Deciphering clues in the CBC count

By Julie Miller, BSN, RN, CCRN, and Brandi Starks, BSN, RN, CCRN
AS NURSES, WE REVIEW our patient’s lab values daily. The complete blood cell (CBC) count is one of the most frequently ordered screening tests, as well as a tool to evaluate anemia. Anemia is a condition in which there’s a reduction in the number of circulating erythrocytes, the amount of hemoglobin, or the volume of packed cells (hematocrit).

This article reviews the components of the CBC count, which includes a red blood cell (RBC) count, hematocrit, hemoglobin, RBC indexes, white blood cell (WBC) count, differential WBC count, and platelet count. Understanding these values will help you pinpoint reasons for acute changes in your adult patient’s clinical status.

Throughout this article, normal lab value ranges are referenced as a guideline, but you’ll need to check your own lab reference range. Besides looking at your patient’s current lab results, be sure to look for trends during the patient’s entire hospital course.

**The ABCs of CBCs**
Tests of RBCs include the RBC or erythrocyte count, hemoglobin, hematocrit, and RBC indexes.

The **RBC or erythrocyte count** determines the total number of erythrocytes in a cubic millimeter of blood. This measurement is important in the evaluation of anemia or polycythemia (an abnormal increase in the number of RBCs). The normal RBC count is 4.2 to 5.4 × 10^6/mm^3 in men and 3.6 to 5.0 × 10^6/mm^3 in women. Causes of decreased RBC count values include anemias, Hodgkin disease, and other lymphomas. Causes of an increased RBC count (also known as erythrocytosis) include polycythemia vera, renal disease, and pulmonary disease.

The **hematocrit** value is determined by spinning blood in a centrifuge, which causes blood cells and plasma to separate. This test indirectly measures the RBC mass. Results are expressed as the percentage by volume of packed RBCs in whole blood. It’s important, along with hemoglobin and RBC, to determine anemia or polycythemia. The normal reference range is 36% to 48% in women and 42% to 52% in men. The same conditions that raise and lower hemoglobin values also raise and lower hematocrit.

**Hemoglobin** is a protein molecule in RBCs that enables them to transport oxygen and carbon dioxide. Hemoglobin is used to screen for, evaluate, and monitor anemia. A buffer, hemoglobin is also involved in acid-base balance. Evaluate hemoglobin in conjunction with the RBC count and hematocrit. The normal hemoglobin value for men ranges from 14 to 17.4 g/dL; for women, 12 to 16 g/dL. Causes of decreased hemoglobin levels include anemia states, acute or chronic hemorrhage, and liver disease. Causes of increased hemoglobin levels include chronic obstructive pulmonary disease and polycythemia vera.

The **RBC indexes** have four components, which are used to determine the type of anemia a patient has. The **mean corpuscular volume** (MCV), which indicates the average size of RBCs, has a normal value of 82 to 98 mm^3. The MCV indicates whether the average volume of the RBC is normocytic (normal size), microcytic (small), or macrocytic (large). The MCV is used when describing types of anemia.

The **mean corpuscular hemoglobin concentration** (MCHC), which measures the average concentration of hemoglobin in the RBCs, is normally 32 to 36 g/dL. The MCHC indicates whether the RBC is normochromic (normal MCHC or normal color) or hypochromic (decreased MCHC or pale color). The MCHC is also used to describe types of anemia.

The **mean corpuscular hemoglobin** (MCH) indicates the average weight of hemoglobin per RBC. The normal value is 26 to 34 pg/cell. An increased MCH is associated with macrocytic anemia; a decreased MCH is associated with microcytic anemia.

The **RBC distribution width** (RDW) indicates the degree of anisocytosis (abnormal variation in size of RBCs). Normal RBCs have a slight degree of variation. Anemias associated with an increased RDW include sickle cell anemia and immune hemolytic anemia.

The RBC indexes provide clues to help you differentiate various types of anemia. For example, iron-deficiency anemia, the most common type of anemia, is characterized by microcytic (decreased MCV) and hypochromic (decreased MCHC) RBCs. Vitamin B₁₂-deficiency anemia is characterized by macrocytic (elevated MCV), normochromic (normal MCHC) RBCs.

