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Heart Disease, Transplants and New Technology

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Introduction

Heart disease is the silent killer of people in the United States. During 2010 approximately 785,000 individuals experienced their first heart attack and another 470,000 experienced their second heart attack. (1) In 2010 heart disease cost the United States approximately 316.4 billion dollars. The total cost includes the price of health care services along with the medications and lost productivity. A coronary event consists primarily of a heart attack. Every 25 seconds one person experiences a heart attack and one person dies from a heart attack every minute in the USA. Data indicates that more people suffer from heart disease in Mississippi. Minnesota has the lowest rate of heart attack victims. (2)

Overview

The heart is one of the most unique organs in our body. It is responsible for providing a method of locomotion for the delivery of nutrients, oxygen and other important substances in our body. Heart failure affects a large portion of the population. Worldwide approximately five million people suffer from this ailment and 300,000 people die from it every year. Although there are treatments for many varieties of heart disease, there are individuals whose disease continues to get worse, and the only treatment for some forms of heart disease is heart transplant. Scientists have developed artificial hearts because donor hearts were not available. They proved that it was possible to develop a device that could carry on the functions of this organ. But there are three major problems: size of the artificial organ, noise level of the device, and the power supply for the device.

Rationale

Many African Americans suffer from heart related illnesses due to the consumption of a high fatty diet. The education of the African American community concerning organ donation is important if we want to increase participation. The number of African Americans registered on the organ donor list is smaller than other ethnic groups. Religious beliefs, misconceptions, lack of information about the issue, distrust in the medical community, and the lack of insurance are some of the reasons for the lack in participation. I work in a military academy high school; the student population is 98% African American. I consider it my duty as an educator to give my students the facts so they can make informed decisions. Students can take the information they learn in class back home. They can share the information with their parents. The purpose of the curriculum is to empower my students and remove any misconceptions. I want my students to look upon organ donation and usage of artificial organs favorably. Many lives could be saved in minority communities if the public were educated about the facts associated with organ donation and transplants. A major campaign should be launched to address the misconceptions prevalent in these communities.

Background

Claudius Galen was a highly regarded second century scientist and physician. Galen ascribed to the theory of the four humors, which claimed that the body is composed of a balance between four humors: fire, water, earth and air. Like others at that time, Galen said that the four humors are manifested in our body as yellow bile, black bile, water and phlegm.. (3)

William Harvey was born April 1, 1578 and died June 3, 1657. Harvey challenged this idea and established the era of modern medical science. Harvey based his knowledge on the principles of the experimental method. Harvey was the chief primary physician to King Charles I. He was fascinated with the idea of trying to determine the path in which blood flowed through the body. He proposed that blood traveled through the body in a circular pathway that had not been discovered prior to his time. (4) Harvey conducted autopsies on various subjects of the king. Harvey used criminals found in jails as his live specimens for examination. He began to cut them open while they were still alive. He observed the color, shape, size, arrangement, hardness, softness, smoothness, relation, process and depressions of various body parts. (5) People considered this procedure cruel. Harvey contended that this would help physicians find remedies for the innocent people in the future. Harvey proposed that the blood moves from the veins into the ventricles of the heart, and the arteries by means of the heart beat in the body. Blood is diffused through the arteries into the entire body according to Harvey. (6)

Vessels

We now know that the circulatory system is divided into two systems, the pulmonary circuit and the systemic circuit. The pulmonary circuit supplies blood to the lungs and the systemic circuit supplies blood to the rest of the body tissues. Blood flows through a series of tubes in our body. The tubes range in size from large to small. The human body consists of three major types of blood vessels: arteries, veins and capillaries. The walls of the arteries and veins are made up of three different layers. Tunica interna is the inner layer of the blood

vessel. The top layer of the tunica interna consists of endothelial cells. A layer of connective tissue can be found just beneath the endothelial layer. Elastic fibers are dispersed throughout the connective tissue.

The tunica media is the middle layer of the blood vessel. Collagen and elastic fibers provide the framework for this layer. Smooth muscle cells are dispersed inside the framework. Smooth muscle cells allow the vessel to contract. When contraction occurs the diameter of the vessel decreases and dilation (the opposite of contraction) occurs when the cells relax. This is important because the amount of blood volume and blood pressure changes under these conditions.

Tunica externa is the outer layer of the blood vessel. It forms a covering around the vessel. It consists of connective tissue and collagen fibers. The collagen fibers tend to intertwine with neighboring tissues, which allow them to anchor and stabilize the blood vessel.(7) The multiple layers of these blood vessels enable them to have certain mechanical properties, including strength and elasticity. The blood is pressurized and the vessels are strong enough to hold up to this pressure. In addition, some vessels are elastic: they can expand in situations of high pressure and return to their normal size when the pressure goes down.

