University of Diyala/ College of Medicine
Department of Physiology
Physiology Lab

Determination of Packed Cell Volume (PCV) OR Hematocrit (Hct) Value

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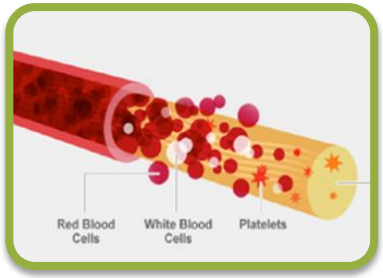
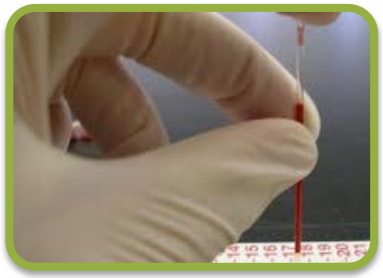
Outlines

- Introduction
- Objectives of PCV Experiment
- Methods and Procedure
- Observations and Reading PCV Value
- Some Clinical Implications

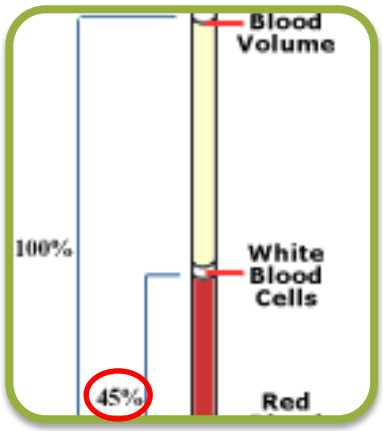
Introduction



Blood consists of a ***liquid plasma portion*** and a ***solid cellular portion***. The solid portion is comprised of red blood cells (RBCs), white blood cells (WBCs), and platelets.

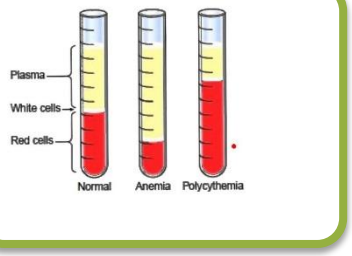


PCV or Hct is defined as the volume of RBCs per unit volume of the whole blood.

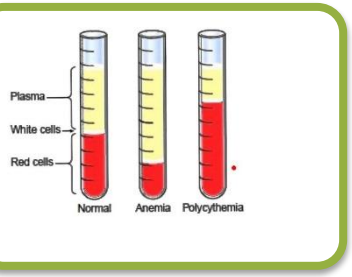


The ***PCV*** is a mathematical expression of the number of RBCs, or packed cell volume, expressed as a percentage of whole blood. ***For example***, a packed cell volume of 45% means that a 100-mL sample of blood contains 45 mL of packed RBCs, which would reflect an acceptable level of RBCs for a patient of any given age.

Introduction



A decrease in the number or size of red cells also decreases the amount of space they occupy, resulting in a lower PCV.



An increase in the number or size of red cells increases the amount of space they occupy, resulting in a higher PCV.

Measurement of packed cell volume (PCV) is the ***most accurate*** and ***simplest of all tests*** in clinical hematology for detecting the presence and degree of anemia or polycythemia. In comparison, ***hemoglobin*** estimation is ***less accurate***, and ***RBCs*** count is ***far less accurate.***

Introduction

- PCV depends primarily on the ***number of RBCs***, however the ***average size of the RBCs*** influences the PCV. Conditions that cause RBC size to be increased (e.g. swelling of the RBC due to change in osmotic pressure related to elevated sodium levels) may increase the PCV while conditions that result in smaller than normal RBCs (e.g. microcytosis related to iron deficiency anemia) decrease the PCV.
- In general, high PCV indicates either increase in the number of RBCs or decrease in plasma volume as seen in cholera. On another hand, a low PCV indicates either decrease in RBCs number or increase in plasma volume.
- **The normal values of PCV vary according to the age and sex of the individuals. The normal ranges are:**

- *Males:* 40 %–54 %
- *Females:* 37 %–47 %
- *Newborns: 53-65 %*

- **Critical value of PCV** = <15 % or >60 %.

