Whole Blood and Blood Components

Background

Blood may be transfused as whole blood or as one of its components. Because patients seldom require all of the components of whole blood, it makes sense to transfuse only that portion needed by the patient for a specific condition or disease. This treatment, referred to as "blood component therapy," allows several patients to benefit from one unit of donated whole blood. Blood components include red blood cells, plasma, platelets, and cryoprecipitated antihemophilic factor (AHF). Up to four components may be derived from one unit of blood.

Whole blood is a living tissue that circulates through the heart, arteries, veins, and capillaries carrying nourishment, electrolytes, hormones, vitamins, antibodies, heat, and oxygen to the body's tissues. Whole blood contains red blood cells, white blood cells, and platelets suspended in a fluid called plasma.

If blood is treated to prevent clotting and permitted to stand in a container, the red blood cells, which weigh more than the other components, will settle to the bottom; the plasma will stay on top; and the white blood cells and platelets will remain suspended between the plasma and the red blood cells. A centrifuge may be used to hasten this separation process. The platelet-rich plasma is then removed and placed into a sterile bag, and it can be used to prepare platelets and plasma or cryoprecipitated AHF. To obtain platelets, the platelet-rich plasma is centrifuged, causing the platelets to settle at the bottom of the bag. Plasma and platelets are then separated and made available for transfusion. The plasma also may be pooled with plasma from other donors and further processed, or fractionated, to provide purified plasma proteins such as albumin, immunoglobulin (IVIG), and clotting factors.

Red blood cells are perhaps the most recognizable component of whole blood. Red blood cells contain hemoglobin, a complex iron-containing protein that carries oxygen throughout the body and gives blood its red color. The percentage of blood volume composed of red blood cells is called the "hematocrit." The average hematocrit in an adult male is 47 percent. There are about one billion red blood cells in two to three drops of blood, and, for every 600 red blood cells, there are about 40 platelets and one white cell. Manufactured in the bone marrow, red blood cells are continuously being produced and broken down. They live for approximately 120 days in the circulatory system and are eventually removed by the spleen.

Red blood cells are prepared from whole blood by removing the plasma, or the liquid portion of the blood. They can raise the patient's hematocrit and hemoglobin levels while minimizing an increase in volume.

Patients who benefit most from transfusions of red blood cells include those with chronic anemia resulting from disorders such as kidney failure, malignancy, or gastrointestinal bleeding and those with acute blood loss resulting from trauma or surgery. Since red blood cells have reduced amounts of plasma, they are well suited for treating anemia patients who have congestive heart failure or who are elderly or debilitated; these patients might not tolerate the increased volume provided by whole blood.

Improvements in cell preservative solutions over the last 15 years have increased the shelf life of red blood cells from 21 to 42 days. Red blood cells may be treated and frozen for extended storage (up to 10 years).

Plasma is the liquid portion of the blood — a protein-salt solution in which red and white blood cells and platelets are suspended. Plasma, which is 90 percent water, constitutes about 55 percent of blood volume. Plasma contains **albumin** (the chief protein constituent), **fibrinogen** (responsible, in part, for the clotting of blood), **globulins** (including antibodies), and other clotting proteins. Plasma serves a variety of functions, from maintaining a satisfactory blood pressure and volume to supplying critical proteins for blood clotting and immunity. It also serves as the medium of exchange for vital minerals such as sodium and potassium, thus helping maintain a proper balance in the body, which is critical to cell function. Plasma is obtained by separating the liquid portion of blood from the cells. Plasma is usually not used for transfusion purpose but is fractionated (separated) into specific products such as albumin, specific clotting factor concentrates and IVIG (intravenous immune globulin).

Fresh frozen plasma is plasma frozen within hours after donation in order to preserve clotting factors, stored for one to seven years, and thawed before it is transfused. It is most often used to treat certain bleeding disorders, when a clotting factor or multiple factors are deficient and no factor-specific concentrate is available. It also can be used for plasma replacement via a process called ***plasma exchange.***

Cryoprecipitated AHF is the portion of plasma that is rich in certain clotting factors, including Factor VIII, fibrinogen, von Willebrand factor, and Factor XIII. Cryoprecipitated AHF is removed from plasma by freezing and then slowly thawing the plasma. It is used to prevent or control bleeding in individuals with hemophilia and von Willebrand's disease, which are common, inherited major coagulation abnormalities. Its use in these conditions is reserved for times when viral-inactivated concentrates containing Factor VIII and von Willebrand factor are unavailable and plasma components must be used. It may also be used as hemostatic preparation [fibrin sealant or fibrin glue] in surgery.