We have two types of arteries in our body. The largest type of artery is elastic; its diameter could reach up to 1 inch (2.5cm). These include the vessels that are found in the pulmonary and aortic trunk, and also the major arterial branches. The elastic fibers found in these blood vessels absorb the pressure shock generated in systole; systole is the contraction of the heart ventricle, which causes blood to leave the heart.(8) The pressure increases rapidly in the aorta, because blood is rapidly ejected from the heart into systemic circulation during systole. The diameters of these vessels are large in order to accommodate the large amount of blood flow. The opposite occurs during ventricular diastole or relaxation of the heart after contraction. In diastole, arterial blood pressure decreases and the elastic fibers recoil and return to their original shape. Image a rubber band stretching and then returning back to its original shape. A rigid rubber band would not have the ability to change its shape. A rigid aorta would not be able to expand to accommodate the blood ejected during the systole; instead the additional blood would cause the vessel to break. And we would have a breach in the system.

The medium size arteries are muscular and they distribute blood to the peripheral organs, the diameter is about 0.15 inches (0.4 cm). The carotid artery is an example of this type. It is not necessary for the carotid artery to expand as much as the arteries coming directly from the heart. The medium size arteries contain more smooth muscle cells and less elastic fiber. Arterioles are smaller than the muscular arteries. The average diameter of an arteriole is about 30 *u*m. (9) The tunica media of arterioles has approximately one to three layers of smooth muscle cells. Because they have abundant smooth muscle cells, medium sized arteries and arterioles can change their diameter. A change in diameter of the arteries and the arterioles alters the resistance of the vessel to flow: the body uses this muscular control of vessel size to modulate the rate of flow of the blood to different tissues.

Capillaries are blood vessels that contain walls that allow an exchange between blood and surrounding interstitial fluid. The walls of a capillary are thin, and the diffusion distance is very small allowing the exchange of gases to happen quickly. Blood flows through capillaries at a slower rate allowing more time for diffusion and transport of materials across the capillary walls. The average diameter of a capillary is approximately 8*u*m (micrometers). Red blood cells range in size from about 6*um* to 8*u*m. The size of the red blood cell requires it to flow through the capillary in a single file arrangement. Endothelial cells make up the entire lining of the capillary. Gaps between the cells allow substances to leave the capillary by diffusion. (10) The quantity of oxygen extracted from the blood in the capillaries is determined by the relationship between the rate of

oxygen used and the blood flow. The human body is made up of several types of tissues. The oxygen requirement varies depending upon the type of tissue. Contracting skeletal muscles, as compared to connective tissues or glands have different requirements for blood flow through their capillary networks. (11)

Circuits of the heart

The heart is responsible for pumping blood to all cells of the body. It is also responsible for pumping blood to the lungs where the blood gives up carbon dioxide and takes on oxygen. Our heart is a very efficient machine that has the ability to do two jobs; the heart is the common link between the two circuits. The pulmonary circuit is responsible for blood leaving the heart through the pulmonary arteries. The blood goes to the lungs and returns to the heart through the pulmonary veins. In the systemic circuit blood leaves the heart through the aorta and goes to all organs of the body. The blood travels through the systemic arteries and then returns to the heart through systemic veins. (12)

Basic facts about the heart

The heart weighs approximately 7-15 ounces (200-425 grams). Over the course of a lifetime the heart will beat about 3.5 billion times. It generally beats about 100,000 per day. The heart pumps 2000 gallons of blood per day. The heart is the size of a fist. The heart sits in a fluid filled double walled sac called the pericardium.

When blood pressure is measured, it detects the pressure in blood flowing through the arteries because it is higher than the pressure running through veins. Blood pressure is measured using two numbers. The first number represents the pressure when the heart contracts, also called systolic pressure. During this phase the ventricles contract and pump blood into the heart.

The second number represents pressure when the heart relaxes, called the diastolic pressure. During this phase the ventricles are relaxed and the heart fills with blood. The

The two numbers are usually expressed in millimeters of mercury (mmHg). A column of mercury rises and falls when your heart beats. The height of the column is measured in millimeters. Normal blood pressure falls within the range of 110-150 millimeters when the heart contracts and 60 to 80 when the heart relaxes. Blood pressure increases when you exercise and decreases when you sleep. When the blood pressure is too high or too low you may be in danger of getting heart disease.(14)

Systematic Arterial Pressure

High pressures maintained within the systemic arteries make up the pressure reservoir. The pressure reservoir acts as a driving force to propel the blood through a vast network of narrow channels in the microcirculation.(15) The hydrostatic pressure is normally 120/80 mm.-Hg. When the pressure falls below the critical level of 60/40 mm.-Hg. there is insufficient pressure to drive blood flow to the brain, and the person will fall into a state of unconsciousness. In this situation, the body will not have enough blood flow to provide oxygen for metabolizing tissues such as the heart and kidneys. They will not to operate properly.

Cardiac output is the volume of blood pumped by the heart per minute (mL blood/min). Cardiac output is a function of heart rate and stroke volume. The heart rate is the number of heart beats per minute. The stroke volume is the volume of blood, in milliliters (mL), pumped out by the heart with each beat.(16) Increasing the heart rate or stroke volume increases cardiac output. Cardiac output in mL/min=heart rate (beats/min) x stroke volume (ml/beat). An average person has a resting heart rate of 70 beats per minute and a resting

stroke volume of 70 mL per beat. The cardiac output for a person at rest is: Cardiac Output= 70 (beats/min) x 70 (mL/beat) = 4900 mL/minute. The total volume of blood in the circulatory system is 5 liters (5000 mL).(17) At rest the entire volume of blood within our circulatory system is pumped by the heart every minute.

