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A BRIEF REVIEW OF CARDIOVASCULAR DISEASE & CURRENT TREND FOR RESEARCH

Prof. Ashwini Shrikrushna Taware*

M. Pharmacy (Quality Assurance Techniques), PDEA'S College of Pharmacy Hadapsar Pune-28 (Department of Pharmaceutical Chemistry).

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***Corresponding Author**
Prof. Ashwini Shrikrushna Taware
M. Pharmacy (Quality Assurance Techniques), PDEA'S College of Pharmacy Hadapsar Pune-28 (Department of Pharmaceutical Chemistry).

ABSTRACT

Cardiovascular diseases are the leading cause of premature death & disability in humans & their incidences in on the rise globally. CVDs also generate a high socioeconomic burden in the general population. The underlying pathogenesis and progression associated with nearly all CVDs are predominantly of atherosclerotic origin that leads to the development of coronary artery disease, cerebrovascular disease, venous thromboembolism and, peripheral vascular disease, subsequently causing myocardial infarction, cardiac arrhythmias or stroke. The etiological risk factors leading to the onset of CVDs are well recognized and include hyperlipidemia, hypertension, diabetes, obesity, smoking and, lack of physical activity. Besides making favorable lifestyle modifications, primary regimes for the prevention and treatment of CVDs include lipid-lowering drugs, antihypertensive, antiplatelet and anticoagulation therapies. Despite their effectiveness, significant gaps in the treatment of CVDs remain. In this review, we discuss the epidemiology and pathology of the major CVDs that are prevalent globally. We also determine the contribution of well-recognized risk factors towards the development of CVDs and the prevention strategies. In the end, therapies for the control and treatment of CVDs are discussed.

KEYWORDS: Cardiovascular diseases**,** Epidemiology, Pathology, Risk factors, Prevention strategies, Therapies.

INTRODUCTION

Definition: A hollow muscular organ of vertebrate animals that by its rhythmic contraction acts as a force pump maintaining the circulation of the blood.

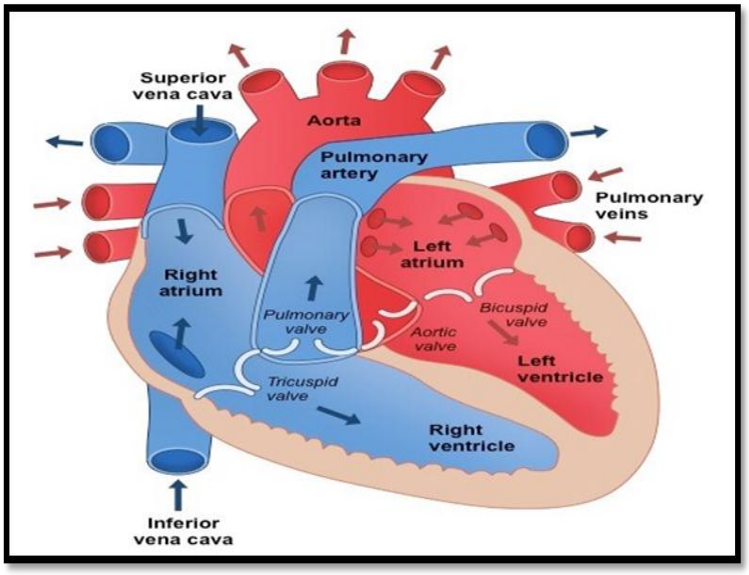

Fig.1.1: Heart.

Location: -Your heart is located between your lungs in the middle of your chest, behind and slightly to the left of your breastbone (sternum). A double-layered membrane called the pericardium surrounds your heart like a sack. The outer layer of the pericardium surrounds the roots of your heart's major blood vessels and is attached by ligaments to your spinal column, diaphragm, and other parts of your body. The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of your fist. By the end of a long life, a person's heart may have beat (expanded and contracted) more than 3.5 billion times. In fact, each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood.

The parts of your heart are like the parts of a house

Your heart has

- ✓ Walls.
- ✓ Chambers (rooms).
- ✓ Valves (doors).
- ✓ Blood vessels (plumbing).
- ✓ Electrical conduction system (electricity).

