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Review Article

The Succinct Scenario- Vascular Exponents

Siniša Franjić*

Faculty of Law, International University of Brcko District, Brcko, Bosnia and Herzegovina

***Corresponding Author**: Siniša Franjić, Faculty of Law, International University of Brcko District, Brcko, Bosnia and Herzegovina.

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Abstract

Blood is red, opaque and thick, with a special aroma and salty taste. It flows through the body's circulatory system and transports nutrients and oxygen through the body. The total amount of blood in the adult body is 5 - 6 liters, which is about 8% of the total body weight. Blood is functionally the most important body fluid in humans. Blood serves the function of respiration, i.e. for the transfer of oxygen and carbon dioxide, then for the transport of nutrients, wastes, hormones, enzymes, vitamins, etc. It also plays a role in regulating the volume of body fluids, regulating acid-base balance, and regulating body temperature and it also plays a major protective role. The blood flows to the body in a closed system of tubes and blood vessels, consisting of arteries, veins and capillaries.

Keywords: *Blood; Blood Vessels; Abnormalities; Health*

Introduction

Single-celled organisms do not need blood [1]. They obtain nutrients directly from and excrete wastes directly into their environment. The human organism cannot do that. Our large, complex bodies need blood to deliver nutrients to and remove wastes from our trillions of cells. The heart pumps blood throughout the body in a network of blood vessels. Together, these three components-blood, heart, and vessels-makes transport: blood.

Recall that blood is a connective tissue. Like all connective tissues, it is made up of cellular elements and an extracellular matrix. The cellular elements-referred to as the formed elements-include red blood cells (RBCs), white blood cells (WBCs), and cell fragments called platelets. The extracellular matrix, called plasma, makes blood unique among connective tissues because it is fluid. This fluid, which is mostly water, perpetually suspends the formed elements and enables them to circulate throughout the body within the cardiovascular system.

Nutrients from the foods you eat are absorbed in the digestive tract. Most of these travel in the bloodstream directly to the liver, where they are processed and released back into the bloodstream for delivery to body cells. Oxygen from the air you breathe diffuses into the blood, which moves from the lungs to the heart, which then pumps it out to the rest of the body. Moreover, endocrine glands scattered throughout the body release their products, called hormones, into the bloodstream, which carries them to distant target cells. Blood also picks up cellular wastes and byproducts, and transports them to various organs for removal. For instance, blood moves carbon dioxide to the lungs for exhalation from the body, and various waste products are transported to the kidneys and liver for excretion from the body in the form of urine or bile.

Characteristics

When you think about blood, the first characteristic that probably comes to mind is its color [1]. Blood that has just taken up oxygen in the lungs is bright red, and blood that has released oxygen in the tissues is a more dusky red. This is because hemoglobin is a pigment that changes color, depending upon the degree of oxygen saturation.

Blood is viscous and somewhat sticky to the touch. It has a viscosity approximately five times greater than water. Viscosity is a measure of a fluid's thickness or resistance to flow and is influenced by the presence of the plasma proteins and formed elements within the blood. The viscosity of blood has a dramatic impact on blood pressure and flow. Consider the difference in flow between water and honey. The more viscous honey would demonstrate a greater resistance to flow than the less viscous water. The same principle applies to blood.

The normal temperature of blood is slightly higher than normal body temperature-about 38°C (or 100.4°F), compared to 37°C (or 98.6°F) for an internal body temperature reading, although daily variations of 0.5°C are normal. Although the surface of blood vessels is relatively smooth, as blood flows through them, it experiences some friction and resistance, especially as vessels age and lose their elasticity, thereby producing heat. This accounts for its slightly higher temperature.

The pH of blood averages about 7.4; however, it can range from 7.35 to 7.45 in a healthy person. Blood is therefore somewhat more basic (alkaline) on a chemical scale than pure water, which has a pH of 7.0. Blood contains numerous buffers that actually help to regulate pH.

Blood constitutes approximately 8 percent of adult body weight. Adult males typically average about 5 to 6 liters of blood. Females average 4 - 5 liters.