Many factors influence the stroke volume. Ventricular filling pressures, as well as resistance of the ventricular walls during contraction and expansion influence the diastolic ventricular volume. The ventricular pressure depends on the total volume of blood in the cardiovascular system and the distribution of blood as it is affected by the venous capacity in various channels and reservoirs .The myocardium requires a constant source of energy in order for it to contract and to expel blood. The energy has to be supplied continuously by a process that is dependent upon the continued flow of blood through the coronary arteries.

The nervous system plays a role in controlling our heart rate. The total nervous system contribution represents a balance between the sympathetic and parasympathetic neural inputs into the region of the heart pacemaker. Every beat in our heart is caused by the electrical signal that was generated from within the heart. The signal begins with the sinoatrial node (SA). The sinoatrial node is also referred as our natural pacemaker. The number of signals the sinoatrial produces per minute is your pulse (heart rate). When the systemic arterial pressure is lowered specialized receptors found in the carotid sinus and the aortic arch cause our heart to beat faster.(18)The heart rate increases whenever you are exposed to certain types of stimuli such as sounds, cold, pain and celebratory events.

The major function of the arterial system is to accept the intermittent inflow of blood from the heart and turn it into to steady outflow through the peripheral resistance vessels that make up the capillary network. Arteries carry blood away from the heart and veins carry blood towards the heart.

Path of Blood Flow

The heart is the pump for our circulatory system. The left side has two chambers that are connected. The top chamber is called the left atrium and the bottom chamber is called the left ventricle. The right side of the heart has two connected chambers. The top chamber is called the right atrium and the bottom portion is called the right ventricle. A tissue called a septum separates the two sides of the atria and ventricle. The top part of the wall is called the interatrial septum and the bottom portion is called the interventricular septum.(19)

The heart has four valves, which are important for its operation. The function of the valves is to allow blood flow in only one direction. The valves of the heart open and close when the atria and ventricle contract. The valves have a flap of skin called a cusp. The role of the cusp is to seal or open the valve. When this occurs the pumped blood will pass through different chambers of the heart and enter into the blood vessels. The actions of the valves prevent pumped blood from flowing backward.

Blood flows through the systemic and pulmonary circuits in a regular cycle. Oxygen poor blood from the vena cavae fills the right atrium. The atrial systole happens when the atrium contracts. The tricuspid valve located between the right atrium and the ventricle opens up for a short period of time, allowing blood to flow from the atrium into the ventricle, and then shuts. With the valve closed, blood within the right ventricle cannot flow back into the atrium. When the right ventricle contracts, this process is called ventricular systole. The pulmonary valve located between the right ventricle and pulmonary artery opens, allowing blood to flow into the pulmonary arteries, and then closes. Closing of the valve prevents any flow back into the right ventricle. Blood travels through the pulmonary arteries picking up more oxygen. The oxygen rich blood returns from the lungs to the left atrium through the pulmonary veins. The left atrium fills up with blood and contracts. The

contraction is called the atrial systole. The mitral valve that is located between the left atrium and the left ventricle opens allowing blood to pass from the left atrium into the left ventricle. The mitral valve closes, preventing back flow. When the ventricle fills up it contracts; the process is called ventricular systole. The aortic valve located between the left ventricle and the aorta opens allowing blood to flow into the aorta. The aortic valve closes, preventing flow back. The aorta is the main artery that carries blood from the heart to the rest of the body. The aortic valve closes quickly preventing the blood from flowing back into the ventricle, which is readily filling up.(20)

Identifying Heart Disease Symptoms/Diagnostic Exams

Symptoms of heart disease include chest pains, shortness of breath, loss of weight, discoloration. Several tests are performed on patients suspected of having heart disease. It is important for the doctor to gather excellent knowledge about the medical history of the patient. Careful evaluation will enable the doctor to set a reliable baseline so the problem can be treated effectively. It is important to take the pulse of an individual and electrocardiogram of the person. In many situations it may be necessary to know the output of blood for each section of the heart. External examination of the jugular vein can help determine venous pressure; however an internal examination is more reliable.(21)

The pulse is taken to determine if the heart has an abnormal beat. Noninvasive tests are administered first. One example of a noninvasive test is a typical x-ray. Echocardiography, fluoroscopic exams, electrocardiogram, stress tests, radioactive tracers, cardiac catheterization are additional ways to detect heart disease. X-rays will detect any size increase to the heart. The x-ray is also to detect pulmonary congestion, excess fluid around the heart and any cloudiness in the lungs. The fluoroscopic exam allows examination of the motion and movement of the heart valves. The patient is required to swallow a substance containing barium. The barium makes those parts of the body easier to see with x-rays.(22)

