

## **1. Introduction:**

### **1.1. Brief description about Heart**

Heart is the specialized muscular organ necessary in sustaining life. It functions spontaneously to pump blood through a large volume of blood vessels of the circulatory system. That's how it supplies oxygen and nutrients throughout the body. It also assists in the removal of metabolic wastes. (Guyton & Hall, 2011) From the very beginning or birth until death, the pump goes on. Human heart will contract about 3 billion times; without a single stop except for a fraction of a second between beats. A healthy person's heart continues to beat an average of 100,000 times per day. Many believe that the heart is the first functional organ in the human body. There is an average 60,000 miles of vessels throughout an adult body. (Tortora & Grabowski, 2000). The heart is a hollow, muscular organ located in the left side of thoracic cavity. The heart is a four-chambered, double pump and it is a self-exciting cardiac muscles, meaning it has its own impulse conduction machinery. This is in compare with skeletal muscle, which requires either conscious or reflex nervous stimuli. The heart has continuous rhythmic contractions. The frequency rate of heart can be changed by control of a nervous stimulus or hormonal influence such as exercise or the perception of moments. (Anderson RM, 1993).

#### **1.1.1. Covering of Heart**

**Myocardium** is the muscular tissues of the heart that is composed of specialized cardiac muscle cells. It functions with an ability of spontaneous rhythmic contraction and differ from muscle tissue elsewhere in the body. Cardiac muscle, like other muscles, can

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contract, but it can also conduct electricity, like nerves. **Pericardium** is a thick, membranous sac that covers the heart. It protects and lubricates the heart for its smooth functioning. The pericardium consists of two layers, fibrous pericardium and serous pericardium. The serous pericardium has two layers and in between these two layers a space is there which is called pericardial cavity. The layer next to the heart is the visceral layer, also known as the **Epicardium**, innermost layer and consists of connective tissue.

### 1.1.2. Heart Chambers and Valves

The heart has four chambers, **two atria** and **two ventricles**. The atria are smaller with thin walls, while the ventricles are larger and much stronger. There are two atria on either side of the heart. On the right side is the atrium that contains blood which is poor in oxygen. The left atrium contains oxygenated blood and circulates throughout the body. Right atrium by superior vena cava and inferior vena cava. The left atrium also receives oxygenated blood from the left and right pulmonary veins which are coming from two lungs present in the thoracic cavity.

The ventricle collects blood from an atrium and pumps it out of the heart. There are two ventricles: the right ventricle pumps blood into the pulmonary circulation for the lungs, and the left ventricle pumps blood into the systemic circulation for the rest of the body. Comparing the left and right ventricle, the left ventricle has thicker walls because it needs to pump blood to the whole body.

The interventricular **septum** is the thick muscular wall separating the ventricles from lower chambers of the heart from one another. The two **atrioventricular** (AV) and two

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**semilunar** (SL) valves that ensure that blood flows from the atria to the ventricles and heart to arteries respectively not the other way. Between the right ventricle and the pulmonary trunk have another valve known as pulmonary semilunar valve (Van De & Kent, 2002).

## 1.2. Circulatory pathway

It is convenient to describe the flow of the blood through the right side of the heart and then through the left side, it is important to realize that both atria and ventricles contract at the same time. The heart works as pumps, one on the right side and another on the left side.

The right side pump pumps the blood to the lungs or the pulmonary circulation at the same time that the left pump pumps blood to the systemic circulation.

Deoxygenated blood from systemic circulation enters the right atrium through the superior and inferior vena cava. The right atrium contracts and forces the blood

into the right ventricles through atrioventricular valve and the same time right ventricles contract and force the blood into the pulmonary trunk through the pulmonary semilunar valve and out the pulmonary artery to the lungs where the blood releases carbon dioxide and receives oxygen. The oxygenated blood is carried in the pulmonary veins that take it to the left atrium and forces the blood into the left ventricle. Finally, the left ventricle contraction appears and forcing oxygen rich blood through the aortic semilunar valve into the ascending aorta to all parts of the body.

