

## What is a Complete Blood Count (CBC) ?

by Robert Fusco, MD

Okay, you have just seen your family doctor for a checkup. As you leave the office, the nurse says the doctor wants you to have some blood tests as part of your exam. She hands you a laboratory form cryptically marked "CMP and CBC." What do these strange acronyms mean? Very simply, *the CMP blood test evaluates the many chemical compounds found in the liquid portion of your blood while the CBC evaluates the blood cells themselves.*

### Your cells need oxygen

The human body is made up of billions of small cells that are grouped together in the various specialized organs such as the lungs, heart, and liver. These cells work behind the scenes 24/7 to keep you healthy and active. Day and night, they quietly perform many functions such as growth and repair of tissues, production of heat, motion, circulation, digestion, and so forth. Individually, each small cell is much like a tiny machine that requires many things to do its job - including oxygen. The oxygen obviously comes from the air that you breathe. The problem is: How do you deliver oxygen to each and every cell?

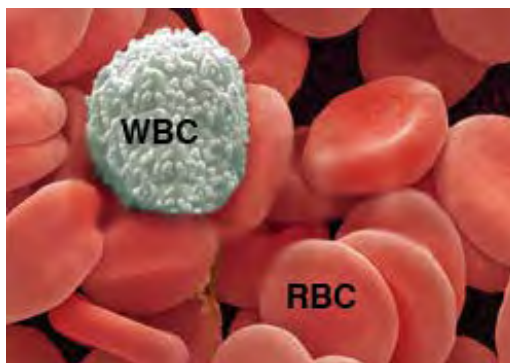
### Your bloodstream

The answer lies in your circulatory system, or bloodstream. Your bloodstream is a river of fluid, called plasma. Blood is in constant motion pulsing forward within your arteries and veins with each beat of your heart. Floating within this river are three types of living cells, each with a specific job.

CELL TYPE	ABBREV.	FUNCTION
Red Blood Cell	RBC	carries oxygen
White Blood Cell	WBC	fight infection
Platelets	PLT	clots blood

The bone marrow is the soft, spongy tissue found in the center of the large bones. All cells made in the bone marrow start out as a single kind of cell called a stem cell. Depending on what type of cell the body needs, a stem cell can become one of three major types of blood cells: a red cell, a white cell, or a cell that makes platelets. Blood cells must be mature to carry out their jobs properly. The Complete Blood Count (CBC) is a tool your doctor uses to evaluate these three types of cells in your bloodstream.

### How a CBC is measured



In the past, the components of a CBC had to be manually estimated by viewing a fresh specimen of blood on a microscope slide and counting each cell, a very tedious and time consuming process. During my Medical Internship at Duke University 40



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years ago, I spent many sleepless nights on call staring into a microscope counting the different cells in my patient's blood. Today, computerized counting machines can accurately perform a CBC test in less than a minute. CBC results provide the doctor with 11 different parameters, but when doctors evaluate the results of a patient's CBC, they usually focus on four basic measurements:

WBC = White Blood Cell Count

RBC = Red Blood Cell Count

MCV = Mean Corpuscular Volume (size of RBC's)

PLT = Platelet Count

### White Blood Cells (WBC)

White blood cells (also called leukocytes) are your body's mobile defense system against infections. Like a SWAT team, white blood cells travel in the bloodstream to areas of infection and destroy harmful bacteria. A normal WBC count is 4.8 to 10.8 thousand cells per cubic millimeter, but varies from day to day depending upon the circumstances.

The WBC count decreases temporarily when the body defends itself against a viral infection such as the common cold. A low WBC (leukopenia) is also an expected side effect of some chemotherapy medications and some drugs used to treat inflammatory bowel disease such as Imuran and Purinethol.

A high WBC count (leukocytosis) is often found when the body is attacked by more serious infections such as bacterial pneumonia or diverticulitis. It is not unusual to see values around 15,000 to 30,000 during a serious bacterial infection. As the infection responds to antibiotic treatment, the WBC count quickly returns to normal. An extreme elevation in the WBC count is seen when cancer of the blood cells develops, a serious condition called leukemia. In this instance, the WBC may be well over 100,000.

