Complete blood count

Definition

A complete blood count (CBC) test measures the following:
The number of red blood cells (RBCs)
The number of white blood cells (WBCs)
The total amount of hemoglobin in the blood
The fraction of the blood composed of red blood cells (hematocrit)
The mean corpuscular volume (MCV) -- the size of the red blood cells
CBC also includes information about the red blood cells that is calculated from the other measurements:
MCH (mean corpuscular hemoglobin)
MCHC (mean corpuscular hemoglobin concentration)
The platelet count is also usually included in the CBC.

Alternative Names
Complete blood count

There is no special preparation needed. The CBC is a screening test, used to diagnose and manage numerous diseases. The results can reflect problems with fluid volume (such as dehydration) or loss of blood. It can show abnormalities in the production, life span, and rate of destruction of blood cells. It can reflect acute or chronic infection, allergies, and problems with clotting.
MCV, MCH, and MCHC values reflect the size and hemoglobin concentration of individual cells, and are useful in the diagnosis of various types of anemia.

Normal Results
RBC (varies with altitude):
Male: 4.7 to 6.1 million cells/mcL
Female: 4.2 to 5.4 million cells/mcL
WBC: 4,500 to 10,000 cells/mcL
Hematocrit (varies with altitude):
Male: 40.7 to 50.3 %
Female: 36.1 to 44.3 %
Hemoglobin (varies with altitude):  
Male: 13.8 to 17.2 gm/dL  
Female: 12.1 to 15.1 gm/dL  
MCV: 80 to 95 femtoliter  
MCH: 27 to 31 pg/cell  
MCHC: 32 to 36 gm/dL  
(cells/mcL = cells per microliter; gm/dL = grams per deciliter; pg/cell = picograms per cell)

What Abnormal Results Mean

High numbers of RBCs may indicate:
- Low oxygen tension in the blood
- Congenital heart disease
- Cor pulmonale
- Pulmonary fibrosis
- Polycythemia vera
- Dehydration (such as from severe diarrhea)
- Renal (kidney) disease with high erythropoietin production

Low numbers of RBCs may indicate:
- Blood loss
- Anemia (various types)
- Hemorrhage
- Bone marrow failure (for example, from radiation, toxin, fibrosis, tumor)
- Erythropoietin deficiency (secondary to renal disease)
- Hemolysis (RBC destruction)
- Leukemia
- Multiple myeloma
- Malnutrition (nutritional deficiencies of iron, folate, vitamin B12, or vitamin B6)

Low numbers of WBCs (leukopenia) may indicate:
- Bone marrow failure (for example, due to infection, tumor or fibrosis)
- Presence of cytotoxic substance
- Autoimmune/collagen-vascular diseases (such as lupus erythematosus)
- Disease of the liver or spleen
Radiation exposure
High numbers of WBCs (leukocytosis) may indicate:
Infectious diseases
Inflammatory disease (such as rheumatoid arthritis or allergy)
Leukemia
Severe emotional or physical stress
Tissue damage (such as burns)
Low hematocrit may indicate:
Anemia (various types)
Blood loss (hemorrhage)
Bone marrow failure (for example, due to radiation, toxin, fibrosis, tumor)
Hemolysis (RBC destruction) related to transfusion reaction
Leukemia
Malnutrition or specific nutritional deficiency
Multiple myeloma
Rheumatoid arthritis
High hematocrit may indicate:
Dehydration
Burns
Diarrhea
Polycythemia vera
Low oxygen tension (smoking, congenital heart disease, living at high altitudes)
Low hemoglobin values may indicate:
Anemia (various types)
Blood loss
The test may be performed under many different conditions and in the assessment of many different diseases.
Risks
Excessive bleeding
Fainting or feeling light-headed
Hematoma (blood accumulating under the skin)
Infection (a slight risk any time the skin is broken)
Multiple punctures to locate veins
Considerations
Red blood cells transport hemoglobin which, in turn, transports oxygen. The amount of oxygen received by tissue depends on the amount and function of RBCs and hemoglobin. The MCV, MCH, and MCHC reflect the size and hemoglobin content of individual red blood cells.

The hematocrit is an expression of the proportion of whole blood that is composed of red blood cells (since the contribution by the WBCs is almost negligible). The hematocrit is a compound measure of RBC number and size.

WBCs are mediators of inflammation and the immune response. There are various types of WBCs that normally appear in the blood:
- Neutrophils (polymorphonuclear leukocytes)
- Band cells (slightly immature neutrophils)
- T-type lymphocytes (T cells)
- B-type lymphocytes (B cells)
- Monocytes
- Eosinophils
- Basophils

Veins and arteries vary in size from one patient to another and from one side of the body to the other. Obtaining a blood sample from some people may be more difficult than from others.

*Complete Blood Count (CBC)*

The complete blood count is a test of red blood cells, white blood cells, and platelets. Blood consists of these components suspended in a thick, colorless fluid called plasma. Automated machines rapidly count the cell types.

*White Cells*

The white cell count is normally between 5,000-10,000. Increased values suggest inflammation or infection.

Such things as exercise, cold, and stress can temporarily elevate the white cell count.
**Red Cells**

Normal values for the red cell count vary with gender.

- Males normally have values around 5-6 million per microliter.
- Females have a lower normal range at 3.6-5.6 million red cells per microliter.

**Hemoglobin / Hematocrit**

Hemoglobin, the iron containing component of red cells which carries oxygen, is also measured in a complete blood count. The normal hemoglobin value for males is 13-18 g/dl. Normal for females is 12-16 g/dl. The hematocrit measures the percent of total blood volume which is red cells. Normal value for males is 40-55%, and the normal value for females is 36-48%. Generally, the hemoglobin times 3 equals the hematocrit. Decreased values are indicative of anemia.