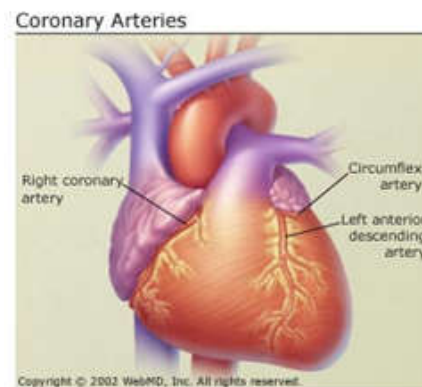


Fig-1. Heart coronary arteries.

### 1.3. Complications with the Heart:

The most common congenital abnormality of the heart takes place in the bicuspid aortic valve. In this condition, instead of three cusps, the aortic valve has two cusps. This condition is often undiagnosed until the person develops calcific aortic stenosis. Aortic stenosis occurs in this condition usually in patients in their ages of 40yrs or 50yrs, an average of 10 years earlier than in people with normal aortic valves. Another common complication of rheumatic fever is thickening and stenosis (partial blocking) of the mitral valve. For patients who had rheumatic fever dentists advised to prophylactically administer antibiotics prior to dental work to prevent bacterial endocarditis. Because these bacteria from the teeth enter the circulation and attach to damaged heart valves.

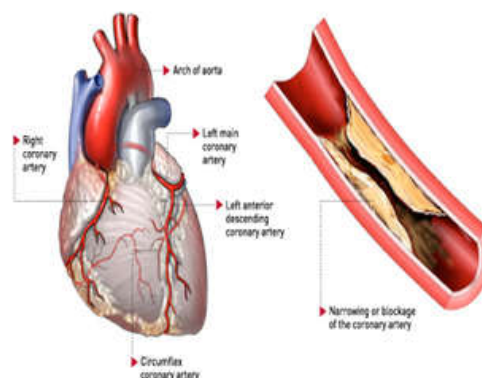


Fig-2. Atherosclerotic plaque in coronary artery.

In developed countries, the two leading causes of death are myocardial infarction and stroke each of these are the direct results of an arterial system that has been slowly and progressively compromised by years of deterioration.

‘Heart disease’ is the term which addresses conditions and disorders that affect the structuring and functioning of the heart in some way or the other. Common known heart conditions include heart failure, heart valve diseases, congenital heart diseases, heart muscle diseases or irregular heart rhythms.

## **1.4. Types of Cardiovascular Disease**

### **1.4.1. Abnormal Heart Rhythms**

The heart is an amazing organ. It beats in a steady, even rhythm, about 60 to 100 times each minute. An irregular or abnormal heartbeat is called an arrhythmia. An arrhythmia (also called a dysrhythmia) can produce an uneven heartbeat, or a very slow or very fast beat. On the basis of heart beat the abnormal beat are classified in two way namely bradycardia and tachycardia. Bradycardia is when; the heart rate is less than 60 beats per minute. Tachycardia is when; the heart rate is more than 100 beats per minute. In this arrhythmia condition the heart may not be able to pump enough blood for whole body system. Sudden cardiac arrest (SCA) and sudden cardiac death (SCD) both are most popular phenomena in case of heart disease that is when the heart suddenly begins to beat in an irregular rhythm (arrhythmia). Without organized activity of heart muscle, the systemic ventricles contraction is disrupted, causing impaired cardiac output (forward pumping of blood from heart to rest of the body). Different types of arrhythmia are already introduced, but the ones most frequently recorded in SCA and SCD are ventricular tachycardia (VT) or ventricular fibrillation (VF).

### **1.4.2. Atrial Fibrillation**

Atrial Fibrillation is regarded as one of the main types of heart diseases and also a common type of Arrhythmia. In this case, the impure (deoxygenated) blood flows through the

body due to mismatched electrical signals. This happens when the built-in pacemaker sends mismatched impulses.

