

Routine Lab Reports: What Do They Mean?

By Bob Geng, MD



MUCH OF TODAY'S modern diagnostic process is heavily reliant on the interpretation of laboratory studies, especially in the areas of primary immunodeficiency disease (PI) and autoimmune disorders. However, the interpretation of even the most common lab tests is often not fully explained to patients, leaving them misinformed about such a routine, and some would argue essential, part of their healthcare management.

This article focuses on two of the most common routine lab tests — the complete blood count (CBC) and the basic metabolic panel (BMP) — that most patients have received or will receive at some point in their care. The purpose of these routine screening labs is not to provide a specific disease diagnosis. Rather, the purpose is to help physicians develop a panoramic portrait of their patients' health by examining the function of some of the most essential organ systems in their bodies. The CBC details the status of patients' blood cells. Irregularities may indicate problems with the immune system, bone marrow disease, drug toxicity, nutritional deficiencies, signs of infection and other organ dysfunctions. The BMP evaluates the levels of the most abundant chemicals in the blood such as sodium, potassium, chloride, bicarbonate and glucose. Abnormalities may indicate problems with kidney function, diabetes and side effects from medications.

CBC

In the CBC, the most important elements are hemoglobin, white blood cell count and platelet count (see Table 1). Hemoglobin is the molecule in red blood cells that carries oxygen. The measurement of hemoglobin in the blood is a direct measurement of oxygen-carrying capacity and an indirect measurement of the abundance of red blood cells. The normal range of hemoglobin is between 13 and 17 grams per deciliter for men and between 12 and 15 grams per deciliter for women.

Decreased hemoglobin level is indicative of anemia, which means there is a deficiency in the quantity of red blood cells. This can be the result of blood loss, increased destruction of red blood cells or decreased production. There are many causes of anemia, including bleeding, nutritional deficiencies (i.e., iron, B12 and folate deficiency), chronic inflammation, autoimmune destruction or bone marrow dysfunction. While anemia is not a definitive diagnosis, it is a manifestation of certain types of illnesses and a sign to guide physicians in making an exact diagnosis.

Increased hemoglobin beyond the normal range is called polycythemia, which can be an isolated finding or the result of a secondary cause. Increased production could be due to bone marrow abnormality or due to chronic deprivation of proper oxygenation such as persistent tobacco use or living in high

Table 1. Normal Ranges for Key CBC Values

White Blood Cells	4,500-10,000 cells/mL
Hemoglobin	Men: 13-17 g/dL Women: 12-15 g/dL
Platelets	150,000-400,000 platelets/mL

altitudes. The concern for polycythemia is that the increased concentration of red blood cells may lead to thickening of the blood, which increases the risk of clot formation in the vessels.

White blood cell count is often the first element listed in the CBC. White cells are essentially all blood cells other than red cells, so it is a heterogeneous mix, including neutrophils, lymphocytes, eosinophils, basophils and macrophages. The normal range of white count is between 4,500 and 10,000 cells per microliter. An elevated total white count is often a sign of increased systemic inflammation and possibly infection. Neutrophils and macrophages are often elevated if there is a bacterial illness. Eosinophils are typically elevated in allergic disease, but they can be elevated in some forms of autoimmune disorders, as well as hematologic conditions. A low white count can be indicative of immunodeficiency due to an inadequate number of immunologic cells. A decrease in a specific type of immunologic cell can help point toward a specific form of immunodeficiency (i.e., innate vs. adaptive immune system defect). Decreased white count may also indicate a decreased ability to fight off infections.

The last major component of the CBC is the platelet count. The normal platelet count is generally between 150,000 and 400,000 per microliter. Platelets are the crucial elements in blood that help it clot. A platelet count below normal could indicate that the blood may not clot as efficiently and bleeding time would increase. A low platelet count could be secondary to a number of causes, including increased destruction of platelets (due to drugs or autoimmune disorders), increased consumption of platelets (due to aggregation in small vessels that causes them to be used up, thus decreasing the circulating concentration) or decreased production of platelets (due to bone marrow or liver abnormality). Certain PIs such as Wiskott-Aldrich syndrome are associated with low platelet counts. Common variable immunodeficiency is also often associated with autoimmune platelet destruction, and sometimes the first presenting symptom is a low platelet count.

An increased platelet count can occur as an isolated disorder due to abnormal increase in production within the bone marrow. Again, just like in polycythemia, the concern is that an overly high level may increase the blood's propensity to cause abnormal clotting in the vessels, leading to blockage. Platelet count can also often be increased when there is inflammation, which may guide the physician toward discovering an underlying infection or autoimmune condition.

BMP

The BMP is an overview of the concentration of key chemicals in the blood that help the body function. There are several elements of the BMP, but the most important ones are sodium,

Table 2. Normal Ranges for BMP Values

Sodium	135-145 mmol/L
Potassium	3.5-5 mEq/L
Bicarbonate	23-29 mEq/L
Creatinine	Men: 0.7-1.3 mg/dL Women: 0.6-1.1 mg/dL
BUN	7-20 mg/dL
Glucose	Pre-Meal: 70-130 mg/dL Post-Meal (1-2 hours): <180 mg/dL

potassium, bicarbonate, glucose and creatinine (see Table 2). Sodium is one of the most abundant molecules in the blood, and abnormalities can provide insight into the potential for metabolic disorders. A normal sodium level can vary among individuals, but it generally runs between 135 and 145 mmol per liter. A sodium level above the normal range can be indicative of dehydration from inability to obtain water, an imbalance of hormones that are involved in sodium excretion/retention, loss of water (from diarrhea or medications that lead to water loss) and kidney disease. A sodium level below the normal range can indicate an imbalance of the hormones that are involved in sodium excretion/retention, loss of sodium through the urine or the gastrointestinal tract, heart failure, liver failure or kidney failure. In addition, an abnormally low sodium level can be a reflection of inadequate diet or massively excessive water consumption. Mild to moderately low sodium levels are often asymptomatic, but a severely low level can result in changes in mental activity, as well as seizures.