Ultrasound is used to study the location and motion of heart structures. Electrocardiogram provides a graphic display of all electrical activity in the heart. Stress tests are used to determine the functional capacity of the heart. Nuclear medicine techniques can also be used; radioactive tracers such as thallium attach themselves to potassium receptors in the blood stream. The path of blood can be examined using this process. Cardiac catheterization is used to determine blood flow and blood pressure within the chambers of the heart. A long, thin flexible tube called a catheter is put into a blood vessel in your arm, groin or neck and threaded to your heart.(23) Doctors can perform diagnostic tests and give treatments on your heart with a catheter. A special dye is put into the catheter. The dye will flow through the bloodstream to the heart. When the dye reaches the heart it will enable the cardiologists to examine the inside of the coronary arteries on the x-rays, this test is called coronary angiography.(24) The dye will show whether plaque is present in the coronary arteries. Plaque is made up of fat, cholesterol, calcium and other substances found in the blood. Plaque narrows the inside diameter of the arteries, causing a restriction of the blood to the heart. When the plaque builds up in the arteries the condition is caused coronary heart disease or coronary artery disease.(25) Blockages in the coronary arteries can also be seen using ultrasound during cardiac catheterization. Ultrasounds create a detailed picture of the blood vessels found in the heart. Another alternative of treating a blockage is to insert a tiny balloon through the catheter, this is called angioplasty.(26) The balloon is inflated causing the plaque to push up against the wall of the artery, causing a wider pathway for blood flow to the heart.

Types of Heart Disease

Heart disease results when blood flow is obstructed or altered. Heart disease can be divided into six types. Diastolic dysfunction, systolic dysfunction, and cor pulmonale (pulmonary heart disease) are examples of

congestive heart disease that affect the chambers of the heart. Cardiomyopathy and myocarditis are examples of heart disease that affect the muscle from within. Some heart diseases only affect the valves of the heart. Examples of this type of disease are mitral stenosis, mitral valve regurgitation, mitral valve prolapse, aortic stenosis, rheumatic heart disease, tricuspid stenosis and tricuspid regulation.(27) Angina, atherosclerosis and coronary artery disease affects the arteries and veins. Aterial fibrillation and premature atrial contraction are examples of heart disease involving the electrical system of the heart.

Endocarditis is heart disease in the lining of the heart. Congenital heart disease can affect any part of the heart: congenital means that individuals are born with it. Congential heart disease can affect the heart muscle, valves and blood vessels. Aortic stenosis is an example of a congential heart disease. Hypertension is another name for high blood pressure. A reading of 140/90 is considered as high. The high blood pressure will damage the heart. It causes a diastolic dysfunction in older people. Consumption of large amounts of salt and fatty foods, obesity, and diabetes can lead to heart disease. Excessive intake of alcohol can lead to hypertension. Hypertension can lead to a stroke. Systolic and diastolic blood pressure is reduced in individuals who suffer from a stroke.(28)

Oral contraceptives and hormone replacement drugs have caused an increase in venous thromboembolism in women. Studies have been made and a comparison was done comparing the women in the United States and women in Sweden. Women taking contraceptives had a higher incidence of developing blood clots. Post-menopausal women have a moderate rate for developing blood clots. The common factor in both situations was the presence of hormone replacement. Scientists have linked hypercoagulability to hormone replacement. It was higher in women who take hormone replacement drugs.(29)

Statistics about Heart Disease in African Americans

African American women were found to have a higher risk of developing cardiovascular disease when they were compared to other ethnic groups. They are less likely of knowing that they may have major risk factors. Diabetes, smoking, high blood pressure, high blood cholesterol, physical inactivity, overweight/obesity and family history of heart disease are the leading causes of heart disease and strokes.(30) African American women are not well informed about cardiovascular disease, statistics indicate that 41% consider themselves well informed. Cardiovascular disease is 44.7 %, compared to 32.4 percent in white females. African American females and males have higher death rates from heart disease and strokes and other cardiovascular diseases than white females and males.(31) High blood pressure is the leading cause of stroke, the rate of high blood pressure for non-Hispanic black females age 20 and older is 45.4 percent. Compared to Caucasian women, African American women have an 85 percent higher rate of ambulatory medical care visits for high blood pressure. The risk of heart disease and stroke increases with physical inactivity. Physical inactivity is more prevalent in women. Non-Hispanic black females age 18 and older, 33.9 percent are inactive, compare to 21.6 percent of non-Hispanic white females. Approximately 77.2 percent of non-Hispanic females ages 20 and older are obese, also 17.2 percent in the age group of 18 and older smoke cigarettes.(32) Smoking increases the risk of developing a heart attack and stroke.

Heart Attack/Myths

A heart attack occurs when blood flow to a part of the heart is blocked. The heart muscle is damaged during a heart attack because it is denied oxygen rich blood, this is called myocardial infarction.(33)A heart attack requires immediate medical attention. Chest pain is a common symptom of a heart attack. The pain may occur in one part of the body or it can move from the chest to your arms, shoulder, neck, teeth, jaw, belly area or back. The pain will range from severe to mild. Severe pain can last longer than 20 minutes. It will feel like a

heavy pressure on your chest. Other symptoms of a heart attack include: anxiety, fainting, dizziness, vomiting, palpitations, shortness of breath and sweating. Some people like the elderly, people with diabetes and women have little or no chest pain. They will suffer what is known as a "silent heart attack", a heart attack with no symptoms.(34) There are many myths associated with a heart attack. They range from the heart is attacked, the heart stops beating. People tend to believe that severe chest pain means that you are getting a heart attack. It is very difficult to determine the cause of a chest pain. People tend to believe that if you have one heart attack you are in bad shape. However, if you have two then you are crippled, other myths including the idea that once your heart stops you are a dead. And the final myth is that surgically replacing a sick heart valve makes the heart good as new. All of these are incorrect. Once the heart develops scar it will remain as scar tissue.