### **1.4.3. Coronary Artery Disease (CAD)**

Coronary artery disease (CAD) is the most known type of vascular disease which is the leading cause of death in both men and women. This type of cardiovascular disease involves atherosclerosis—hardening and narrowing—of the coronary arteries, producing blockages in the vessels that carry blood to the heart. This is due to the build-up of cholesterol and other material which form plaque on the inner walls of arteries. This is commonly known as atherosclerosis. Atherosclerosis happens over time, slowly blocking arteries and eventually restricting blood flow to the heart (Fig-2). As a result, the heart muscle can't get the blood or oxygen in sufficient amount. This can lead to chest pain (angina) or a heart attack. Most heart attacks happen when a blood clot suddenly cuts off the heart's blood supply, causing permanent heart damage. Long time, CAD (Fig: 2 ) can also weaken the heart muscle and contribute to heart failure and arrhythmias.

### **1.4.4. Heart Failure**

Heart failure doesn't mean that the heart stops beating. The main function of the heart is to pump blood, and supply oxygen and vital nutrients to the different parts of the body. When the heart fails to pump enough blood to meet the requirement of the body, the condition of a heart failure arises. Due to insufficient oxygen and nutrient heart muscles have to survive in hypoxic condition and in this situation, it is unable to pump properly. Because, the normal function or the normal blood circulation through heart is decreased so the blood circulates through the

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heart and vessels at slower rate than normal condition. And that is the reason why the blood pressure is increased in dramatic way. In this condition, the force of the blood against the artery walls become too high but the oxygen and nutrient circulation is dropped due to the slower blood circulation, resulting fatigue and shortness of breath.

#### 1.4.5. Heart Attack

Also called "myocardial infarction" (MI), a heart attack happens when blood flow to the heart is severely reduced or cut off, due to the hardening and narrowing of the coronary arteries due to formation of atherosclerotic plaque (by accumulation of lipids) resulting permanent damage or death of part of the heart muscle. Sometime plaque ruptures give rise the blood clotting and then blocking the blood vessels. So, an unexpected loss of heart function, breathing and consciousness is appeared.

#### 1.4.6. Heart Valve Disease

Heart valve problem is one of the major problems in heart disease. Sometime heart valves don't open properly to allow the sufficient blood flow through heart, it is called stenosis. Moreover the heart valves don't close properly and allow blood to leak through, it's called regurgitation. When the valve leaflets bulge or prolapse back into the upper chamber, it's a condition called prolapsed (Fig-3).

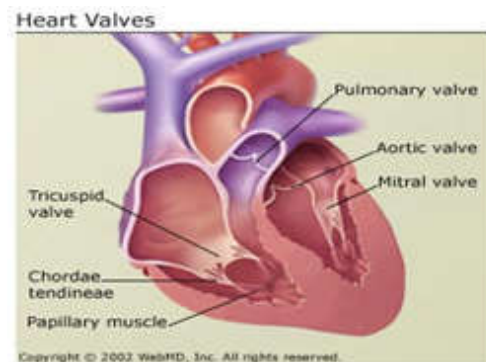


Fig-3. Different heart valves

**Mitral valve prolapse:** The valve between left upper and left lower chambers doesn't close right.

**Aortic stenosis:** The aortic valve narrows. It affects blood flow from your heart to the rest of your body. **Mitral valve insufficiency:** The mitral valve doesn't close tightly enough. This causes blood to leak backwards, leading to fluid backup in the lungs.

**1.4.7. Congenital Heart Disease:** Congenital heart defects are present at birth. These defects are not a disease, but rather an abnormality that occurs while a fetus is developing.

**1.4.8. Angina:** Angina is the chest pain caused when heart muscle survives in hypoxia due to low blood flow through blood vessels. It may feel like pressure or squeezing in chest. The discomfort occurs in different body part such as shoulders, arms, neck, jaw, or back. Angina pain may even feel like indigestion.

The primary cause of Angina is the accumulation of plaque in the walls of arteries which narrow down or restrict the flow of blood to the heart muscles.