Blood vessels

Blood is carried through the body via blood vessels [1]. An artery is a blood vessel that carries blood away from the heart, where it branches into ever-smaller vessels. Eventually, the smallest arteries, vessels called arterioles, further branch into tiny capillaries, where nutrients and wastes are exchanged, and then combine with other vessels that exit capillaries to form venules, small blood vessels that carry blood to a vein, a larger blood vessel that returns blood to the heart.

Arteries and veins transport blood in two distinct circuits: the systemic circuit and the pulmonary circuit. Systemic arteries provide blood rich in oxygen to the body's tissues. The blood returned to the heart through systemic veins has less oxygen, since much of the oxygen carried by the arteries has been delivered to the cells. In contrast, in the pulmonary circuit, arteries carry blood low in oxygen exclusively to the lungs for gas exchange. Pulmonary veins then return freshly oxygenated blood from the lungs to the heart to be pumped back out into systemic circulation. Although arteries and veins differ structurally and functionally, they share certain features.

The walls of arteries and veins are largely composed of living cells and their products (including collagenous and elastic fibers); the cells require nourishment and produce waste [1]. Since blood passes through the larger vessels relatively quickly, there is limited opportunity for blood in the lumen of the vessel to provide nourishment to or remove waste from the vessel's cells. Further, the walls of the larger vessels are too thick for nutrients to diffuse through to all of the cells. Larger arteries and veins contain small blood vessels within their walls known as the vasa vasorum-literally "vessels of the vessel"-to provide them with this critical exchange. Since the pressure within arteries isrelatively high,the vasa vasorum must function in the outer layers of the vessel or the pressure exerted by the blood passing through the vessel would collapse it, preventing any exchange from occurring. The lower pressure within veins allows the vasa vasorum to be located closer to the lumen. The restriction of the vasa vasorum to the outer layers of arteries is thought to be one reason that arterial diseases are more common than venous diseases, since its location makes it more difficult to nourish the cells of the arteries and remove waste products. There are also minute nerves within the walls of both types of vessels that control the contraction and dilation of smooth muscle. These minute nerves are known as the nervi vasorum.

Blood vessels are not inert conduits; they are formed during embryonic development and have plasticity throughout adult life [2]. Far from representing a uniform category, we must distinguish between the different types of blood vessels. The first is the arteries and veins, which have different structures and functions. The second subdivision of the vascular tree is a function of size and distinguishes between large vessels and smaller vessels called arterioles, venules, and capillaries (by decreasing size). Capillaries have an essential role in the exchange of nutrients and oxygen with the tissues. They are also heterogeneous and are distinguished as fenestrated and unfenestrated capillaries. Fenestrated capillaries have small openings that allow fluids and macromolecules to pass. They are mainly present in the kidneys and the lungs.

The structure of the blood vessels depends on their size; in other words, their form and function are different and constituted as microvessels or larger vessels. Capillaries consist mainly of endothelial cells, which may be covered with a layer of so-called mural cells or pericytes. These cells are in contact with proteins forming a basal collagen membrane. The largest vessels are formed of several layers called intima, media, and adventitia.

The flow of fluid through the interstitial space between arteries and veins depends on capillary hydrostatic pressure, capillary permeability, osmotic pressure of blood proteins, and the presence of open lymphatic channels [3]. The capillary hydrostatic pressure filters fluid from the blood through the capillary endothelium. The capillary permeability determines the ease with which the fluid can pass through the capillary endothelium and whether larger proteins can leak into the tissue. The osmotic pressure exerted by the proteins in the blood plasma (called colloid osmotic pressure) attracts fluid from the interstitial space back into the vascular compartment. Osmotic pressure, which was considered in the discussion on cells and tissues, may be defined as the property causing fluid to migrate in the direction of a higher concentration of molecules. The osmotic pressure of the plasma depends primarily on the concentration of the plasma proteins (termed the plasma oncotic pressure). Because normal capillaries are impermeable to protein, the protein tends to draw water from the interstitial fluid into the capillaries and to hold it there. However, changes in capillary permeability (as occur in inflammation) may allow proteins to leak into tissue, reducing the plasma oncotic pressure. Open lymphatic channels collect some of the fluid forced out of the capillaries by the hydrostatic pressure of the blood and return the fluid to the circulation.