Treatment

Improvements have been made in treating heart disease. New medicines and surgical procedures have been developed over the past few years for treating heart disease. The procedures have extended the life of many people suffering from heart disease. Catheterization has improved and the as a result the risk of morbidity and mortality have decreased.(35)Balloon angioplasty, bypass surgery, vein grafts, pace makers and transplants are surgical procedures used to treat heart disease. Drugs have made a significant impact in the treatment of heart disease. Digoxin, nitrates, nitroprusside, Inotropes, dopamine, heparin, dobutamine and lipoproteins are some of the medicines used to treat individuals suffering from heart disease. Medication along with a change in the diet of heart patients have prolonged the life of heart patients.(36)

The History of Heart Transplantation in Humans

Two major types of heart transplant surgery are readily performed in this country. Orthrotopic Heart transplant surgery is when a heart is removed, preserved and packed for transportation. The heart must be transplanted into the patient within 4-5 hours or it will be rendered useless. Heterotopic heart transplantation uses the heart of the patient along with a donor heart. The transplanted heart is placed on the right side. It will aid the patient whenever complications occur with the heart of the recipient.(37)

James D. Hardy performed the first human cardiac transplant. Donor teams were organized in December of 1963. The major problem that the team faced was trying to find a suitable donor who died approximately around the time that the recipient was classified as terminal. During this time they did not have any laws that identified a person as brain dead. The surgical team faced several laws that prevented them from removing the heart from the body of a person still alive. Hardy had obtained the heart of two chimpanzees in the event a human donor was not available.

A patient suffering from severe heart disease was dying because his heart was failing. Another person in the same hospital was brought in and he was placed on a ventilator. The patient was declared brain dead. The surgical team refused to take the brain dead patient off the ventilator in order to remove his heart. They felt that is was morally wrong and refused to perform the surgery. Instead the heart of a chimpanzee was used. The heart failed because the heart of the chimpanzee was too small to support the circulation of the man. The recipient died shortly after the transplant.(38)

Christian Bernard performed the first orthotopic homotransplant on humans in 1967. A donor heart was taken from a patient who had not any electrocardiographic activity for approximately five minutes. The donor was given a blood thinner and his chest was opened. The donor was placed on the heart bypass machine and his body temperature was cooled down to 16 degrees Celsius. The heart was removed and placed into a

container. The patient waiting for the heart was in the operating room next door. The donor heart was without blood for 7 minutes at normal room temperature, 14 minutes at 22 degrees Celsius. The heart had undergone an additional 117 minutes of perfusion then the heart was defibrillated after 31minutes and the patient was removed from the cardiopulmonary bypass machine after 47 minutes. The patient had to go back on the cardiopulmonary bypass machine after 3 minutes because he suffered from high blood pressure. The patient was eventually removed from the machine after 221 minutes of pump time. Azathioprine and other steroids were given to the patient in order to stop any rejection of the organ.(39) Since then numerous heart transplants have been performed in various hospitals all over the world, 102 heart transplants were performed in 1968.

Transplants and Organ Donation

Transplantation has progressed significantly since performed in 1958 However three questions remained the same. The first concern is type matching between the donor and the recipient prior to the transplant. Organ rejection is a major concern for with heart transplant surgery. Medications are given to the recipient of the organ to cut down on rejection. It is very costly whenever a recipient gets an organ and the body rejects the new organ. Our immune system will go on the attack whenever a foreign body is introduced. Medications are given to the person prior to getting the organ. The purpose of the medications is to prevent tissue rejection and allow time for the body to heal. Another problem was how to preserve the organ and transport the new organ to the donor. When a surgical team decides to perform a transplant two hospitals have to be on call. One surgical team is involved in removing the organ and the other team is involved in getting the donor prepared for surgery. Transplantation surgery is extremely expensive.

An alternative to heart transplantation is an artificial heart. But artificial hearts are not yet developed to be a reliable alternative. One problem with artificial hearts is the power source. Scientists have not developed a compact battery source small enough to fit inside of the chest of a man or women. Several artificial heart devices were developed during the 1970's. Scientists even used the heart of a primate and transplanted it inside of a human. The patient survived for a short period of time. Many people die while waiting for heart transplants and artificial hearts can serve as a bridge to transplantation. Doctors are now implanting a cardioverter defibrillator inside the body of individuals waiting for donor hearts. Advances in this field of technology have allowed doctors to implant these devices transvenously with hardly any deaths. (40)

Infection after transplantation is one factor that will cause the patient to reject an organ. An extensive evaluation is necessary prior to the person going on the heart transplant organ donor list. Several factors are examined by the transplant team. The medical history of the candidate is completely examined. A recipient will be asked if they have had any of the following types of infections: bacterial, viral, fungal, and parasitic. It is necessary to know this information prior to surgery. Some candidates may even be eliminated from the list depending upon their answers. Sexual behavior of the recipient will be examined by the transplant team. High risk sexual behavior is a major concern because if a candidate has been exposed to the HIV virus it could cause organ rejection. HIV-antibody tests are given to all candidates awaiting transplant organs.

