

Complete Blood Count (CBC) Basics

The three of most commonly ordered lab tests are:

- CBC (Complete Blood Count) with or without a differential,
- BMP (Basic Metabolic Panel),
- CMP (Comprehensive Metabolic Panel).

In this article, we shall cover the basics of complete blood count and what elements are taken into consideration by the test.

Complete blood count – With or without differential

Peripheral venous blood is collected in a lavender tube that contains the anticoagulant EDTA and should be thoroughly mixed. A specimen which has clotted or greater than 48 hours old from the time of collection is regarded as an Unacceptable specimen:

The methodology of testing:

Testing for complete blood count requires a whole blood analyzer. This test is always available at any time in most hospitals 7 days/week.

What is measured?

• Red blood cell data

- Total red blood cell count (RBC),
- Hemoglobin (Hgb),
- Hematocrit (Hct),
- Mean corpuscular volume (MCV),
- Red blood cell distribution width (RDW),

• White blood cell data

- Total white blood cell (leukocyte) count (WBC),
- A white blood cell count differential may also be ordered.

• Platelet Count (PLT)

Total Red Blood Cell Count.

- Count of the number of circulating red blood cells in 1 mm cubic of peripheral venous blood.

To start our discussion lets look at each component.

Hemoglobin

The hemoglobin concentration is a measure of the amount of hemoglobin in the peripheral blood, which reflects the number of red blood cells in the blood. It is to be remembered that hemoglobin constitutes over 90% of the red blood cells.

- A decrease in hemoglobin concentration indicates anemia.
- An increase in hemoglobin concentration indicates [polycythemia](#).

Hematocrit

Hematocrit is a measure of the percentage of the total blood volume that is made up of the red blood cells. The hematocrit can be determined directly by centrifugation ("spun hematocrit"). The height of the red blood cell column is measured and compared to the column of the whole blood.

This image above shows how a centrifuged blood looks like.

Normal Hct in adult males 40-54%.

Normal Hct in adult females 34-51%.

In anemia – there is a low percentage of RBCs (low hematocrit).

How do you calculate the Hematocrit?

More commonly the Hct is calculated directly from the RBC and MCV

$$\text{Hematocrit \%} = \text{RBC (cells/liter)} \times \text{MCV (liter/cell)}$$

Because the Hct is a derived value, errors in the RBC or MCV determination will lead to spurious results.

Mean Corpuscular Volume

The MCV is a measure of the average volume, or size, of an RBC. It is determined by the distribution of the red blood cell histogram. The mean of the red blood cell distribution histogram is the MCV.

What are the uses of MCV Result?

- The MCV is important in classifying anemias.

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- **Normal MCV = normocytic anemia.**
- **Decreased MCV = microcytic anemia.**
- **Increased MCV = macrocytic anemia.**

Red Blood Cell Distribution Width.

RDW is an indication of the variation in the RBC size (referred to as [anisocytosis](#)).

It is derived from the red blood cell histogram and represents the coefficient of variation of the curve.

In general, an elevated RDW (indicating more variation in the size of RBCs) has been associated with anemias with various deficiencies, such as iron, B12, or folate.

Thalassemia is a microcytic anemia that characteristically has a normal RDW.

White Blood Cell Count

A count of the **total** WBC, or leukocyte, count in 1 mm³ of peripheral blood.

A decrease in the number of WBCs is referred to as Leukopenia.

An increase in the number of WBCs is Leukocytosis.

WBC Differential

When a differential is ordered, the percentage of each type of leukocyte present in a specimen is measured.

The types of leukocytes are:

- Neutrophils (includes bands),
- Lymphocytes,
- Monocytes,
- Eosinophils,
- Basophils.

WBC differentials are either performed manually or by an automated instrument.

Manual” WBC differential

Manual” WBC differentials are performed by trained medical technologists who count and categorize typically 100 white blood cells via microscopic examination of a [Romanowsky](#) stained peripheral blood smear

In addition to the differential count, evaluation of the smear provides the opportunity to morphologically evaluate all components of the peripheral blood, including red blood cells, white blood cells, and platelets

The manual differential allows for the detection of disorders that might otherwise be lost in a totally automated system

This applies to < 20% of specimens

The instrument is programmed with criteria to flag an operator when a manual differential should be performed

Automated Differentials

The clinical laboratory may perform an “automated differential” – Via instruments with the capability of performing differential leukocyte counts.

Usually based on the determination of different leukocyte cellular characteristics that permit separation into subtypes by using flow-cytometric techniques.

Platelet Count (PLT)

This is the count of the number of platelets (thrombocytes) per cubic milliliter of blood.

- A decreased number of platelets is known as Thrombocytopenia whereas an increased number of platelets is Thrombocytosis.

MCH and MCHC

Both MCH and MCHC are of little clinical diagnostic use in the vast majority of patients (so we are not talking about them in any detail).

MCH is the hemoglobin concentration per cell.

MCHC is the average hemoglobin concentration per total red blood cell volume.

Essentially normal CBC WBC, Hgb, Hct, MCV, RDW, PLT count values are all within the normal reference ranges

The automated differential shows normal distribution (total and percentage) of WBC components

See next slide for more explanation

Absolute numbers (#) of various cell types are calculated by multiplying the percentage (%) of the white cell by the total WBC.

Common Clinical Uses of CBC

CBC demonstrates.

- Leukocytosis,
- Microcytic anemia with elevated red cell distribution width,
- [Thrombocytopenia](#).