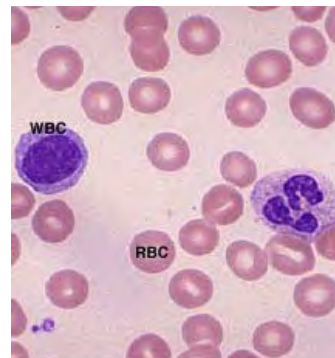
Not all WBCs are the same. In fact, there are five different types of white blood cells that together make up the total WBC count. Some are better at fighting infection while others focus on supporting the immune system. Some may be involved in allergic reactions. If the doctor orders a CBC with differential, or smear, the lab will break down the WBC count into the different types of white blood cells. This information is sometimes useful in determining the type and severity of an infection, allergic reactions, and other blood disorders.

### Red Blood Cell (RBC) level

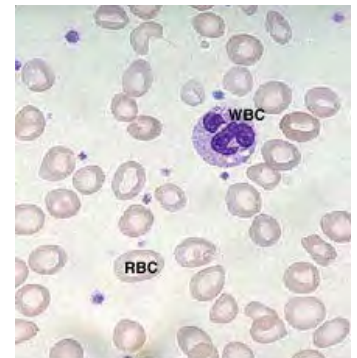
Red blood cells (also called erythrocytes) have the important job of carrying oxygen from your lungs to all the parts of your body. When you do not have enough red blood cells, you develop a condition called *anemia*. When severe, anemia can cause symptoms of weakness, fatigue, dizziness, pounding in your head, heart palpitations, and shortness of breath.

There are different types of anemia. The most common is due to iron deficiency. More common in women, iron deficiency anemia is often due to pregnancy or heavy menstrual periods. Iron deficiency anemia can also result from slow chronic blood loss from the digestive tract. Strangely, some patients with iron deficiency anemia develop a compulsive craving to eat ice, starch and even dirt. This odd craving, called pica, disappears as the iron is replenished.

Below are examples of what the blood cells look like when magnified 1000x times under a microscope. Iron makes hemoglobin, the pigment that makes your blood red and carries oxygen to all the cells in your body. Note how pale the RBCs look when the patient has low iron and iron deficiency anemia.



Normal Blood Smear

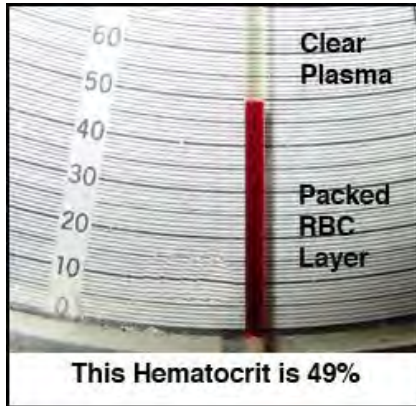


Iron Deficiency Anemia

More numerous than WBCs, red blood cells are measured in millions per cubic millimeter. A normal RBC count is 3.5 to 5. However, in clinical practice, most doctors use another RBC measurement that is often referred to as the "H & H." This acronym stands for *Hemoglobin and Hematocrit*, two other ways to monitor the amount of red blood cells in the body.

Hemoglobin is the oxygen carrying protein that gives red blood cells their red color. Hemoglobin allows red blood cells to carry fresh oxygen to the body's cells and to transport carbon dioxide waste back to the lungs where it is exhaled. Hemoglobin is measured in grams per deciliter. A normal hemoglobin is different between the sexes: 14 to 18 gms for men and 12 to 16 gms for women.

Another common measurement of red blood cells is the Hematocrit (HCT) which measures the amount of space that RBCs take up in the blood. This simple test is done by placing fresh unclotted blood in a narrow centrifuge tube, which is spun rapidly, forcing the red blood cells to the bottom of the tube and displacing the plasma to the top. The HCT is reported as a percentage of red blood cells to the total blood volume. A normal HCT is different between the sexes: 42 to 52% for men and 37 to 48% for women.