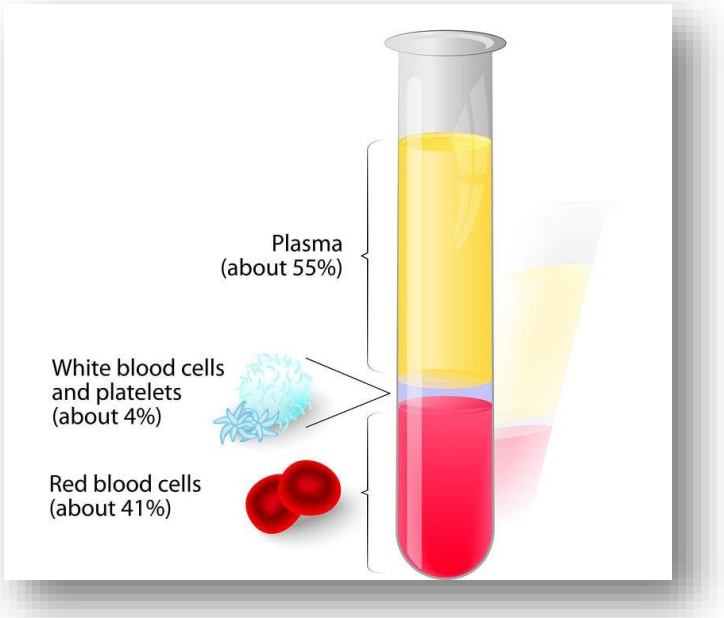
Purposes of RBC Count Experiment

1. To know : what is PCV, methods for determination PCV value, and clinical importance of PCV.
2. To determine the volume or the amount of RBCs in 100 *ml* of blood.
3. To assess whether there is a sufficient number of circulating RBCs to transport the required amount of oxygen throughout the body.

Principle of PCV

- ***Hematocrit*** is derived from Greek words ‘Haima’ meaning “blood” ,‘krites’ meaning “to separate”. Together “***Hematocrit”*** means ‘***to separate blood***’ where blood cells and plasma are separated by centrifugation.

- When a known volume of blood is centrifuged, the ***cells*** being heavier, settle down leaving a clear column of ***plasma*** above.



Methods

Microhematocrit Method

- Requires less blood and less time to get the value of PCV (commonly used). **It is the method that we are going to use in today lab.**

Macrohematocrit Method

- Also known as a Wintrobe method.
- Time consuming, requires large amount of blood, and has a higher degree of plasma trapping.

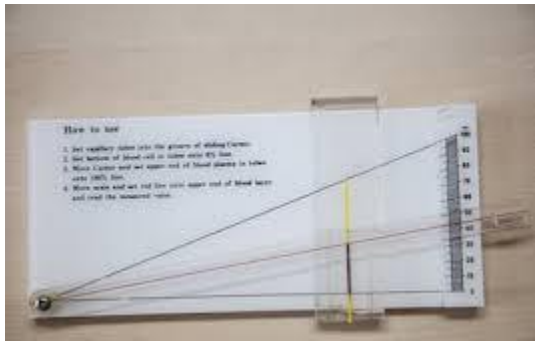
Automated Method

- Automated hematology Analyzer.

Materials and Instruments

1. Microhematocrit tube (capillary tube) which is 75 mm in length and 1 mm in diameter . It contains heparin and shows a red ring at one end of the tube.
2. Microhematocrit centrifuge device.
3. Plastic seal to seal one end of the capillary tube.
4. Microhematocrit reader.
5. Lancet, Alcohol 70%, and Cotton.