Platelets (or thrombocytes) are very small cellular components of blood that help the clotting process by sticking to the lining of blood vessels. Platelets are made in the bone marrow and survive in the circulatory system for an average of 9–10 days before being removed from the body by the spleen. The platelet is vital to life, because it helps prevent massive blood loss resulting from trauma, as well as blood vessel leakage that would otherwise occur in the course of normal, day-to-day activity. Units of platelets are prepared by using a centrifuge to separate the platelet-rich plasma from the donated unit of whole blood. The platelet-rich plasma is then centrifuged again to concentrate the platelets further.

Platelets also may be obtained from a donor by a process known as apheresis, or plateletpheresis. In this process, blood is drawn from the donor into an apheresis instrument, which, using centrifugation, separates the blood into its components, retains the platelets, and returns the remainder of the blood to the donor. The resulting component contains about six times as many platelets as a unit of platelets obtained from whole blood. Platelets are used to treat a condition

called thrombocytopenia, in which there is a shortage of platelets, and in patients with abnormal platelet function. Platelets are stored at room temperature for up to five days.

White blood cells are responsible for protecting the body from invasion by foreign substances such as bacteria, fungi, and viruses. The majority of white blood cells are produced in the bone marrow, where they outnumber red blood cells by two to one. However, in the blood stream, there are about 600 red blood cells for every white blood cell. There are several types of white blood cells; Granulocytes and macrophages protect against infection by surrounding and destroying invading bacteria and viruses, and lymphocytes aid in immune defense.

Granulocytes can be collected by apheresis or by centrifugation of whole blood. They are transfused within 24 hours after collection and are used for infections that are unresponsive to antibiotic therapy. The effectiveness of white blood cell transfusion is still being investigated.

Plasma derivatives are concentrates of specific plasma proteins that are prepared from pools (many units) of plasma. Plasma derivatives are obtained through a process, known as fractionation, developed during World War II, and are heat-treated and/or solvent detergent-treated to kill certain viruses, including HIV and hepatitis B and C. Plasma derivatives include:

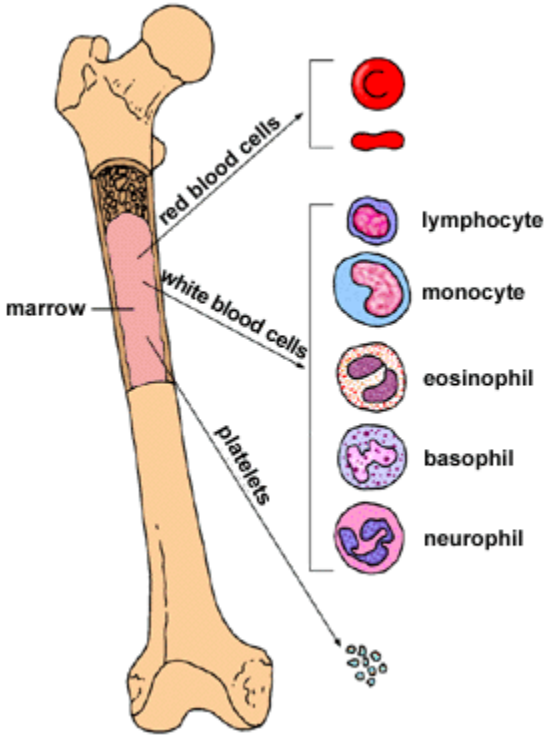
- Factor VIII Concentrate
- Factor IX Concentrate
- Anti-Inhibitor Coagulation Complex (AICC)
- Albumin
- Immune Globulins, including Rh Immune Globulin
- Anti-Thrombin III Concentrate
- Alpha 1-Proteinase Inhibitor Concentrate

What is blood?
Blood is the life-maintaining fluid that circulates through the body's:

- Heart.
- Arteries.
- Veins.
- Capillaries.