Now let’s look at a case study.

**Crashing hemoglobin and hematocrit**
Glen McDonald, 55, was admitted after a motorcycle crash, when he sustained a right hemopneumothorax requiring placement of a chest tube. He has no significant medical or surgical history and takes no medication. His admission hemoglobin was 11.4 g/dL and his hematocrit was 33.7%. On the third day of hospitalization, his hemoglobin dropped to 7.5 g/dL and his hematocrit fell to 22.1%; the chest tube output for the previous 24 hours was 330 mL.

You call the healthcare provider to report the patient’s morning lab values and your physical assessment findings.
You anticipate an order for a transfusion of packed RBCs to raise the hemoglobin to facilitate better oxygen transport to the tissues and raise the oxygen saturation. The healthcare provider may also order a chest X-ray to evaluate the patient’s hemopneumothorax.

**WBC and the differential**

Now, let’s take a look at tests of WBCs (leukocytes), which help fight infection by phagocytosis. In this process, activated leukocytes engulf and degrade bacteria and cellular debris. The normal reference value for the WBC count in adults is 4,500 to 10,500 cells/mm<sup>3</sup>. Causes of an increased WBC count (leukocytosis) include acute infections, tissue necrosis, and myeloproliferative disorders. Some common drugs that elevate the WBC count are epinephrine, aspirin, allopurinol, steroids, and heparin.

Causes of a decreased WBC count include overwhelming bacterial infections, bone marrow depression, and pernicious anemia. Some drugs that may decrease the WBC count include antibiotics, antithyroid drugs, antiepileptic drugs, antihistamines, barbiturates, diuretics, and chemotherapeutic agents.

WBCs are divided into two main groups. **Granulocytes** include neutrophils, basophils, and eosinophils. **Agranulocytes** include monocytes and lymphocytes. Each of these five types of leukocytes is associated with specific functions. (See Sorting out the differential WBC count for normal values for each type of WBC.)

- **Neutrophils** play a major role in fighting bacterial infections.
- **Basophils** and eosinophils fight parasitic infections and respond to allergens.
- **Monocytes** combat severe infections such as sepsis.
- **Lymphocytes** play a major role in combating viral infections.

The differential count is expressed as a percentage of the total number of WBCs. These percentages indicate the relative number of each type of WBC in the blood. The absolute count of each type of WBC is calculated mathematically by multiplying its relative percentage by the total WBC count. For example, look at Determining the absolute neutrophil count to learn how to perform this calculation.

**A closer look at granulocytes: neutrophils, basophils, and eosinophils**

**Neutrophils** consist of immature stab or band cells (bands) and mature segmented cells (segs). The term _band_ refers to the appearance of the nucleus, which hasn’t taken on the lobed shape of the mature cell. To keep them straight, remember that the bands are the babies and the segmented cells are the seniors. An increase in immature neutrophils (increased bands), called a left shift, occurs when the body responds to a bacterial infection by producing immature neutrophils to fight the infection.

Neutropenia is the inability to fight infection due to limited numbers of neutrophils. You can determine whether your patient is neutropenic by calculating the absolute neutrophil count (ANC) based on the bands and segs. See Determining the absolute neutrophil count for this calculation.

**Basophils** are active in patients with chronic inflammation. Basophils are elevated in patients with myelocytic leukemia, uremia, and myeloproliferative diseases such as myelofibrosis and polycythemia vera. Basophils are decreased in acute allergic reactions, hyperthyroidism, and stress reactions.

The **eosinophils** are cells that actively fight against parasitic infections and are involved in allergic disorders. Normally the eosinophil count remains low unless a parasite or allergen invasion occurs. Consider this case study involving increased eosinophils.

**Eosinophils signal a parasite**

Roberta Rinaldi, who has recently been traveling internationally, complains of diarrhea, vomiting, and severe abdominal pain lasting for more than 2 weeks. Her total WBC count is elevated with eosinophils increased to 25% of the total WBCs. Stool cultures reveal a parasitic infection. The eosinophil count will return to normal as the parasite is eradicated.

Now let’s look at a case study that involves bands and segs.