Your heart walls have three layers

Endocardium: Inner layer.

Myocardium: Muscular middle layer.

Epicardium: Protective outer layer. The epicardium is one layer of your pericardium. The pericardium is a protective sac that covers your entire heart. It produces fluid to lubricate your heart and keep it from rubbing against other organs.

Heart chambers

Your heart is divided into four chambers. You have two chambers on the top (atrium, plural atria) and two on the bottom (ventricles), one on each side of the heart.

Right atrium: Two large veins deliver oxygen-poor blood to your right atrium. The superior vena cava carries blood from your upper body. The inferior vena cava brings blood from the lower body. Then the right atrium pumps the blood to your right ventricle.

Right ventricle: The lower right chamber pumps the oxygen-poor blood to your lungs through the pulmonary artery. The lungs reload blood with oxygen.

Left atrium: After the lungs fill blood with oxygen, the pulmonary veins carry the blood to the left atrium. This upper chamber pumps the blood to your left ventricle.

Left ventricle: The left ventricle is slightly larger than the right. It pumps oxygen-rich blood to the rest of your body.

Heart valves

Your heart valves are like doors between your heart chambers. They open and close to allow blood to flow through. **The atrioventricular (AV) valves open between your upper and lower heart chambers.**

They include

Tricuspid valve: Door between your right atrium and right ventricle.

Mitral valve: Door between your left atrium and left ventricle.

Semilunar (SL) valves open when blood flows out of your ventricles.

They include

Aortic valve: Opens when blood flows out of your left ventricle to your aorta (artery that carries oxygen-rich blood to your body).

Pulmonary valve: Opens when blood flows from your right ventricle to your pulmonary arteries (the only arteries that carry oxygen-poor blood to your lungs).

Blood vessels

Your heart pumps blood through three types of blood vessels: **Arteries** carry oxygen-rich blood from your heart to your body's tissues. The exception is your pulmonary arteries, which go to your lungs. **Veins** carry oxygen-poor blood back to your heart. **Capillaries** are small blood vessels where your body exchanges oxygen-rich and oxygen-poor blood. our heart receives nutrients through a network of coronary arteries. These arteries run along your heart's surface. They serve the heart itself.

Left coronary artery: Divides into two branches (the circumflex artery and the left anterior descending artery).

Circumflex artery: Supplies blood to the left atrium and the side and back of the left ventricle.

Left anterior descending artery (LAD): Supplies blood to the front and bottom of the left ventricle and the front of the septum.

Right coronary artery (RCA): Supplies blood to the right atrium, right ventricle, bottom portion of the left ventricle and back of the septum.

Electrical conduction system

Your heart's conduction system is like the electrical wiring of a house. It controls the rhythm and pace of your heartbeat.

It includes:

Sinoatrial (SA) node: Sends the signals that make your heart beat.

Atrioventricular (AV) node: Carries electrical signals from your heart's upper chambers to its lower ones.

Your heart also has a network of electrical bundles and fibers.

This network includes:

Left bundle branch: Sends electric impulses to your left ventricle.

Right bundle branch: Sends electric impulses to your right ventricle.

Bundle of His: Sends impulses from your AV node to the Purkinje fibers.

Purkinje fibers: Make your heart ventricles contract and pump out blood.

How blood circulates in the heart?