Many people wait on organ donor lists for a long time depending upon which organ they are waiting for. People have the opportunity to indicate if they would like to become an organ donor when their driver's license is renewed. The unpleasant task of getting the permission of the family is removed when the donor indicates this request. New advances in science are creating artificial tissues which could possibly be used in transplantation. However the demand for organs continues to increase because people are living longer. It is necessary to the increase the awareness organ donor campaigns in all cities across the country.

Objectives

Students will be able to identify the primary controllable and uncontrollable factors that put one at a greater risk for developing heart disease. They will increase their awareness of how lifestyle changes can reduce the chances of developing cardiovascular disease. Students will be able to identify the path that blood takes in the body and understand the importance of the blood vessels in the body. Students will be able to conduct research using the internet and print materials regarding heart disease. Students will be able to write an integrated report discussing the various types of heart disease. Students will integrate anatomy & physiology of the heart using artistically pleasing and anatomically correct diagrams/models of the heart. Students will conduct a public symposium consisting of a panel of 3 cardiologists; they will present pertinent questions to the panel informing the audience about the causes and dangers of heart disease.

Strategies

A multitude of strategies are encompassed in this unit. In order for me to make my unit effective I have to incorporate the different learning style of my students. I will use the KWL strategy at the beginning of the unit. This strategy will inform me of any misconceptions my students may have about heart disease. I will address visual learners by having my students build models and make diagrams; this will facilitate a better understanding of the relationship between structure and function, particularly when studying the physiology and anatomy of the heart.

Laboratory investigations will be conducted in this unit. Students will have the opportunity to examine heart specimens and make microscopic slides from the following animals: chickens, cows, pigs and sheep. Laboratory experimentation gives students the opportunity to conduct a "hands on" investigation. Students will answer a scientific question and observe various phenomena in a laboratory setting. Students will conduct library and internet research projects. The ability to find information is integral to the educational success of my students. Students will make spreadsheets which will allow them collect and organize data in a clear and concise manner. The spreadsheets will aid in the analysis of the data. An extensive amount of vocabulary is incorporated in this unit. Students will have the opportunity of increasing their vocabulary because majority of the words used in this unit derive from Latin. Students are required to go on guided web tours. Web tours will allow students the opportunity to find videos illustrating: circulation of blood in the body, different forms of cardiovascular disease, and procedures used to identify cardiovascular disease. Students will be given prompts and engage in response writing about the videos they observed. They will use the Think/Pair/Share technique at the conclusion of the response writing activity.

Students will work in cooperative learning groups when they develop and execute the plans concerning the Heart Disease Symposium and Valentines' Day fundraiser scheduled for the month of February. The symposium is also a service learning project because the students will invite the public to attend. This is a great opportunity for the students to give back to the community. Several local televisions stations will be invited to cover the event. The entire project will be conducted by the students. Students will plan the program, serve as moderator, develop questions, advertise the event, invite the speakers, decorate the school for the event and last but not least clean up after the event. Students will take a trip to the Franklin Institute

using the funds they raised from the Valentines' Day project. Students will have the opportunity to walk through a large model of the heart at the Franklin Institute. They will write about this experience in their science journals.

Classroom Activities

Students will develop a better understanding of cardiovascular disease and develop a sense of empowerment when the following techniques such as; Q & A, K-W-L charts, graphic organizers, video analysis, cooperative learning strategies, laboratory investigations and service learning projects are used.

Activity #1

The behavioral objectives for this activity include: (1) students will learn about the types of blood vessels found in the human body. (2) students will compare and contrast how the different blood vessels affect the quantity of blood flow in the body.

Arrange the students into groups of two. Distribute five different sizes and lengths of rubber tubing to each group. Give each group some red dye food coloring and one 400 mL beaker, 100 mL, 50 mL,10 mL graduated cylinder and 1 tray approximately 5 inches deep. Ask students to place 6 drops of food coloring into the beaker along with 250 mL. of water. Students are required to pour 50 mL of red water into each piece of rubber tubing. Ask them to describe the flow of the water through the tube. Students should focus on the amount of time it took for the water to flow. Students should compare and contrast the width of the tube and the length. Correlations' can be made between the types of blood vessels found in the body and the role they play inside of us.

Activity #2

The behavioral objectives for this activity include: (1) students will learn the path blood takes when it flows inside of our body; (2) students will learn the role the valves play inside of the heart.