### Mean Corpuscular Volume (MCV)

Mean Corpuscular Volume is a measurement of the average size of your red blood cells. Red blood cells are three-dimensional spheres that have volume. That volume also can be measured and is reported in cubic microns. The normal MCV is around 80 to 100.

A low MCV value means that the red blood cells have shrunk somewhat and are smaller than normal. This is called microcytosis. Most often, it is seen in two circumstances - iron deficiency anemia and a hereditary anemia

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called Thalassemia. A low MCV caused by iron deficiency takes many months to develop and suggests that slow blood loss has been going on for at least several months. Thalassemia is sometimes seen in individuals with Mediterranean heritage. It can be mild or severe, but taking iron supplements won't help.



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A high MCV, or macrocytosis, may be seen in cases of severe deficiency of vitamin B12 or Folic acid. A high MCV is also seen in alcoholics as a toxic effect of alcohol in the bone marrow.

### Platelet (PLT) count

Platelets (also called thrombocytes) are the cells that help stop bleeding. When an injury occurs, free-floating platelets quickly clump together to form clotted blood to stop a hemorrhage. Platelets are made in the bone marrow and last about 8 to 10 days in the bloodstream before being replaced. Platelet counts increase during strenuous activity and in certain conditions called myeloproliferative disorders, infections, inflammation, cancers, and when the spleen has been removed. Platelet counts decrease just before menstruation. They are measured in thousands per cubic millimeter. Normal values range from 150,000 to 400,000 per millimeter.

When you don't have enough platelets, you have a condition called thrombocytopenia which may lead to easy bruising and increased bleeding from the nose or gums. Mild elevations in the platelet count called thrombocytosis, may simply be a manifestation of iron deficiency. But, when severe, thrombocytosis can lead to unwanted blood clots inside the body.

### Two examples

#### 1. Dr. Fusco's normal CBC

Every year, I have my annual physical and blood work. Here are the results of my last CBC. I am pleased to report that at age 76 my blood cells (WBCs, RBCs, and PLTs) are all still in the normal range:

Cell Type	Dr. Fusco's CBC	Normal Range
WBC	5.8	4.8 - 10.8
HBG	14.3	14 - 18 (men)
HCT	42.9	42 - 52 (men)
MCV	84	80 - 100
PLT	182,000	150,000 - 400,000

#### 2. A Patient with Crohn's disease

This is a young man in his twenties who had been sick for 4 months. He came to our Emergency Department when he developed abdominal pain and a fever that would not go away. Diagnostic tests found that he had developed Crohn's disease, an inflammatory condition of the small intestine. This led to malnutrition and anemia. At surgery, he was also found to have an infection in the abdomen that required drainage and antibiotics. Here is his CBC for comparison:

Note the high WBC count which corresponded with his bacterial infection. He was quite anemic with a low Hemoglobin and Hematocrit. The MCV was also quite low signifying that iron deficiency was the cause of his anemia and that it had been present for at least several months. Fortunately, he recovered from his surgery and is now receiving maintenance therapy for Crohn's disease and doing much better. The WBC count returned to normal as the infection cleared and a course of iron supplements corrected his iron deficiency anemia.

Cell Type	Crohns Patient's CBC	Normal Range
WBC	16.9	4.8 - 10.8
HBG	8.5	14 - 18 (men)
HCT	28	42 - 52 (men)
MCV	66	80 - 100
PLT	492,000	150,000 - 400,000

*High WBC caused by infection* (arrow pointing to WBC)

*Anemia with low MCV caused by iron deficiency* (arrow pointing to HBG, HCT, MCV)

*Elevated PLT due to iron deficiency* (arrow pointing to PLT)

### Summary

The CBC is a common inexpensive screening test that helps your doctor determine your general health status. It is also used to diagnose and monitor a variety of conditions such as infections or anemia. There are many numbers in a printed CBC, most of them computer generated and not of value in most cases.

However, the WBC, H&H, MCV, and PLT give your doctor a lot of information about your health. Normal values can vary slightly from laboratory to laboratory. The results of a CBC must be interpreted by the doctor, taking into consideration the age and sex of the patient and any symptoms that may be present. Now that you have a better understanding of the CBC, you can better discuss your results with your doctor.