What is the function of blood?
Blood carries the following to the body tissues:

- Nourishment.
- Electrolytes.
- Hormones.
- Vitamins.
- Antibodies.
- Heat



- Oxygen.

Blood carries the following away from the body tissues:

- Waste matter.
- Carbon dioxide.

What are the components of blood? Human blood consists of about 22 percent solids and 78 percent water. The components of human blood are:

- Plasma, in which the blood cells are suspended, including:
    - Red blood cells (erythrocytes) - carry oxygen from the lungs to the rest of the body.
    - White blood cells (leukocytes) - help fight infections and aid in the immune process. Types of white blood cells include:
        - Lymphocytes.
        - Monocytes.
        - Eosinophils.
        - Basophils.
        - Neutrophils (granulocytes).
    - Platelets (thrombocytes) - help in blood clotting.
    - Fat globules.
    - Chemical substances, including:
        - Carbohydrates.
        - Proteins.
        - Hormones.
    - Gases, including:
        - Oxygen.
        - Carbon dioxide.
        - Nitrogen.

Where are blood cells made? Blood cells are made in the bone marrow. The bone marrow is the spongy material in the center of the bones that produces about 95 percent of the body's blood cells.

There are other organs and systems in our bodies that help regulate blood cells. The lymph nodes, spleen, and liver help regulate the production, destruction, and differentiation (developing a specific function) of cells. The production and development of new cells is a process called hematopoiesis.

Blood cells formed in the bone marrow start out as a stem cell. A "stem cell" (or hematopoietic cell) is the initial phase of all blood cells. As the stem cell matures, several distinct cells evolve such as the red blood cells, white blood cells, and platelets. Immature blood cells are also called blasts. Some blasts stay in the marrow to mature and others travel to other parts of the

body to develop into mature, functioning blood cells.

What are the functions of blood cells? The primary function of red blood cells, or erythrocytes, is to carry oxygen and carbon dioxide. Hemoglobin (Hgb) is an important protein in the red blood cells that carries oxygen from the lungs to all parts of our body.

The primary function of white blood cells, or leukocytes, is to fight infection. There are several types of white blood cells and each has its own role in fighting bacterial, viral, fungi, and parasitic infections. Types of white blood cells that are most important for helping protect the body from infection and foreign cells include the following:

- Neutrophils.
- Eosinophils.
- Lymphocytes.
- Monocytes.
- Granulocytes.

White blood cells:

- Help heal wounds not only by fighting infection but also by ingesting matter such as dead cells, tissue debris and old red blood cells.
- Are our protection from foreign bodies that enter the blood stream, such as allergens.
- Are involved in the protection against mutated cells, such as cancer.

The primary function of platelets, or thrombocytes, is blood clotting. Platelets are much smaller in size than the other blood cells. They group together to form clumps, or a plug, in the hole of a vessel to stop bleeding.

What is a complete blood cell count (CBC)? A complete blood cell count is a measurement of size, number and maturity of the different blood cells in a specific volume of blood. A complete blood cell count can be used to determine many abnormalities with either the production or destruction of blood cells. Variations from the normal number, size, or maturity of the blood cells can be used to indicate an infection or disease process. Often with an infection, the number of white blood cells will be elevated. Many forms of cancer can affect the bone marrow production of blood cells. An increase in the immature white blood cells in a complete blood cell count can be associated with leukemia. Anemia and sickle cell disease will have abnormally low hemoglobin.

Common hematology tests: Some common hematology tests include the following:

Test	Uses
Complete blood count (CBC), which includes:	To aid in diagnosing anemia and other blood disorders and certain cancers of the blood; to

• white blood cell count (WBC) • red blood cell count (RBC) • platelet count • hematocrit red blood cell volume (HCT) • hemoglobin concentration (HB) - the oxygen-carrying pigment in red blood cells • differential blood count	monitor blood loss and infection; to monitor a patient's response to cancer therapy, such as chemotherapy and radiation.
Platelet count	To diagnose and/or monitor bleeding and clotting disorders.
Prothrombin time (PT)	To evaluate bleeding and clotting disorders and to monitor anticoagulation (anti-clotting) therapies.

Your child's physician will explain the purpose and results of any blood tests with you.

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