Heart

The heart is the primary organ of the cardiovascular system that acts as a pump, which supplies oxygenated blood to the body from the lungs and deoxygenated blood to the lungs for removal of carbon dioxide [4]. The human heart is approximately the size of a large fist and is located in middle of the chest, between the lungs within thoracic cavity. It has four chambers: lower left and right ventricles and upper left and right atrium. The blood pressure (BP) is created by the contraction of left ventricles. The normal BP range is 120/80 - 140/90 for a healthy person. The mass of an adult heart is approximately 250 - 350 gm. The cardiac cycle is a complete heart beat that consists of a sequence of mechanical and electrical events which are repeated with every heartbeat. It starts with systole that is a contraction of atria or ventricles and ends with diastole that is a relaxationand filling of ventricles or atria with blood. The heart rate is the frequency of cardiac cycle, and it is expressed in beats per minute. The normal heart rate of an adult person is from 60 to 100 beats per minute. The heart generates the electrical activity throughout the cardiac cycle as a result of which atria and ventricles contract. The vibrations are produced by the opening and closure of valves, which are audible and can indicate the condition of heart.

The cardiovascular disease involves the blood vessels or heart. It normally refers to blockage or narrowing of blood vessels causing stroke, angina pain, or heart attack. There are three types of heart diseases: electrical, circulatory, and structural. Irregular or abnormal heartbeats called arrhythmia are caused by the problems in electrical activity of the heart. It means a heartbeat is added and skippedand the heart is beating fast or slow. Arrhythmia can be either harmful or harmless and one might not notice them. Circulatory diseases caused by the disordersin circulatory system such as high BP, blockageof blood vessels, etc. The structural disease involvesheart muscles/valves and congenital problems. The main causes of CVD are high blood pressure, poor diet, smoking, obesity, diabetes, high cholesterol, genetics, age, gender, lack of exercise, and physical inactivity.

CVS

The CVS (Cardiovascular system) is concerned with the heart and the blood vessels: arteries, veins and capillaries [5]. Traditional methods of examination are used. Evidence that the heart is not working efficiently, called congestive heart failure, may be provided by looking at the veins of the neck which may show raised pressure; by looking at the ankles or sacrum which may show indentation of the skin under pressure, called pitting oedema or swelling because the pitting takes some time to clear; and by listening to the chest, which may reveal moist sounds, called creps, in the lungs and abnormal heart sounds, called murmurs. Such examination may reveal an enlarged boot shaped heart and murmurs consistent with heart valve disease. There may also be basal creps in the lungs and an elevated jugular venous pulse. The pressure in the arteries called the blood pressure is measured with an instrument called a sphygmomanometer. Two pressures are measured in each heart beat cycle. The systolic or squeezing pressure is the higher and the diastolic or resting pressure is the lower. The upper limit of the normal blood pressure is 140/90, or 140 systolic and 90 diastolic, all pressures being measured in millimetres of mercury (mm Hg).

The blood vascular system has evolved to transfer respiratory gases between lungs and tissues. Different types of blood vessel are recognisable from their different structures and functions. An artery is thick walled and elastic, a property which resides in the presence of a specialised tissue called elastic tissue, and it conveys blood in a high pressure system from heart to tissues, for example, to voluntary muscle. A vein is thin walled and conveys blood in a low pressure system back from the tissues to the heart. In the tissue itself, the artery has subdivided repeatedly to form very small vessels called capillaries, whose walls have a single layer of cells to facilitate gas exchange between capillary vessels and muscle fibrils, the individual muscle units. The capillaries then unite to form small veins, called venules, and these unite in turn to form veins.

Abnormalities

Hemostasis (blood clotting) is central to the tissue response to injury [3]. Rupture of larger veins and arteries often occurs after vascular injury resulting from trauma, inflammatory or neoplastic damage, erosion of a vessel wall, or occasionally with congenital malformations of the vasculature. All may lead to hemorrhage, uncontrolled movement of blood into tissues, body spaces, and the gastrointestinal or urinary tract. The term hemorrhagic diathesis refers to a variety of clinical disorders, some congenital, some acquired, in which usually insignificant (or even unapparent) injury leads to unusual bleeding.

