Complete Blood Count

- Red Blood Cell Tests -

Hematocrit Determination

The hematocrit (HCT), also referred to as Packed Cell Volume (PCV), is the percentage of blood volume that occupied by red cells (the ratio of red blood cells to the whole blood volume). It depends on the number and size of red blood cells. Hematocrit is often performed as part of a complete blood count, it is a screening test for anemia or polycythemia, and one of primary determinants of blood viscosity. The hematocrit is usually expressed either as a percentage or as a decimal fraction.

Principle:

The principle of hematocrit test is a measurement of the volume ratio that occupied by the red blood cells to the volume of the whole blood after centrifugation.

Procedure:

1. Blood samples should be fresh as possible. By using a heparin capillary tube, allow blood to enter the tube by capillary action for 2/3 of their total length.

2. Seal the empty end by pushing into modeling clay.

3. Place the tube into microhematocrit centrifuge, with the sealed end in the away from the center (pointed toward the outside), for 5 min at 12000 g.

4. Read the PCV in the microhematocrit reader. The beginning of blood from the sealed end applied to the zero, and the final limit of plasma applied to 100. The limit between packed cells and Buffy coat represent the PCV in percentage (%).

Reference value:

Newborn: 50-65%

Children: 32-42%

Adult male: 42-52%

Adult female: 36-46%

Variations:

A. Physiological Variations:

1. The normal value of HCT varies with age and gender, the normal value for infants is higher *(because the newborn has an increased red cell mass and many macrocytic red cells)*. HCT value in females is usually slightly lower than male *(because the red cell count less than male)*.

2. In the period of pregnancy the hematocrit is decreased *(there is a hemodilution because the plasma volume increases)*.

3. The people who live at high altitude have increased values of the hematocrit *(as result of increased erythrocyte number)*.

4. Dehydration produces a falsely high hematocrit that returns to normal when proper fluid balance is restored.

B. Pathological Variations:

1. The hematocrit increases in polycythemia *(increased number of erythrocytes)*.

2. Patients with anemia have decreased hematocrit *because of the decreased red blood cell number*.

3. The hematocrit increases in the period of shock *(The water and micromolecules pass from the blood into the interstitial fluid because of the hyper permeability of the capillaries)*.

4. After bleeding the hematocrit decreases, *result hemodilution because the passage of water and micromolecules from the interstitium into the blood capillaries*.

5. When red cells have irregular shapes such as macrocytic, spherocytosis, thalassemia, and sickle cell, the trapped plasma *(amount of intracellular plasma remaining in the packed cell column after centrifugation)* may be increased enough to cause a significant change in the hematocrit.

6. Chemotherapy drugs decrease hematocrit, abuse of erythropoietin drug elevate hematocrit.

If a hemoglobin result is available and sample have normal erythrocytes, can use the Rule of Three to ensure the accuracy of result.

Rule of Three is (RBC X 3 = Hb) , (Hb X 3 = HCT ± 3)

If the result of this calculation and the hematocrit are NOT within ± 3, further action is taken (repeating the testing, examine the slide for red cell morphology abnormalities, and patient condition investigation).

 Red Blood Cell Indices

Red blood cell indices are blood calculated parameters that provide information about the red blood cell size, hemoglobin content of red blood cells.

These parameters are calculated from total red cell count, hematocrit, and hemoglobin concentration. Abnormal values of these parameters indicate the presence of anemia and type of it.

1) Mean Cell (Corpuscular) Volume (MCV)

Is the average volume of a red blood cell expressed in femtolitres (fl) (*1fl=1x10-15 L*). This parameter is useful to classifying anemia into Microcytic, Normocytic, and Macrocytic.

Calculation Formula:

MCV = HCT% RBC count in million X 10

Normal Range: (80 - 100 fl)

 If results are less than (80 fl), the red cells are called **Microcytic**.

 MCV value is within the normal range **Normocytic**.

 If results are higher than **(**100 fl), the red cells are called **Macrocytic**.

Mean Cell (Corpuscular) Hemoglobin (MCH)

Is the average amount of hemoglobin per red blood cell, expressed in pictograms (pg) (*1pg=1x10-12 g*).

Calculation Formula:

MCH = Hb (g/dl) RBC Count in million X 10

Normal Range: (27 - 31 pg)

 Macrocytic red cells have higher MCH, because they are larger and contain more hemoglobin.

 Microcytic red cells have lower MCH, because they are smaller and contain less hemoglobin.

3) Mean Cell Hemoglobin Concentration (MCHC)

Is the average concentration of hemoglobin per red blood cell, in other words, what percentage of the RBC is hemoglobin; expressed as g/dl or percentage. MCHC is a useful guide to the degree of hypochromia.

Calculation Formula:

MCHC = Hb (g/dl) HCT % X 100

Normal range: (32 - 36 g/dl (%))

 If MCHC is within normal range, red cells are called **normochromic**.

 If MCHC is less than normal, red cells are called **hypochromic,** which is seen in microcytic hypochromic anemia such as iron deficiency anemia.

 MCHC is never exceed 36% because RBCs can't accommodate more than (36 g/dl) of hemoglobin, which is seen in cases associated with spherocytosis. Macrocytic anemia has normal MCHC.

 Since red blood cell indices are used to help diagnose the cause and type of anemia, these results for diagnosed anemiac (decrease RBCs & Hb) indicate for:

 Low MCV: *Microcytic anemia (may be due to low iron levels, lead poisoning, or thalassemia)*

 Normal MCV: *Normocytic anemia (may be due to sudden blood loss, kidney failure, or aplastic anemia)*

High MCV: *Macrocytic anemia (due to low folate or B12 levels, or chemotherapy)*

 Low MCH: *Hypochromic anemia (often due to low iron levels)*

 Normal MCH: *Normochromic anemia (may be due to sudden blood loss, long-term diseases, kidney failure, or aplastic anemia)*

 High MCH: *Hyperchromic anemia (due to low folate or B12 levels, or chemotherapy)*