The heart consists of four chambers, four one-way valves, and a set of arteries and veins that regulate the normal flow of blood within the body. The smooth functioning of the circulatory system is maintained by a complex network of blood vessels that circulate blood throughout the body and back to the heart. Whereas veins bring deoxygenated blood back into the heart, those that carry oxygenated blood away from the heart to other tissues in the body are known as arteries. The two exceptions to these are the pulmonary arteries and pulmonary veins, as well as the umbilical artery and vein. The heart's two upper chambers are called the atria, with the atrial septum dividing the right and left atria. The superior and inferior vena cava are major veins that supply the right atrium with deoxygenated blood from the rest of the body. The superior vena cava brings deoxygenated blood into the right atrium from the upper limbs and head, whereas deoxygenated blood from the lower abdomen and limbs is brought into the heart through the inferior vena cava. The pulmonary veins supply oxygenated blood from the lungs into the left atrium and are the only veins in the body to carry oxygenated blood. However, during pregnancy, the umbilical vein carries oxygenated and nutrient-rich blood from the placenta to the fetus. Both atria contract and release blood into the ventricles when full, a process controlled by the atrioventricular valves. The flow of deoxygenated blood from the right atrium into the right ventricle is regulated by the tricuspid valve, while the mitral valve controls the flow of oxygenated blood from the left atrium to the left ventricle. The two lower chambers of the heart are called the ventricles. The right ventricle receives deoxygenated blood that collects in the right atrium. This process occurs by systematically opening and closing the atrioventricular and semilunar valves. The semilunar valve connecting the right ventricle to the lungs is the pulmonary valve. This valve remains closed while the tricuspid valve opens and releases blood into the right ventricle from the right atrium. Similarly, the left ventricle receives oxygenated blood from the left atrium through the mitral valve. During this process, the other semilunar valve, known as the aortic valve, remains closed to allow the left ventricle to fill with blood. The ventricles contract when full, subsequently causing the tricuspid and mitral valves to close and the pulmonary and aortic valves to open on the right and left sides, respectively. When the right ventricle contracts, deoxygenated blood flows through the pulmonary valve into the lungs through the pulmonary trunk. The pulmonary trunk splits into the left and right pulmonary arteries, the only arteries in the body to carry deoxygenated blood. However, during pregnancy, the umbilical artery will also carry deoxygenated blood from the fetus to the placenta to re-oxygenate the fetal blood supply. Oxygenated blood is pumped through the aortic valve into the aorta when the

left ventricle contracts. The aortic valve splits into smaller arteries, known as common iliac arteries, which carry blood to the rest of the body through a complex network of arteries.

Function of heart

- Primary function of Heart pumps oxygenated blood to other parts of the body.
- It also pumps out hormones & other essential substances to different parts of the body via blood.
- Another primary function of the heart is to receive oxygen poor blood & pump it to the lungs for oxygenation, transporting metabolic waste products from body.
- Function of heart in any body organism is to maintain a constant blood throughout the body. This replenishes oxygen & circulates nutrients among the cells and tissue.

There are two types of circulation within the body, namely pulmonary circulation and systemic circulation.

Pulmonary circulation and Systemic circulation

Pulmonary circulation is a portion of circulation responsible for carrying deoxygenated blood away from the heart, to the lungs and then bringing oxygenated blood back to the heart.

Systemic circulation is another portion of circulation where the oxygenated blood is pumped from the heart to every organ and tissue in the body, and deoxygenated blood comes back again to the heart.

Now, the heart itself is a muscle and therefore, it needs a constant supply of oxygenated blood. This is where another type of circulation comes into play, the coronary circulation. Coronary circulation is an essential portion of the circulation, where oxygenated blood is supplied to the heart.

This is important as the heart is responsible for supplying blood throughout the body. Moreover, organs like the brain need a steady flow of fresh, oxygenated blood to ensure functionality.

Following diagram show Pulmonary circulation (blue) and Systemic circulation (red)