The MCV, MCH, MCHC are red cell indices which indicate the size and hemoglobin content of individual red cells. These indices give clues as to the probable cause of an existing anemia.

**Platelets**

Platelets are components which are important in clot formation. Many medications used in the treatment of arthritis can decrease the platelet count or affect platelet function. Normal values range from 150,000-400,000.

**Differential**

The percent and absolute number of each type of white blood cell is called the differential.

- Neutrophils are increased in bacterial infections and acute inflammation.
- Lymphocytes are increased in viral infections.
• Monocytes are increased in chronic infections and eosinphils are increased in allergies.
• Basophils, which are generally 1 or 2% do not usually increase.

**Inflammation**

The process of inflammation can cause changes in the blood count. The red cell count may go down, the white cell count may go up, and the platelet count may be elevated. While anemia may accompany inflammatory arthritis it may be caused by other things such as blood loss or iron deficiency. Only when other causes have been ruled out can a doctor interpret blood abnormalities as a sign of inflammation.

**Chemistry Panels**

The chemistry panels are a series of tests which are used to evaluate overall health. For example, according to A.D.A.M., "the CHEM-20 is a group of 20 chemical tests performed on serum (the portion of blood without cells). Electrolytes are ionized salts in blood or tissue fluids (ions are atoms or molecules that carry an electrical charge). Electrolytes in the body include sodium, potassium, chloride, and many others."

The tests also include heart risk indicators, diabetes indicators, as well as tests for:

• kidney function
• liver function
• thyroid function

For example, a patient with a high creatinine level may have a problem with the kidneys. Creatinine is a waste product found in the blood. Certain types of inflammatory arthritis can affect kidney function. Certain arthritis drugs can affect kidney function too. Uric acid is another test of the blood chemistry panel which, if elevated, may be indicative of gout.
Erythrocyte Sedimentation Rate (ESR)

The erythrocyte sedimentation rate is a test which involves placing a blood sample in a tube and determining how fast the red blood cells settle to the bottom in one hour. When inflammation occurs the body produces proteins in the blood which make the red cells clump together. Heavier cell aggregates fall faster than normal red cells. For healthy individuals, the normal rate is up to 20 millimeters in one hour. Inflammation increases the rate significantly. Since inflammation can be caused by conditions other than arthritis, the sedrate test alone is not diagnostic.

Rheumatoid Factor (RF)

Rheumatoid factor is an antibody found in unusually large amounts of patients with rheumatoid arthritis. Rheumatoid factor was discovered in the 1940's and became a significant diagnostic tool in the field of rheumatology. 80% of RA patients have RF in their blood. Usually, the higher concentration of RF, the more severe the rheumatoid arthritis. RF can take many months to show up in a patients blood. If tested too early in the course of the disease, the result could be negative and retesting should be considered at a later date. There are also patients with all the signs and symptoms of RA but are seronegative for RF. Some doctors suspect another disease masquerading as RA in these cases. RF can occur in response to inflammatory of infectious diseases other than RA, though usually in these cases, the amount is lower.

HLA Typing

White blood cells may be typed for the presence of HLA-B27. This test is common in medical centers because it is needed for transplants. What has been found is that this genetic marker is present in some forms of arthritis, chiefly ankylosing spondylitis and Reiter's syndrome.

Antinuclear Antibody (ANA)
ANA (antinuclear antibody) test is performed to help detect certain rheumatic diseases. Patients with certain diseases, especially lupus, make antibodies to the nucleus, or command center, of the body's cells. These antibodies are called antinuclear antibodies and are tested for by placing a patient's blood serum on a microscope slide containing cells with visible nuclei. A substance containing fluorescent dye is added which binds to the antibodies. Under a microscope the abnormal antibodies can be seen binding to the nuclei.

- Over 95% of patients with lupus have a positive ANA test.
- 50% of rheumatoid arthritis patients are positive for ANA.

Patients with other diseases also can have positive ANA tests. Other criteria must be involved in definitive diagnosis.

**C-Reactive Protein (CRP)**

C-Reactive Protein measures the concentration in blood serum of a special type of protein produced in the liver that is present during episodes of acute inflammation or infection.

As a blood test, CRP is not specific. A high result serves as a general indication of acute inflammation. In cases of inflammatory rheumatic diseases, such as rheumatoid arthritis and lupus, doctors can utilize the CRP test to assess the effectiveness of a specific arthritis treatment and monitor periods of disease flareup.

**Lupus Erythematosus (LE)**

The LE cell test is not commonly performed anymore. Its initial discovery opened up the whole field of antinuclear antibodies though. Only 50% of lupus patients are found to have positive LE tests. Therefore the test does not identify 50% of patients as having the disease.

**Anti-CCP**
Anti-CCP (anti-cyclic citrullinated peptide antibody) is a new and exciting blood test to help doctors confirm a diagnosis of rheumatoid arthritis.

**Anti-DNA and Anti-Sm**

Lupus patients have antibodies to the heredity material DNA (deoxyribonucleic acid). It is a useful diagnostic tool since it is unusual to find these antibodies in people who do not have lupus. The test is also a good monitoring tool since the levels of anti-DNA rise and fall with disease activity.

Lupus patients also have antibodies to Sm, another substance in the cell's nucleus. These antibodies also occur only in lupus patients. The test is not particularly useful in monitoring disease activity however.

**Complement**

The complement system is a complex set of blood proteins which are part of the body's defense system. These proteins are inactive until an antibody binds to an antigen and activates the complement system. The system produces factors which help destroy bacteria, and combat invaders with white cells. These reactions consume complement and leave depressed levels indicative of immune complex formation. Lupus patients often show decreased levels of total complement. The complement test may be helpful in tracking the disease activity of a lupus patient.