**Evaluation aided by bands**

Alice Chen, who’s undergoing radiation therapy and chemotherapy, has a total WBC count of 1,500 cells/mm<sup>3</sup>. Her band count is 40% and her seg count is 25%. Here’s the math:

\[
0.4 + 0.25 = 0.65 \times 1,500 = 975 \text{ cells/mm}^3
\]
An ANC less than 1,500 cells/mm³ is considered abnormal. Less than 1,000 cells/mm³ is the threshold for neutropenic precautions. The patient is placed on neutropenic precautions.

Several days later, you note Ms. Chen's WBC count is up to 3,200 cells/mm³, and you wonder if she can be taken off neutropenic precautions. Her band count is 20% and her seg count is 10%.  

\[0.2 + 0.1 = 0.3 \times 3,200 = 960 \text{ cells/mm}^3\]

This calculation reveals that her neutropenia is actually worse, even though she has a higher total WBC count. An elevation in the band count indicates that the bone marrow is responding to an infection. By reviewing trends in the band count, you’re able to monitor how well your patient is fighting an infection.

**A closer look at agranulocytes:**

**Monocytes and lymphocytes**

Monocytes are the largest of the circulating WBCs and have a longer life span than the granulocytes. In response to inflammatory stimuli, monocytes leave the circulation and mature into macrophages in the tissues. Monocyte values are elevated with tissue breakdown, cancers such as myelocytic leukemia or lymphoma, and chronic infections. They also play a role in immune system support by producing interferon in response to viral invasions.

Lymphocytes, the principal cells of the immune system, include T and B lymphocytes. B lymphocytes are essential for humoral or antibody-mediated immunity. T lymphocytes produce cell-mediated immunity and help in antibody production. Causes of increased lymphocytes (lymphocytosis) include viral diseases and some bacterial diseases, such as tuberculosis. Causes of decreased lymphocytes (lymphopenia) include chemotherapy, radiation therapy, and aplastic anemia.

**Understanding the platelet count**

Platelets (thrombocytes) are essential for normal coagulation, so a platelet count helps you assess patients with bleeding disorders. A platelet count between 140,000 and 400,000 cells/mm³ is normal for adults. Causes of abnormally increased numbers of platelets (thrombocythemia or thrombocytosis) include renal failure, malignancies, and chronic pancreatitis. Causes of abnormally decreased numbers of platelets (thrombocytopenia) include disseminated intravascular coagulation, hemolytic anemia, and bone marrow malignancies. A platelet count of less than 20,000 cells/mm³ is associated with a tendency for spontaneous bleeding and prolonged bleeding time. Many drugs, including heparin and aspirin, can affect your patient’s platelet count.

The following case study illustrates the important assessment clues provided by the platelet count.

**Watching out for HIT**

Leslie Franks, 54, was admitted with a deep vein thrombosis following knee replacement surgery. She has a history of acute myocardial infarction and endovascular stent placement. She’s started on low-molecular-weight heparin (LMWH). On day four, as you prepare to administer the LMWH, you note her platelet count is 200,000 cells/mm³, which is in the normal range. However, you also note that her platelet count was 400,000 cells/mm³ on admission. You hold the LMWH and notify the healthcare provider of the drop in her platelet count by 50% from baseline. The healthcare provider will order more tests to rule out heparin-induced thrombocytopenia (HIT), an antibody-mediated adverse reaction to heparin that’s strongly associated with venous and arterial thrombosis.

**Unlocking key assessments**

Reviewing the CBC count can reveal abnormalities in your patient’s tissue oxygen delivery, coagulation, and immune system support. Your astute assessment of changes, trends, and abnormal values can help you to intervene early and appropriately for your patient. Keeping track of your patient’s lab values may help you intervene early to prevent potential complications and optimize care for your patient.

**REFERENCES**


**RESOURCES**


At Trinity Mother Frances Hospitals and Clinics, in Tyler, Tex., Julie Miller is a staff development educator in critical care and Brandi Starks is a staff nurse/preceptor in the medical, surgical-trauma ICU. Julie Miller is also president and founder of PAWS to Learn—Empowering Nurses with Knowledge in Whitehouse, Tex.