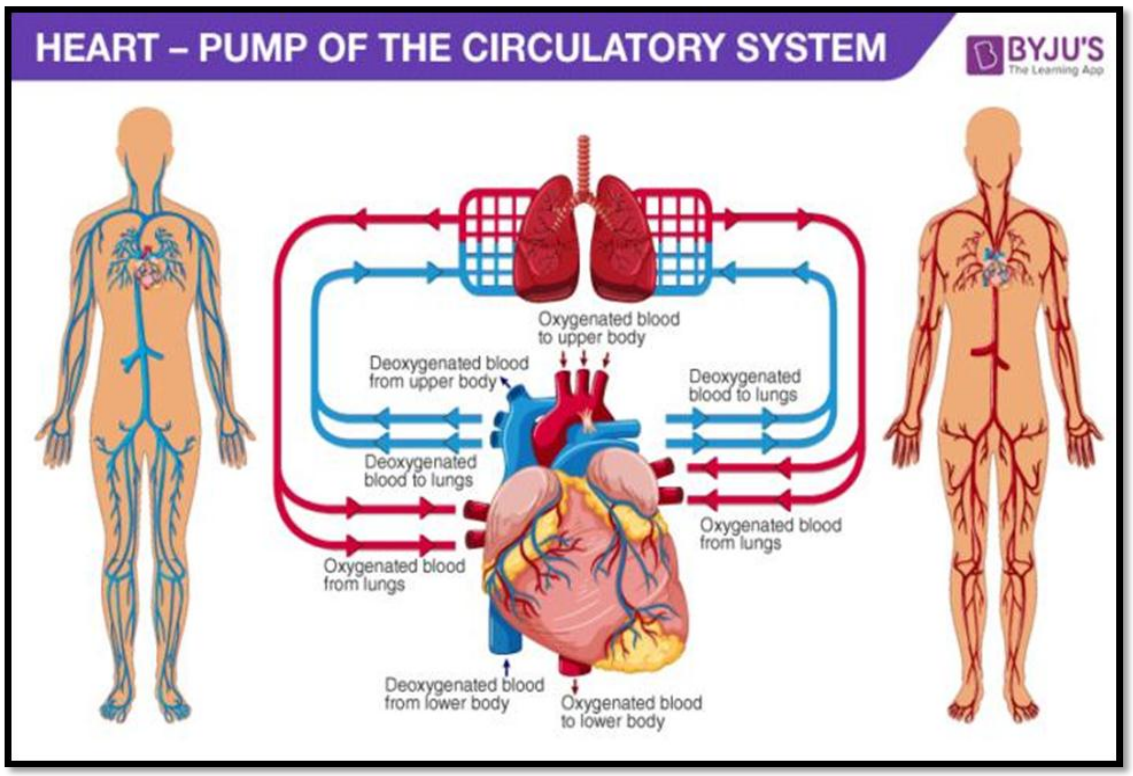

Fig.1.2: Blood Circulation Systems.

Cardiovascular Diseases

Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels.

OR

A type of disease that affects the heart or blood vessels. Also called cardiovascular disease.

List of heart diseases

- Heart attack
- Heart failure
- Heart muscle disease (cardiomyopathy)
- Heart valve disease
- Pericardial disease
- Peripheral vascular disease
- Rheumatic heart disease
- Stroke
- Vascular disease (blood vessel disease)
- Unstable angina. Unstable angina can be undiagnosed chest pain or a sudden worsening of existing angina

- ❖ Arrhythmia (abnormal heart rhythms)
- ❖ High blood pressure
- ❖ Congenital heart conditions
- ❖ Inherited heart conditions
- ❖ CVD includes coronary artery diseases (CAD)
- ❖ Angina
- ❖ Myocardial infarction (commonly known as a heart attack).
- ❖ Hypertensive heart disease
- ❖ Abnormal heart rhythms
- ❖ Valvular heart disease
- ❖ Cordites
- ❖ Aortic aneurysms
- ❖ Peripheral artery disease
- ❖ Venous thrombosis
- ❖ Aorta disease and Marfan syndrome
- ❖ Pulmonary embolism

Causes of Heart Diseases: Diseases occur because of irregular or bad circulation in heart.

What are some signs of bad blood circulation?

- o Tingling or numbness in hands and feet
- o Cold hands or feet
- o Swollen ankles and legs
- o Loss of memory and difficulty in concentrating
- o Issues with the digestion of food
- o Fatigue
- o Muscle cramps
- o Changes in skin color
- o Occurrence of ulcers
- o Varicose veins

Common medical tests to diagnose heart conditions

- Blood tests.
- Electrocardiogram (ECG)

- Exercise stress test.
- Echocardiogram (ultrasound)
- Nuclear cardiac stress test.
- Coronary angiogram.
- Magnetic resonance imaging (MRI)
- Coronary computed tomography angiogram (CCTA)

Blood Test

Certain elements in your blood, like your cholesterol, triglycerides, or fibrinogen, are like a window to your heart health. Using blood tests to understand your risk of coronary artery disease is a proactive approach to a healthier heart. Work with your healthcare provider to understand your results and determine the best next steps.