Normal hemostasis must accomplish two seemingly contradictory functions: the maintenance of blood in a fluid, thrombus (clot) free state in normal vessels and at the same time have the ability to form a localized hemostatic plug at the site of an injury. Such hemostatic plugs are referred to as thrombi, when within the body, and clots when they occur outside the body. The overall process is usually referred to as blood clotting or coagulation. Thrombosis is the opposite of hemorrhage, the pathologic activation of hemostasis under inappropriate conditions.

The proper functioning of the hemostasis system depends on the integrated functioning of four major components. These include integrity of the small blood vessels and their lining cells (endothelium), adequate numbers of structurally and functionally normal platelets, normal levels of humoral coagulation factors (proteins found in the blood plasma), and normal levels of coagulation inhibitors to control, localize, and terminate the hemostatic process to prevent pathologic thrombosis. Adequate concentration of calcium ions in the blood is also necessary for appropriate hemostasis (although hypocalcemia is not commonly associated with hemorrhagic symptoms).

Some specialized terminology is associated with the description of hemorrhagic processes. A hematoma is the accumulation of blood within tissue. It may be insignificant such as a bruise (ecchymosis) on a limb or life-threatening should it occur within the skull. A large accumulation of blood within a body space is a hemarthrosis (if within joints), hemothorax (within the chest), and hemopericardium (between the heart and its pericardial lining). Such accumulations are likely to lead to compromise of normal function. For example, a hemopericardium may lead to cardiac tamponade, a condition in which the accumulation of blood adjacent to the heart prevents normal cardiac function. Petechiae are small 1 to 2 mm pinpoint hemorrhages in the skin, mucous membrane, or serosa that are often indicative of a failure of platelet function and of capillary bleeding.

Blood pressure

Blood pressure represents lateral force exerted on the vasculature by flowing blood [6]. Pressure is maximal shortly after ventricular systole (SBP). The diastolic pressure (DBP) follows cardiac diastole and is the lowest pressure in the cycle.

Pulse pressure is the arithmetic difference between the systolic and diastolic pressures. Pulse pressures vary with stroke volume or vascular compliance. Pulse pressures less than 30 mm Hg are common with hypovolemia, tachycardia, aortic stenosis, constrictive pericarditis, pleural effusions, and ascites. Widened pulse pressures may be due to aortic regurgitation, thyrotoxicosis, patent ductus arteriosus, arteriovenous fistula and coarctation of the aorta. Variability of pulse pressure and systolic pressure during the respiratory cycle has been correlated with response to intravascular fluid repletion.

The initial upstroke and peak of the arterial waveform are produced by left ventricular ejection. The end of systole is marked by a brief decline in pressure until the aortic valve closes and redirects backflowing blood into the aorta. The "dicrotic notch" so created may be detected on recordings obtained from aortic or proximal arterial sites. The waveform becomes more peaked and of higher amplitude as it progresses distally. The initial upstroke is prolonged, producing a higher systolic and a lower diastolic pressure.

The velocity of blood flow is slowest in the largest arteries because they are distensible and absorb energy from the pressure wave front. The pulse wave travels at a rate of 7 - 10 m/s in large arteries such as the subclavian artery and increases to 15 - 30 m/s in smaller distal arteries.

When a pressure wave front enters a small, nondistensible artery, part of the wave may be reflected back proximally. If a reflected wave strikes an oncoming wave, the two summate, causing a higher pressure than would occur otherwise. This phenomenon produces pressures in the distal peripheral arteries that paradoxically may be more than 20 - 30 mm Hg above those recorded in the aorta.

The blood pressure varies considerably in any individual, depending on such factors as their activity or anxiety levels [7]. A single blood pressure reading should not be relied upon before initiating treatment. At least three readings on three separate occasions must be taken. Some patients increase their blood pressure even at the prospect of having it measured (white coat hypertension). If there are doubts about the validity of blood pressure measurements, the solution is to carry out continuous monitoring whilst the patient leads their normal life. Unfortunately, this facility is not always available. There is accumulating evidence that sustained hypertension in elderly patients should be treated. Since elderly patients had previously been excluded from blood pressure trials, this information has been slow in being acquired and the position in the very old (those aged over 90) remains uncertain. If, on examination and investigation, the patient shows evidence of end organ damage, then the necessity for treatment is more compelling. The sort of damage that the professional should look out for is impaired kidney function, damage to the eyes and evidence of heart failure or previous strokes. Any patient who is also diabetic is particularly vulnerable to the ravages of hypertension.