Potassium is highly concentrated within the cells of the body, and only a small amount circulates in the blood, but it is very tightly regulated. The normal range of potassium in the serum is generally between 3.5 and 5 milliequivalents per liter. A low potassium level is usually secondary to either loss through the gastrointestinal tract or kidney or a temporary shift of potassium from the bloodstream into the cells. Certain medications may also lead to increased excretion of potassium by the kidneys. Often, mildly decreased potassium is asymptomatic, but a significantly low level can present with nausea, vomiting, weakness, muscle cramps and cardiac arrhythmia. A high potassium level can be caused by a shift of potassium out of the cells

into the bloodstream, kidney failure, deficiency of the hormones that regulate potassium excretion or a side effect of various medications. Since potassium is mostly eliminated from the body by the kidneys, people with chronic kidney disease who ingest foods with massive quantities of potassium may present with significant elevations of potassium in the serum. A mild degree of potassium elevation may be asymptomatic, but a severe elevation may be associated with weakness and cardiac arrhythmias. Severe potassium elevation in the blood is a medical emergency and needs to be managed rapidly.

Bicarbonate is a measurement of the acid/base status of blood. The normal range of bicarbonate in the blood varies between 23 and 29 milliequivalents per liter. The bicarbonate level provides insight into the acidity of the blood without having to perform more invasive tests such as the arterial blood gas. A higher bicarbonate level can suggest that the blood is too basic, which can be associated with medication side effects, loss of fluids in the gastrointestinal tract, aldosterone excess (one of the adrenal hormones) or severely low potassium levels. However, an elevated bicarbonate level can also represent an excessive retention of carbon dioxide in the lungs. Conditions like chronic obstructive pulmonary disease and other conditions that lead to decreased ventilation of the lungs will lead to a buildup of carbon dioxide with a subsequent rise in bicarbonate level in the blood as a way of compensation. A lower than normal bicarbonate level suggests that the blood is too acidic, which could be caused by a multitude of metabolic disorders, kidney disease, ingestion of various chemicals/medications, starvation or inadequate tissue oxygenation. However, a low bicarbonate level may also represent systemic compensation for hyperventilation resulting in a decreased amount of carbon dioxide present in the lungs. Therefore, the bicarbonate level can provide essential clues to kidney and lung function, as well as many other metabolic processes, and it may serve as the impetus for physicians to order additional specific testing.

Creatinine and blood urea nitrogen (BUN) are two measurements in the BMP that look directly at kidney function. Creatinine generally runs between 0.7 mg/dL and 1.3 mg/dL for men and 0.6 mg/dL and 1.1 mg/dL for women. This discrepancy is due to the fact that creatinine is derived from muscle, and men on average have more muscle mass than women. The normal range of BUN is from 7 to 20 mg/dL. Lower creatinine or BUN levels are generally not a significant issue. Higher creatinine or BUN levels can indicate kidney disease, liver disease or heart failure. In addition, certain medications can lead to a rise of creatinine, so it is always important to report all medications that are being taken to a physician.

Lastly, the glucose level in the blood is helpful for diagnosing and/or monitoring diabetes. However, the glucose level can

fluctuate depending on food ingestion. The normal pre-meal blood glucose range is between 70 and 130 mg/dL, and the normal one- to two-hour post-meal level should be less than 180 mg/dL. For non-diabetics, an elevated level may provide clues to physicians to run additional testing to assess the potential of diabetes. For diabetics, an elevated level would provide insight that the diabetes is not well-controlled and a more optimal diet/medical regimen should be implemented. For those on medications for the treatment of diabetes, a fasting blood glucose less than 70 mg/dL is indicative of hypoglycemia likely from insufficient nutrient intake or excessive anti-diabetic medication use. For non-diabetics, glucose of less than 70 mg/dL can be caused by increased insulin production or decreased glucose production in the body due to various disorders. Hypoglycemia is a potentially dangerous condition and often very symptomatic (weakness, anxiety, changes in mental status, sweatiness), and it needs to be addressed immediately.

THE BMP IS AN OVERVIEW OF THE CONCENTRATION OF KEY CHEMICALS IN THE BLOOD THAT HELP THE BODY FUNCTION.

What the Basics Mean

Overall, these basic laboratory assessments are very helpful tools that allow physicians to gain a clearer insight into the status of patients' health. While they do not provide a specific diagnosis, they can often direct physicians toward a more targeted path of investigation to make the proper diagnosis and perform the appropriate management of a condition. In the era of modern medicine, patients need to play an active role in their health management, and with a better understanding of the fundamentals of routine laboratory tests, they can become a more informed and astute member of their healthcare team. ■

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