Electrocardiogram

An electrocardiogram (ECG or EKG) records the electrical signal from the heart to check for different heart conditions. Electrodes are placed on the chest to record the heart's electrical signals, which cause the heart to beat. The signals are shown as waves on an attached computer monitor or printer.

Exercise stress test

Exercise makes the heart pump harder and faster. A stress test can show problems with blood flow within the heart. A stress test usually involves walking on a treadmill or riding a stationary bike. A health care provider watches your heart rhythm, blood pressure and breathing during the test.

Echocardiogram

An echocardiogram can help diagnose and monitor certain heart conditions by checking the structure of the heart and surrounding blood vessels, analyzing how blood flows through them, and assessing the pumping chambers of the heart.

Nuclear cardiac stress test

A nuclear stress test uses a small amount of radioactive material (tracer) and an imaging machine to create pictures showing the blood flow to your heart. The test measures blood flow while you are at rest and during activity, showing areas with poor blood flow or damage in your heart.

Coronary angiogram

A coronary angiogram can show blocked or narrowed blood vessels in the heart. A coronary angiogram is a procedure that uses X-ray imaging to see your heart's blood vessels. The test is generally done to see if there's a restriction in blood flow going to the heart

Magnetic resonance imaging (MRI)

A cardiac MRI can show the parts of your heart (including chambers, valves and muscles) and how well they are working — including how your blood moves. These detailed, high-quality images in two or three dimensions help your healthcare provider figure out what's wrong and make a diagnosis.

Coronary computed tomography angiogram (CCTA)

Cardiac computed tomography angiography (or CTA), is a noninvasive test that uses special X-rays to focus on the coronary arteries. It allows the physician to see if you have blockages in the heart arteries.

Signs and symptoms of heart diseases

- Fatigue
- Shortness of breath
- General weakness
- Change in skin color or greyish pallor (episodes of change in skin color associated with weakness)
- Extreme anxiety
- Fainting or loss of consciousness
- Lightheadedness or dizziness
- Nausea or vomiting
- Palpitations (feeling like your heart is beating too fast or irregularly)
- Shortness of breath
- Sweating, which may be very heavy
- Shortness of Breath
- Swelling in the Legs, Ankles, or Feet

Risk factors

Risk factors for heart disease include:

- Age. Growing older increases the risk of damaged and narrowed arteries and a weakened or thickened heart muscle.
- Sex. Men are generally at greater risk of heart disease. The risk for women increases after menopause.
- Family history. A family history of heart disease increases the risk of coronary artery disease, especially if a parent developed it at an early age (before age 55 for a male relative, such as your brother or father, and 65 for a female relative, such as your mother or sister).
- Smoking. If you smoke, quit. Substances in tobacco smoke damage the arteries. Heart attacks are more common in smokers than in nonsmokers. If you need help quitting, talk to your health care provider about strategies that can help.
- Unhealthy diet. Diets high in fat, salt, sugar and cholesterol have been linked to heart disease.
- High blood pressure. Uncontrolled high blood pressure can cause the arteries to become hard and thick. These changes interrupt blood flow to the heart and body.
- High cholesterol. Having high cholesterol increases the risk of atherosclerosis. Atherosclerosis has been linked to heart attacks and strokes.
- Diabetes. Diabetes increases the risk of heart disease. Obesity and high blood pressure increase the risk of diabetes and heart disease.
- Obesity. Excess weight typically worsens other heart disease risk factors.
- Lack of exercises. Being inactive (sedentary lifestyle) is associated with many forms of heart disease and some of its risk factors, too.
- Stress. Unrelieved stress may damage the arteries and worsen other risk factors for heart disease.
- Poor dental health. It's important to brush and floss your teeth and gums often. Also get regular dental checkups. Unhealthy teeth and gums makes it easier for germs to enter the bloodstream and travel to the heart. This can cause endocarditis.

Complications

Complications of heart disease include

- Heart failure. This is one of the most common complications of heart disease. Heart failure occurs when the heart can't pump enough blood to meet the body's needs.