Once it has been decided that a reduction in blood pressure is needed, the next decision is the choice of drug management. All hypertensive patients should be encouraged to achieve an ideal weight, to reduce salt intake (in cooking), to take regular exercise and to avoid smoking. In mild cases, these measures, if successfully accomplished, may be sufficient to bring the blood pressure down to an acceptable level (usually 140/80 mm Hg or less).

Hematology

Hematology is the study of blood in health and disease [8]. It addresses problems with the red blood cells, white blood cells, platelets, blood vessels, bone marrow, lymphnodes, spleen, and proteins involved in bleeding and clotting. If a patientis diagnosed with a blood disease, his healthcare provider may refer him to a hematologist. A hematologist is a physician who has a Without blood, the human body would weaken and die. Organs couldn't get the oxygen and the nutrients they need to survive, and we couldn't warm up or cool down. The average adult man has about 3 gallons, or 24 pints, of blood inside his body; the average adult woman has about 2.5 gallons, or 20 pints.

There is no substitute for blood. It can't be made or manufactured. According to the American Red Cross (2016), donors are the only source of blood for patients who need it, and more than 38,000 blood donations are needed every day. Another way to think about the demand is that in the United States, every 2 seconds a patient is in need of blood. Roughly, adonation equals about a pint, and one donation can help save the lives of up to three people.

Whole blood is living tissue made up of liquid and solids. It has four main parts: plasma, red blood cells, white blood cells, and platelets. The liquid, called plasma, is made of water, sugar, fat, salt, and protein. Plasma, which is 90% water, makes up 55% of blood volume. The main job of plasma is to carry blood cells throughout the body along with nutrients, waste products, antibodies, clotting factors, hormones, and proteins. The solid part of blood has three types of blood cells: red blood cells, white blood cells, and platelets.

Blood and forensics

Blood is one of the most significant and frequently encountered types of physical evidence associated with the forensic investigation of death and violent crime [9]. The identification and individualization of human bloodstains have progressed over the past 100 years since the ABO grouping system was discovered by Landsteiner in 1901. The techniques for the individualization of human blood in forensic science relied on the ABO system for many years. The development of the characterization of the red cell isoenzymes and serum genetic markers in the late 1970s dramatically increased the individualization of human blood. The work of Sir Alec Jeffreys in the development of DNA profiling in 1985 was a milestone in forensic science. Since then the techniques of DNA analysis in forensic cases has rapidly evolved through PCR (polymerase chain reaction) and STR (short tandem repeat) techniques and afforded the forensic scientist a powerful tool for the individualization of human blood. Bloodstains collected from a scene of violent death where bloodshed has occurred and blood samples collected from clothing of the victim and the accused can now provide a link between an assailant and a victim to a high degree of scientific certainty.

The identification and individualization of human blood is cojoined with the discipline of bloodstain pattern analysis (BPA). BPA focuses on the analysis of the size, shape, and distribution of bloodstains resulting from bloodshed events as a means of determining the types of activities and mechanisms that produced them. This information coupled with DNA individualization and wound interpretation from the autopsy examination of the victim by the forensic pathologist provides a basis for the reconstruction of the bloodshed events. The scientific analysis of bloodstain pattern evidence has proved crucial in numerous cases where the manner of death is questioned and the issue of homicide, suicide, accident, or natural death must be resolved in a criminal or civil litigation or proceeding.

Conclusion

The quantity of blood in the body depends on the body surface, ie height and weight. The average total weight of blood in the body is 8% of body weight. The quantity of blood is constant in healthy people at rest, and it increases during exercise and by entry more fluid and food into the body. In the opposite case, blood volume decreases. Physiological changes in blood volume are due to changes in plasma volume. The quantity of blood is distributed differently in the body, mainly according to the needs of individual organs. Blood is a living organ, which can save lives if transfused. Loss of large quantity of blood after injury or illness can cause shock. Then the brain and heart cannot function normally. Blood is also the first connection between mother and child. A person's health can also be determined by his blood condition, and in the same way scientists today can diagnose and investigate complex diseases.

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