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MANAGEMENT OF CARDIOVASCULAR DISEASE

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ABSTRACT: Cardiovascular diseases (CVD) are the leading cause of mortality and morbidity globally, with 17.9 million deaths in 2019. In India, the CVD epidemic is characterized by rapid accumulation, early age of disease onset, and high case fatality rates. India experienced a 59% increase in premature mortality from 23.02 million in 1990 to 37. Million in 2010. Despite improvements in diagnosis and treatment, heart disease remains prevalent, with a 50% chance of developing it by age 45. The main causes of CVD are ischemic heart disease and stroke. India's age-standardized CVD death rate is higher than the global average. Artificial intelligence can enhance the identification and treatment of cardiovascular disease by improving quality control and enhancing medical professionals' expertise. This technology can be used in standard clinical procedures, including nanotechnology-based interventions, risk factors determination, treatment regimens, and patient tracking for chronic cardiovascular diseases. This article highlights the global and Indian burden of cardiovascular diseases (CVD), with rising mortality and early disease onset. It emphasizes the need for improved diagnosis and treatment, noting AI's potential to enhance CVD management through better risk assessment, treatment strategies, and patient monitoring, including nanotechnology-based interventions.

INTRODUCTION: The Heart is one of the most complicated organs of the biological system and hence various diseases are associated with it. Disease association with the cardiovascular system is the leading cause of mortality and morbidity globally, which arise a question of prevention of diseases related to the Heart and the vascular system. About 17.9 million people died from cardiovascular diseases in 2019.

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Cardiovascular diseases (CVD) have been one of the top two causes of death in the US since 1975, accounting for 633,842 deaths, or one in every four deaths. Heart disease was the leading cause of death in 2015, followed by cancer (595,930 deaths).

Concern should be expressed about a few specific aspects of the CVD epidemic in India, such as its rapid accumulation, the population's early age of disease onset, and the high case fatality rate. In a relatively short amount of time, the epidemiological shift in India has gone from primarily infectious disease conditions to noncommunicable diseases. India saw a 59 percent increase in premature mortality, measured in years of life lost due to CVD, from 23.02 million in 1990

to 37. Million in 2010. Heart disease is still very common; the general population has a 50% chance of getting heart disease by the age of 45. This is true even though the age-adjusted rate and acute mortality from myocardial infraction have declined over the past few decades as a result of improvements in diagnosis and treatment. A crucial factor is that heart illnesses are increasingly common among the younger generations as well as cardiovascular disease (CVD) accounts for 25% of all deaths. >80% of deaths from CVD are caused by ischemic heart disease and stroke, which are the main causes. India has an age-standardized CVD death rate of 272 per 100,000 people, according to the Global Burden of Disease study, which is higher than the global average of 235 per 100,000 people.

The Heart: The heart is an intricate component of the human body that has four independent chambers, two superior and two inferiors, and resembles a hollow, muscular organ in the shape of a cone. The heart measures approximately 12 cm (5 inches) in length, 9 cm (3.5 inches) in width, and roughly 6 cm in thickness. A little over two thirds of the organ's mass is located to the left of the body's midline, with an average weight of 250 g for females and 300 g for males [1]. The heart is circumscribed by three layers: the epicardium, which is the outermost layer; the myocardium, which is the middle layer; and the endocardium, which is the innermost layer. The pericardium, a fluid-filled, slippery sac that protects the heart, creates traction between layers of serous pericardium while the heart beats [2]. Deoxygenated blood is circulated into the lungs via the right atrium and ventricle, which have low blood pressure. Blood that has been properly oxygenated is pumped throughout the body via both the left atrium and ventricle at systemic pressure. The interatrial and interventricular septa segregate the chambers, whilst the atrio-ventricular and ventricular-arterial valves convey unidirectional flow [3]. Purkinje fibres carry electrical impulses from the sinoatrial node to the apex, where establishing begins. In order to enable continuous building and relaxation under varied pressure, stresses, and biophysical inputs in each chamber, the heart's complex structure and operation need the skilful regulation of various cell populations. The automatic rhythmic beat is caused by impulses that originate from the atrioventricular and sinoatrial nodes [4].