- Heart attack. A heart attack may occur if a blood clot is stuck in a blood vessel that goes to the heart.
- Stroke. The risk factors that lead to heart disease can also lead to an ischemic stroke. This type of stroke happens when the arteries to the brain are narrowed or blocked. Too little blood reaches the brain. A stroke is a medical emergency brain tissue begins to die within just a few minutes of a stroke.
- Aneurysm. An aneurysm is a bulge in the wall of an artery. If an aneurysm bursts, you may have life-threatening internal bleeding.
- Peripheral artery disease. In this condition, the arms or legs usually the legs don't get enough blood. This causes symptoms, most notably leg pain when walking (claudication). Atherosclerosis can lead to peripheral artery disease.
- Sudden cardiac arrest. Sudden cardiac arrest is the sudden loss of heart function, breathing and consciousness. It's usually due to a problem with the heart's electrical system. Sudden cardiac arrest is a medical emergency. If not treated immediately, it results in sudden cardiac death.

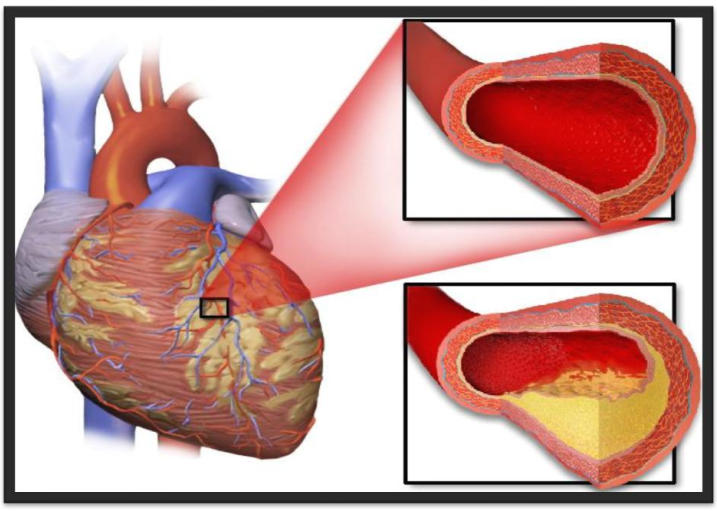

Fig. 1.3: Infected Heart Appearance.

Non Pharmacological Treatments for Heart Disease

- Life style measures
- Avoid Smoking
- Avoid Alcohol
- Diet & Nutrition
- Salt Restriction

- Fluid Intake
- Exercise Training & Rehabilitation
- Maintain a healthy weight.
- Reduce and manage stress.
- Control high blood pressure, high cholesterol and diabetes.
- Get good sleep. Adults should aim for 7 to 9 hours daily.

- **Life style measures:** Life style is important in the management of chronic heart Disease. Social activities should be encouraged & care should be taken to ensure that patients avoid social isolation. If possible should continue their work regular.

- **Avoid Smoking:** Cigarette smoking should be strongly discouraged in patients with Heart Failure. Smoking has adverse hemodynamic effects in patients with congestive heart failure. For example, smoking tends to reduce cardiac output especially in patients with a history of myocardial infarction

- **Avoid Alcohol:** Alcohol consumption should be restricted to moderate levels, given the myocardial depressants properties of alcohol. A high alcohol intake predisposes to arrhythmias & hypertension. Resumed alcohol consumption may lead to acute or worsening heart failure.

- **Diet & Nutrition:** Poor nutrition may contribute to cardiac cachexia, although malnutrition is not limited to patients with obvious weight loss and muscles wasting.

- **Salt Restriction:** 2 gm Sodium intake per day may be useful as an adjuvant to treatment with high dose diuretics. In general patients should be advised that they are rich in salt and not to add salt to their food at the table.

- **Fluid Intake:** Fluid restrictions (1.5-2 liters daily) should be considered in patients with severe symptoms those requiring high dose diuretics, and those with a tendency towards excessive fluid intake. high fluid intake negates the positive effects of diuretics and induces hyponatremia.

- **Exercise Training & Rehabilitation:** Patients show an improvement in symptoms, a greater sense of wellbeing, and better functional capacity. Exercise does not, however, result in obvious improvement in cardiac function. Although bed rest (“armchair

treatment") may be appropriate in patients with acute heart failure, exercise should be encouraged in patients with chronic heart failure. Regular exercise should therefore be advocated in stable patients as there is the potential for improvements in exercise tolerance and quality of life, without deleterious effects on left ventricular function. Cardiac rehabilitation services offer benefit to this group, and patients should be encouraged to develop their own regular exercise routine, including walking, cycling, and swimming. Never the less patients should know their limits, and excessive fatigue or breathlessness should be avoided.