#### 1.4.9. Cardiomyopathy:

It is a disease of the heart muscles wherein the muscles become rigid, enlarged, or thicker than normal (Danny Eapen, 2015). Different types of cardiomyopathy are occurred in different cardio-physiological condition. In dilated cardiomyopathy the ventricles enlarge and weaken. In restrictive cardiomyopathy the ventricle stiffens. It affects any age group and is a serious lifelong condition. In cardiomyopathic condition heart is unable to pump an adequate supply of blood around the body. As cardiomyopathy progresses heart becomes

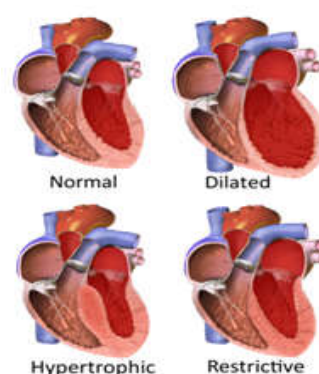


Fig-4. Heart Cardiomyopathy.



weaker. Some types of cardiomyopathy can cause an irregular heartbeat, because the heart muscle becomes stretched (Fig-4).

#### **1.4.10. Aorta disease:**

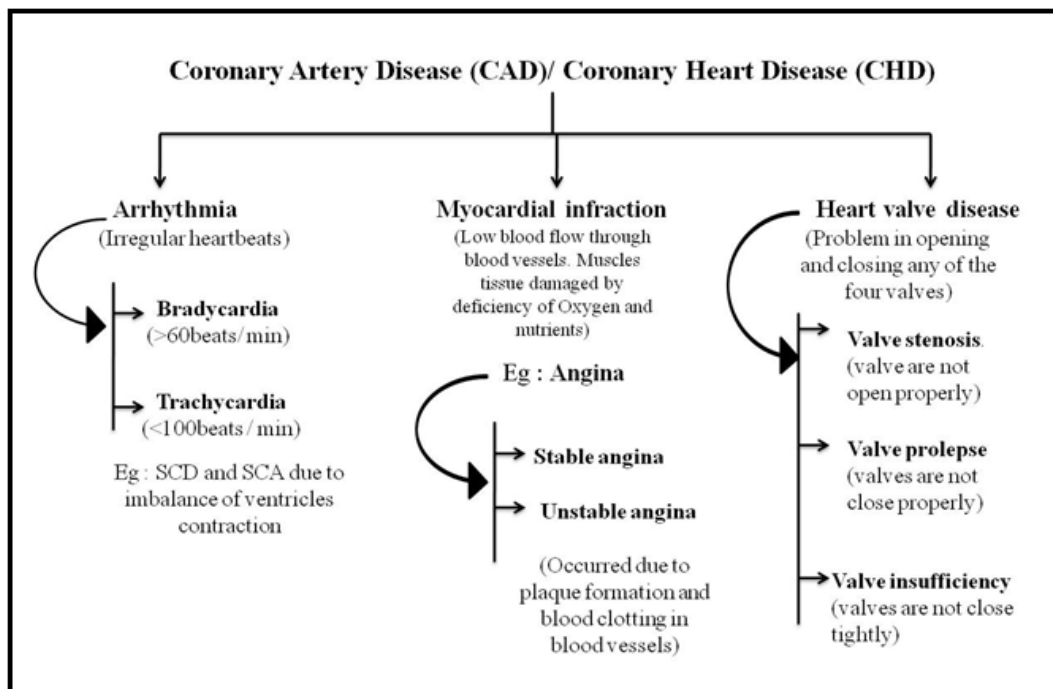
The aorta is the largest artery of the body that leaves the heart and provides oxygen-rich blood to the rest of the human body. Aorta related disease raises the chances of things like as follows:

- Atherosclerosis (hardening of the arteries)
- High blood pressure
- Disorder in connective tissues that affect the strength of the blood vessel-walls. And this is related to the conditions such as scleroderma, osteogenesis imperfecta and polycystic kidney disease

#### **1.4.11. Stroke:**

In this disease condition, brain cells undergo through the oxygen deficiency state due to poor blood flow. And this causes cell death in brain tissues. Two different types of stroke are introduced in human and those are due to a lack of blood flow in brain and hemorrhagic condition due to bleeding. Both are cause to initiate functional disruption of brain. This event finally results in the inability to movements of body, problems in speaking, loss of vision. This condition is also known as cerebrovascular thrombosis.

**1.4.12. Types of CAD and CHD:** Several types of human heart diseases are listed through flow chart below this figure.



**Fig-5.** Flow chart of different types of cardiovascular diseases