Microhematocrit tube



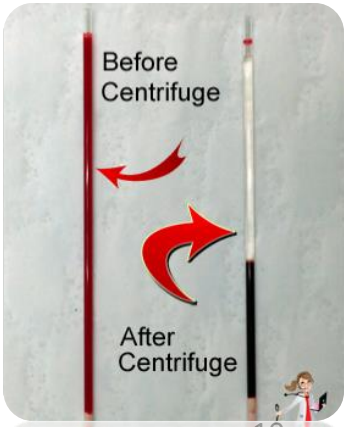
Microhematocrit reader

Microhematocrit centrifuge

Procedure and Observations

- Clean your finger with 70% alcohol and let it dry.
- Blood is drawn into the tube by capillary phenomenon. By holding the tube in a horizontal manner and allow 2/3 to 3/4 of the tube to be filled with blood.
- Seal the dry end of the tube by plastic seal.
- The sealed tube then is placed in the radial grooves of the Microhematocrit centrifuge for 5 min at 11000 R.P. m.
- Balance the tubes in the centrifuge with the clay ends facing the outside away from the center(place the tubes opposite each other in the centrifuge). Looking at a centrifuged hematocrit tube, you will see three distinct layers:

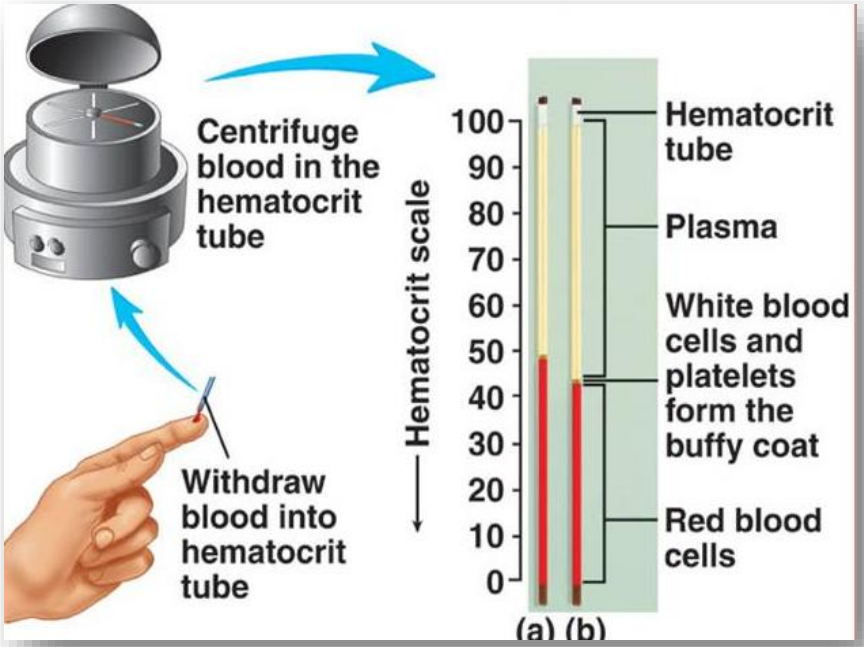
- ***A tall upper layer of clear plasma*** - slightly yellow-colored. It should not be pink or red which would indicate hemolysis of red cells in the sample or within the body in hemolytic diseases.
- ***A greyish-white (buffy layer)*** thin layer (about 1 mm) in thickness consisting of platelets and WBCs.
- ***A tall bottom layer of RBCs*** which have been closely packed together



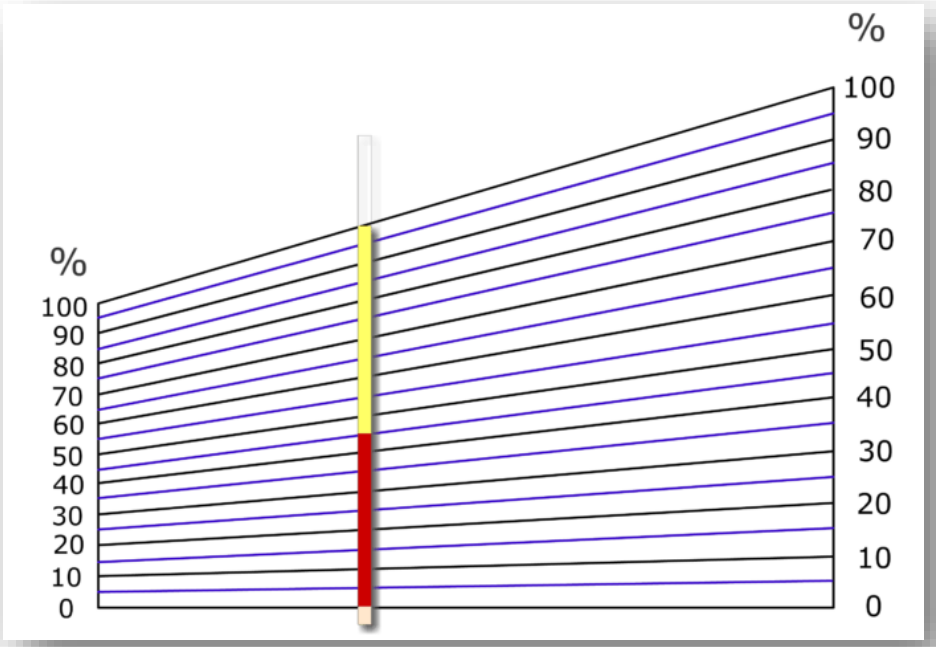
- Using the hematocrit reader (ruler), read the PCV (Htc) value.