Why diseases caused?

Heart Diseases observed when coronary arteries struggle to supply the heart with enough blood, oxygen and nutrients. Cholesterol deposits, or plaques, formation happened. It leads to narrow your arteries, decreasing blood flow to your heart. This can cause chest pain, shortness of breath or even a heart attack.

Mechanism of Action of Beta Blockers

Beta blockers, also known as beta-adrenergic blocking agents, are medications that reduce blood pressure. Beta blockers work by blocking the effects of the hormone epinephrine, also known as adrenaline.

Beta blockers cause the heart to beat more slowly and with less force, which lowers blood pressure. Beta blockers also help widen veins and arteries to improve blood flow.

Beta blockers can also affect cholesterol and triglyceride levels. They can cause a slight rise in triglycerides, a type of fat in the blood, and a modest decrease in good cholesterol, or high-density lipoprotein (HDL) cholesterol. These changes often are temporary.

Table No. 1: Medications used for treatment of cardiovascular diseases either in single or with combination.

Sr. No	Disease	Single	Combination
1.	Heart attack	Aspirin	Metroprolol and metoprolol tartrate
2.	Heart failure	Captopril	Hydralazine with nitrate
3.	Heart muscle disease	Acetazolamide	-
4.	Heart valve disease	Digoxin	-
5.	Pericardial disease	Ibuprofen	NSAID plus colchicine
6.	Peripheral vascular disease	Statins	Aspirin & Clopidogrel
7.	Rheumatic heart disease	Benzathine Penicillin G	-

8.	Stroke	Anticoagulants	Aspirin & Anticoagulants
9.	Vascular disease	Vasodilators	Aspirin & Statins
10.	Unstable angina	Nitrates	Nitrates & Beta blockers
11.	Arrhythmia	Beta blockers	Sotalol & Mexiletine
12.	High blood pressure	ACE inhibitors	Beta Blocker & Alpha Blocker
13.	Congenital heart conditions	Digixin	-
14.	Coronary artery diseases (CAD)	Beta blockers	Statins & Fibrates
15.	Angina	Nitrates	Beta blockers & CCB
16.	Myocardial infarction	Morphin	Beta blockers, Glyceryl Trinitrate & ACE Inhibitors
17.	Hypertensive heart disease	ACE Inhibitors	Calcium antagonist & Renin angiotensin system inhibitors
18.	Abnormal heart rhythms	Sotalol	-
19.	Valvular heart disease	Beta blockers	ACE Inhibitors & ARB
20.	Myocarditis	ACE Inhibitors	-
21.	Aortic aneurysms	Beta blockers	-
22.	Peripheral artery disease	Statins, Antiplatelets	Aspirin & Clopidogrel
23.	Venous thrombosis	Antiicoagulants	-
24.	Aorta disease and Marfan syndrome	Beta blockers	-
25.	Pulmonary embolism	Anticoagulants	-

Current Trend for Research

i. Medications are available for heart diseases either single or in a combination but till yet combined dose of medications are not available. Such as Heart muscle disease, Heart valve disease, Rheumatic heart disease, Congenital Heart Conditions, Abnormal Heart Rhythms, Myocarditis, Aortic aneurysm, Venous Thrombosis, Marfan Syndrome, Pulmonary Embolism

ii. AI in imaging is discussed rather than imaging in general because the imaging technologies available today have not evolved greatly for a number of years. It is the integration of AI into these systems that represents the current innovations of interest.

iii. Current trends in the treatment of CVD revolve around cardiac rhythm management and cardiovascular tissue generation.

CONCLUSION

The annual number of deaths from CVD in India is projected to rise from 2.26 million (1990) to 4.77 million (2020). There is availability of treatments and tools for early detection heart diseases, but as a precautionary measure everyone has to follow healthy lifestyle (i.e. healthy & nutritious diet, daily exercise, avoid smoking alcohol, etc.).

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