Distribute laptop computers to students and have them conduct a video search. One of the best videos is found on the PBS website. Students will have the opportunity to observe the video entitled "Mysterious Human Heart". PBS is a website for teachers; it provides free resources for teaching and learning. Students can take a tour of the heart in this video and engage in several interactive activities when they tour the heart.

Activity #3

The behavioral objectives for this activity include: (1) students will learn the importance of the stethoscope; (2) students will learn how the stethoscope detects heartbeat; (3) Students will be able to hear what a stethoscope actually detects.

Arrange students into groups of two. Give each group one glass T-tube, some rubber tubing, a small plastic funnel, a small glass funnel and a 8 cm. piece of rubber tubing. Insert the 8 cm. piece of rubber tubing over the tip of the glass funnel. Place the T-tube into the other end of the short piece of rubber tubing and attach the longer pieces of tubing into both arms of the T-tube. Have one student hold the funnel firmly over the

heart while the other student holds the ends of the long tubes in his/her ears. Students will be able to hear heart sounds very clearly. Ask students to make the same device using the plastic funnel. Ask students to compare/contrast the differences between the two funnels that they prepared. Have students to run in place for five minutes and use the stethoscope again. Ask students to compare the sound and frequency of the heart beats after running in place.

Activity #4

Behavioral objectives for this activity include: (1) students will learn have to take the pulse rate; (2) students will learn what the pulse rate actually means; (3) students will prepare a spread sheet for the pulse rate of the individuals found in the class.

Students will place two fingers on the wrist and apply a small amount of pressure by pushing against the back of the wrist with the thumb. They will practice finding the pulse rate by counting for 15 and 30 seconds. Once the students are comfortable at finding the pulse rate they should record the pulse rate of their partner on the chart paper in front of the class. Once students have all of the pulse rates recorded they should use the excel program and develop a spreadsheet. Have students compare/contrast the pulse rates of the students in the class.

Activity #5

Behavioral objectives for this activity include: (1) students will be able to compare/contrast the differences between the hearts of the various types of animals based on physical observations; (2) students will be able to prepare microscopic slides of heart cells in various types of animals.

Arrange students into groups of four. Obtain several packs of chicken hearts from your local grocery store. Go to your local slaughter house or meat store an obtain the hearts of the following animals: cow, pig and sheep. Give each group one sample of the heart of a chicken, pig, sheep and cow. Ask the students to carefully observe each specimen. They should record observations in their lab journals. Ask the students to obtain four clean microscope slides and four cover slips. Students should cut a very thin piece of tissue and place it between a microscope slide and a cover slip. They should observe the slide under low power first. It may take several tries in order for the students to obtain a thin piece of tissue. After observation the students should make slides using tissue from different locations of the heart. Students will prepare a diagram of what they observed in their laboratory journals.

Activity #6

Behavioral objectives for this activity include: (1) students will be able to understand the relationship between structure and function of the heart; (2) students will be able to make abstract concepts appear more concrete when they develop physical representations of the heart.

Students will be given the opportunity to develop a model of the heart using any type of products. This is an opportunity for the students to use their creativity when developing their models. It is important for students to labels all of the parts of the model. Models will be on display in the classroom for other students to examine. Students are required to explain how they developed the concept of their model to the class.

Activity #7

Behavioral objectives for this activity include: (1) students will be able to examine the amount of cholesterol

and fat they consume in their diets; (2) students will have the opportunity to reflect on the importance of minimizing the amount of fat and cholesterol they consume on a weekly basis; (3) students will be able to develop a work sheet using the excel program.

Students will make six columns on a sheet of paper. The 1 st column is labeled, "Day"; the 2 nd column, "Type of food"; 3 rd column, "Calories"; 4 th column, "Fat calories"; 5 th column, "Fat (gms)"; 6 th column, "Cholesterol (mg)". Students should record their intake of food for one week. Indicate to the students that this includes everything that the consume. At the end of the week have the students to prepare the "Food /Cholesterol Record Worksheet", using a graphing program on their laptop computers. Students should examine their individual worksheet make several conclusions about their diet. The worksheet will serve as a good indicator for students would may put themselves at risk for developing high blood pressure.

Activity #8

Behavioral Objectives for this activity include: (1) students will be able to identify the different types of cardiovascular diseases, how it is detected and treatment and prevention; (2) students will prepare a PowerPoint presentation for the class.

Each student will be given a specific cardiovascular disease. It is the responsibility of the student to gather information about the disease using internet sources, journals and books. Students will prepare a 15 minute discussion about the disease given to them. Students in the audience will have the opportunity to ask questions.

Activity #9

Behavioral objectives for this activity include: (1) students will be able to raise money for the trip to the Franklin Institute.

Students will develop a template for the student body to use when they compose their Valentines' Day greeting. Once the template is developed the students will cut out red hearts made from construction paper eight and one half inches by fourteen and one half inches. Students will sell the hearts for fifty cents. The hearts will be placed along the walls of the hall close to the ceiling. The money generated is used to pay for the trip.

Activity #10

Behavioral objectives for this activity include: (1) students will be able to engage in a meaningful service activity that will allow them the opportunity to address human and community issues, and provide an opportunity for increased student academic engagement, civic responsibility, personal and social development.