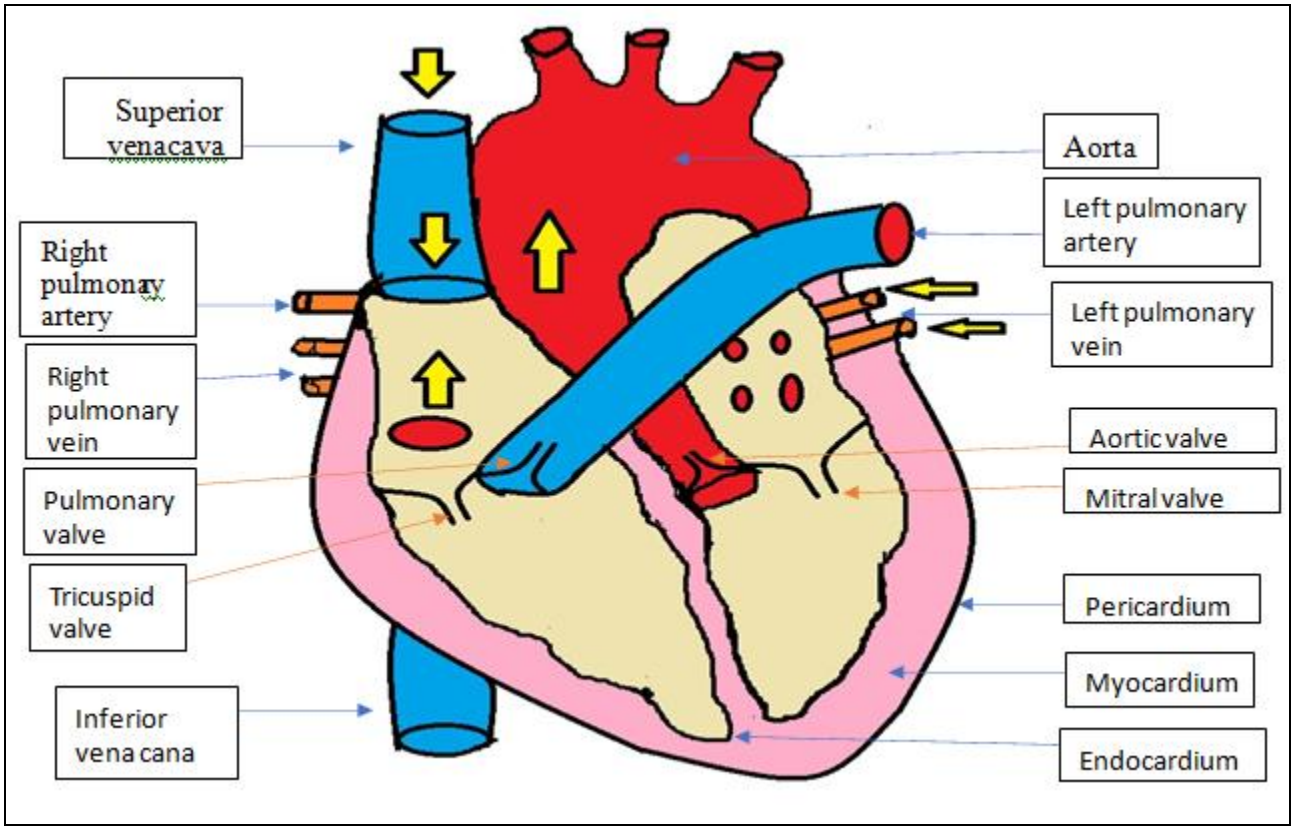

FIG. 1: NORMAL STRUCTURAL OF HUMAN HEART

Heart Cell: There are two heart fields made up of multipotent progenitor cells from which the heart is formed. Both heart fields contribute to the atria, but the left ventricle is primarily populated by cells from the first heart field, and the right ventricle by cells from the second heart field. Changes in postnatal hemodynamic and the unique gene regulatory networks functioning in each heart field likely set the stage for the gene expression patterns seen in adult heart cells [5].

Heart Valve: The heart's valves regulate the direction of blood flow and are found inside the chambers of the heart.

Tricuspid Value: The right atrioventricular value, located between the right ventricle and right atrium [6]. Transfers blood from the atrium to the ventricle, preventing recirculation.

The Left Atrioventricular Mitral Valve: It transfers blood from the left atrium to the left ventricle and also serves to prevent blockage it is also called as Bicuspid value.

Pulmonary Value: It is a semilunar value that prevents backflow and is located between the pulmonary artery and the right ventricle.

