 31%, RDW 13%

Type of anemia ..... Example .....

WHAT HAVE YOU LEARNT

- Anemia is a state of decreased red cell mass leading to decreased oxygen carrying capacity of body.
- Red cell indices play a vital role in classification of anemia
- Red cell indices are
  - MCV – Mean Corpuscular Volume
  - MCH – Mean Corpusculat Hemoglobin
  - MCHC – Mean Corpuscular Hemoglobin Concentration
  - RDW – Red Cell Distribution Width which are useful in classifying anemia.
- MCV is defined as the volume of the average red blood cell expressed in femtoliters.
- MCH is the mass of hemoglobin red cells expressed in pictograms.
- MCHC is the measure of the concentration of hemoglobin in a given volume of PRC expressed as g/L.
- The RDW is a measure of variation of red cell size or anisocytosis.
- Morphologically Anemias are classified as
  - Normocytic Normochromic Anemia
  - Microcytic Hypochromic Anemia
  - Macrocytic Anemia
- Etiologically Anemias are classified as
  - Deficiency of building materials essential for the production of blood like Iron deficiency anemia, Vitamin B12 and folic acid deficiency, Anemia of protein calorie malnutrition.
  - Disease of the bone marrow interfering with normal haematopoiesis like Aplastic and hypoplastic anemia, Leukemia/lymphoma, Fibrosis of the marrow, Inflammatory conditionss.

- Excessive blood loss – Haemorrhagic anemias like Acute blood loss, Chronic blood loss.
- Increased red cell destruction – Haemolytic anemias like Defects inside the RBC (Intra corpuscular defects) Defects outside the RBC (Extra corpuscular defects).

TERMINAL QUESTIONS

1. List the Red Cell Indices with their normal values
2. Classify anemias Morphologically
3. Classify anemia etiologically with examples

ANSWERS TO INTEXT QUESTIONS

15.1

1. Anemia is defined as the state in which the hemoglobin in blood is decreased below the normal level for the age and sex of the patient
2. (a) Normochromic Normocytic anemia
   (b) Hypochromic Microcytic anemia
   (c) Normochromic Macrocytic anemia
3. (a) Mean Corpuscular Volume, 82 – 92 fL
   (b) Mean corpusculat Hemoglobin, 27 – 32 pg
   (c) Mean Corpuscular Hemoglobin concentration, 32 – 36%
   (d) Red cell distribution Width, 11 – 13.5%
4. (a) Normochromic Microcytic Anemia, Anemia of chronic infection
   (b) Normochromic Microcytic Anemia, Megaloblastic Anemia
   (c) Normochromic Microcytic Anemia, Anemia of chronic infection