Reading PCV Value

- The capillary tube should be parallel to graduation and lower level of RBCs on zero line of the scale and the upper level of the scale and the upper level of the clear plasma on 100 % line). Do not include the buffy coat (WBCs and platelets) when reading PCV value.



Procedure of PCV experiment



Reading of PCV value

Sources of Errors

- Improper sealing of the capillary tube.
- Time and speed of centrifugation.
- The buffy coat of the specimen should not be included in the PCV reading, because its inclusion would falsely elevate the result.
- A decrease or increase in the readings may be seen if the micro-hematocrit reader is not used properly.
- The microhematocrit centrifuge should never be forced to stop by applying pressure to the metal cover plate. This will cause the RBC layer to “sling” forward and results in a falsely elevated value.

Some Factors that affect Hct (PCV)

1. Abnormalities of RBCs morphology will affect Hct.
2. Raised values of WBC will alter the Hct.
3. People from high altitude have increased Hct.
4. Chloramphenicol and Penicillin decrease the value.
5. Pregnant women have low values due to hemodilution.
6. Dehydration and hemodilution will affect the Hct.
7. After the hemorrhage values are not reliable.

Clinical Implications

PCV increases in polycythemia and this could be either:

Physiological

- High Altitude and extreme physical exercise or excitement.

Pathological

- Polycythemia Vera, Dehydration leading to Hemoconcentration e.g. diarrhea, burns, and vomiting, Congenital heart failure , and Severe chronic obstructive pulmonary disease (COPD).

Clinical Implications

PCV decreases in :

- ✓ Anemia.
- ✓ Hemoglobinopathies.
- ✓ Cirrhosis.
- ✓ Hemorrhage.
- ✓ Bone marrow failure
- ✓ Renal diseases.
- ✓ Normal pregnancy.
- ✓ Autoimmune diseases.
- ✓ Malignancies like lymphoma, leukemia, multiple myeloma, and Hodgkin's diseases.

Advantages Versus Disadvantages of Microhematocrit Method

Advantages	Disadvantages
✓ Small sample volume ✓ Relatively fast analysis ✓ Hemolysis detected when result is read ✓ No dilution needed	✓ Careful preparation required (sealing of capillaries, etc) ✓ Leakage of sealing gives falsely low results (more RBCs will be lost than plasma). ✓ In blood with abnormally sized or shaped RBCs, more plasma will be trapped, causing a higher positive bias of Hct. ✓ Clots will lead to false packing of the cells, giving falsely high Hct.


Bloody Fun Facts
Approximately 32,000 pints of blood are used each day in the United States.
4.5 million Americans would die each year without life saving blood transfusions.
The average adult has 10 pints of blood in his or her body.
One pint of donated blood can help save as many as three people's lives.
There are about one billion red blood cells in two to three drops of blood.
Blood makes up about 7% of your body's weight.
A newborn baby has about one cup of blood in his or her body.
60% of the US population is eligible to donate only 5% do on a yearly basis
Blood centers often run short of type O and B blood
There are four main blood types: A, B, AB and O. AB is the universal recipient and O negative is the universal donor.
In the days following the September 11 attacks, a half a million people donated blood.
Blood donation takes four steps: medical history, quick physical, donation, and snacks
If you began donating blood at age 17 and donated every 56 days until you reached 76, you would have donated 48 gallons of blood.
Fact from: Blood Center of the Pacific