Aortic Valve: Between the left ventricle and the aorta, it has a semilunar value. Avoid allowing blood to return to the left ventricle [7].

The Cardiovascular System: The circulatory system is made up of blood vessels and the heart. The heart and the vessels that supply it make up the cardiovascular system. The organ that circulates blood through the vessels is the heart. It directly pumps blood into the aorta or the pulmonary artery, respectively. Because they regulate the quantity of blood flow to particular body parts, blood vessels are essential. Venereal, capillary, and artery blood vessels. Large and small arteries can split into arteries that transport blood away from the heart [8]. The blood flow pressure in large arteries is highest, and they are thicker and more elastic to withstand the high pressures. Smooth muscle in smaller arteries, like arterioles, is more abundant and can contract or relax to control blood flow to different parts of the body. Because arterioles experience lower blood pressure, they don't require as much elasticity. Due to their greater rigidity compared to larger arteries, arterioles are primarily responsible for the resistance observed in the pulmonary circulation. Moreover, capillaries are single cell layers that divide from arterioles. Tissues and organs exchange waste products, gases, and nutrients with this thin layer. The veins return blood to the heart as well. To stop blood from flowing backward, they have valves. Basically, the Left side of heart is responsible for the oxygenated blood and the right side of the heart is for deoxygenated blood [9].

Regulation of Heart: The two main loops that comprise the cardiovascular system are the pulmonary and systemic circulations. Its objective is to provide enough blood circulation throughout the body. The pulmonary circulation oxygenates the blood, and the systemic circulation conveys the oxygenated blood and nutrients throughout the body. The heart pumps out about 7000L of blood per day [10].

The Blood: Blood nourishes each cell with nourishment and eliminates waste from them. Whole blood is composed of the liquid matrix, or plasma, and solid-formed components. Red blood cells, white blood cells, and platelets are the different kinds of blood that are generated. The material known as plasma is straw-coloured and thick. Vitamins, contaminants, lipids, proteins, carbohydrates, hormones, and electrolytes constitute some of the other compounds that make up blood [11]. A human being who weighs 140 to 150 pounds has five quarts of blood. Blood cells mostly develop in the red marrow of an adult's pelvic, vertebral, and chest bones. If the body needs to produce more blood cells, yellow marrow can turn into red marrow. The process of making red blood cells in the bone marrow referred to as haematopoiesis. Blood cells start *via* a common precursor cell titled the stem cell. Blast cells are immature blood cells that enter the circulation once they are mature. Because the body of a leukemia patient unveils juvenile blast cells into the peripheral blood, these kinds of cells may be visible in the patient [12].

The Vascular System: The vascular system is one of the earliest performing organ systems to develop in all vertebrate embryos. Throughout the body, gases, nutrients, and metabolites are transported *via*

the circulatory system, which is composed of an incredibly complex network of arteries, veins, capillaries, and lymph vessels. Both expanding embryos and adults rely on it to maintain homeostasis. Morphogenetic plasticity in the vascular system continues to exist in adults and is necessary for normal physiological functions like wound healing and the oestrous cycle [13].

The Blood Pressure and Pulse: The force which blood exerts on the walls of blood vessels is gauged by blood pressure. Systolic blood pressure (SP) is the peak arterial pressure during the last cardiac cycle, whilst the ventricles are contracting. It correlates precisely with stroke volume, and SP improves as stroke volume does.

At the beginning of the cardiac cycle, when the ventricles are relaxing and filling, diastolic blood pressure (DP) refers to the lowest blood pressure in an artery. DP has a direct proportional relationship with total peripheral resistance (TPR).When the heart contracts, blood is pushed into the aorta, generating a pressure wave that causes the arterial wall to expand as it travels through the arteries. You can feel this expansion by pressing the artery against tissue. The pulse provides a measurement of the number of waves and accurately indicates heart rate. Pulse pressure is defined as the disparity between systolic pressure (SP) and diastolic pressure (DP) [14].

Cardiac Cycle: The cardiac cycle describes the path that blood follows through the heart. The sequence of events is as follows: rapid and reduced ejection during the ejection phase, emptying of the left ventricle, closure of the aortic valve, is volumetric relaxation, contraction of the atria, closure of the mitral valve, and rapid and reduced filling of the left ventricle during the filling phase. The circulatory system has a significant impact on regulating the circulation of blood in the entire body [15].