Students will conduct a symposium on heart disease. Students are responsible for developing letters used to send to several cardiologists who have offices near the school. A student will act as the moderator for the panel. The questions the panel will discuss will be developed by the students. It is also their responsibility to get in contact with the news media (radio, television stations). Students will be divided into several committees and the duties will be divided amongst them. The symposium will take place in February, "National Heart Month".

Student Resources

http://http://go.hrw.com. This website is the home page for the publisher of our textbook; it has activities and worksheets directly related to the material in the text.

Johnson, George B., Ph.D. and Raven, Peter H., Holt Biology, Austin: Holt, Rineholt, and Winston, 2004. This book is the recommended textbook for the biology course, as approved by the School District of Philadelphia.

www.SciLinks, This is an online website developed by the National Science Teachers Association. It

Contains content specific activities and provides links to other information you can use for projects, reports, and research papers.

Appendix-Content Standards

The Pennsylvania Academic Standards for Biological Sciences, which will be addressed in this curriculum, was taken directly from the Core Curriculum Standards Alignment and Educational Resource Guide for the School District of Philadelphia. They include the following:

3.3 Biological Sciences Standards (A, B, C)

A. Explain the structural and functional similarities found among living things.

-Explain the relationship between structure and function at the molecular, cellular,

tissue and organ level.

B. Describe and explain the chemical and structural basis of living organisms.

-Explain how cells store and use information to guide their functions.

-Explain cell functions and process in terms of chemical reactions and energy

changes.

C. Describe how genetic information is inherited and expressed.

-Explain the different types of genetic disorders,

Endnotes

[1] "February in American Heart Month," The Center for Disease Control and Prevention, last modified January 31, 2010, http://www.cdc.gov/Features/HeartMonth.

[2] ibid, 1.

[3] "Galen of Pergamum," http://campus.udayton.edu/~hume/Galen/galen.htm

[4] Harvey, "The Circulation of the Blood." xi.

[5] Harvey, "On the Motion of the Heart and Blood in Animals," 7.

[6] Harvey, "The Circulation of the Blood." 115.

[7] Martini, Bartholomew, "Essentials of Anatomy and Physiology." 376, 377.

[8] ibid, 377.

[9] ibid, 377.

[10] ibid, 377.

[11] Rushmer, "Structure and Function of the Cardiovascular System." 119.

[12] Ibid, 25.

[13] "The Human Heart," The Franklin Institute, last modified January 2011,

http://www.fi.edu/learn/heart/vessels/vessels.html.

[14] ibid.148.

[15] ibid, 148.

[16] ibid, 148.

[17] "Cardiac Output," http://www.biosbcc.net/doohan/sample/htm/COandMAPhtm.htm.

[18] "The Human Heart, "The Franklin Institute, last modified January 2011.

http://www.fi.edu/learn/heart/vessels/vessels.html.

[19] ibid, 150.

[20] "The Human Heart," The Franklin Institute, last modified January 2011, http://www.fi.edu/learn/heart/structure/structure.html.

[21] www.nhlbi.nih.gov/health/dci/Diseases/hhw/hhw_circulation.html.

[22] Strong, "Combating Cardiovascular Diseases," 54-66.

[23] "What is Cardiac Catheterization?" http://www.nhlbi.nih.gov/health/dci/Diseases/cath/cath_all.html.

[24] ibid, 1.

[25] ibid, 1.

[26] ibid, 1.

[27] "Types of Heart Disease," http://heart.emedtv.com/heart-diseases/types-of-heart-disease-pg 4.html

[28] Jackson, "Cardiology Current Perspective." 93, 94.tarek, "Heart Valve Replacement And Reconstruction,"9.

[29] Gennazzi, "Hormone Replacement Therapy and Cardiovascular Disease."133.

[30] "Heart & Vascular Center: Women's Heart Care: African American Women Heart Disease & Stroke Statistics."
http://www.muschealth.com/heart/women/africanwomen.htm.

[31] ibid, 1.

[32] ibid, 1.

[33] "Heart Attack," http://www.ncbi.nlm.gov/pubmedhealth/PMH0001246.

[34] ibid, 1.

[35] "What is Cardiac Catheterization?" http://nhlbi.nih.gov/health/dci/Diseases/cath/cath_all.html.

[36] http://www.cincinnatichildrens.org/health/health-encylopedia/treat/surg/transplant.htm.

[37] Myerowitz, "Heart Transplantation." 14

[38] ibid, 14.

[39] ibid, 14

[40] Emery, Miller, "Handbook of Cardiac Transplant." 11.

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""Galen of Pergamum." University of Dayton. http://campus.udayton.edu/~hume/Galen/galen.htm. (accessed July 18, 2011), Website gives provides a good foundation explaining how science changed when actual dissections were performed on people. The idea concerning the four humors was disputed based on scientific evidence.

Center for Disease Control and Prevention. "CDC Features - February is American Heart Month." Centers for Disease Control and Prevention. http://www.cdc.gov/Features/HeartMonth (accessed July 15, 2011). Excellent website that identifies the major causes of heart disease. It give statistics about the number of individuals suffering from hear disease.

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