Blood pressure typically decreases as it moves from the arteries to the veins due to the pressure conquering the vessel resistance. A higher change in resistance within the vasculature leads to an increased pressure drop. Arterioles cause the most substantial decrease in blood pressure and have the highest resistance. When arterioles constrict, less blood flows to capillaries downstream, resulting in a greater drop in blood pressure due to the increased resistance. Conversely, when arterioles dilate, blood flow to capillaries downstream increases, leading to a smaller decrease in blood pressure due to reduced resistance [16].

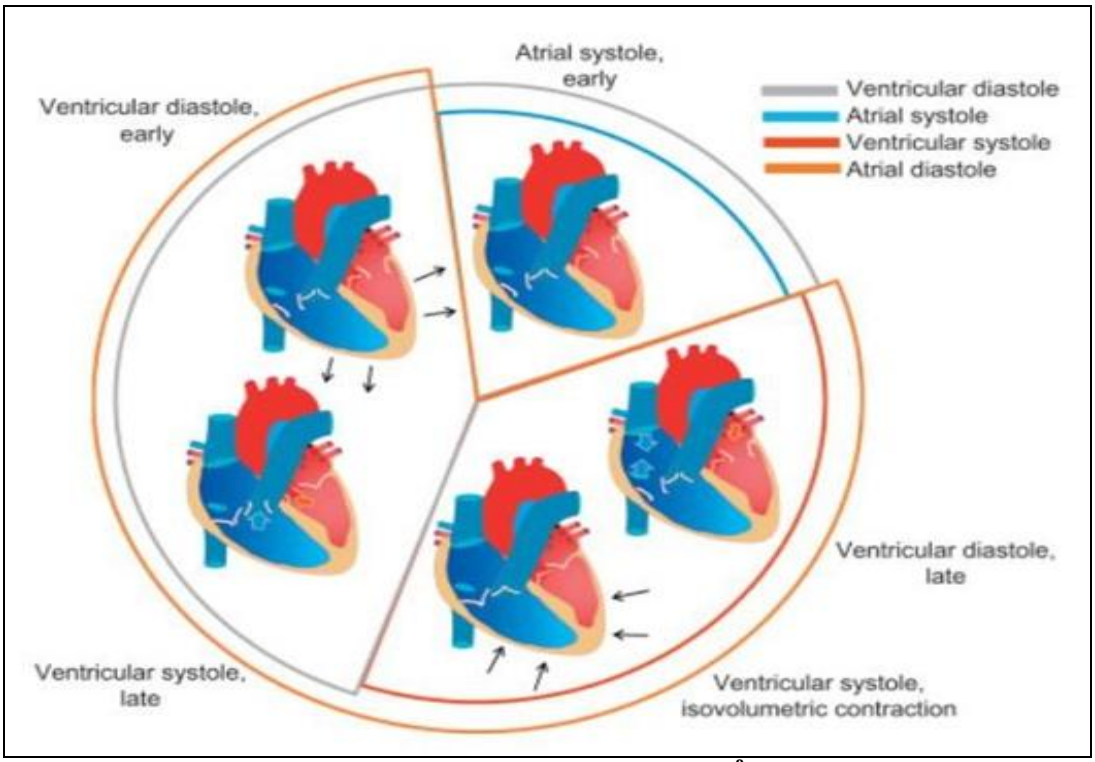

FIG. 2: THE CARDIAC CYCLE [8]

Cardiovascular Diseases: Cardiovascular diseases (CVDs) encompass disorders of the heart and blood vessels. There are various issues that can affect the cardiovascular system, such as endocarditis, rheumatic heart disease, abnormalities in the conduction system, and others. The term heart disease or cardiovascular disease refers to a range of conditions, which are detailed in **Fig. 5** [17]. Heart disease was the top cause of death in 2015, followed by cancer (595,930), but CVDs continue to rank among the top two causes of death in the US since 1975, accounting for 633,842 deaths, or 1 in every 4 deaths. Heart disease is still very common, with 50 percent chance of developing heart disease by the age of 45 in the general population, despite the age adjusted rate and acute mortality from myocardial infraction having decreased over time due to advancements in diagnosis and treatment.

TABLE 1: THE GLOBAL BURDEN OF DISEASE 2010 ESTIMATES FOR INDIA INCLUDE AGE-STANDARDIZED RATES OF CVD DEATH AND DISABILITY [18]

Diseases	Death per 100000 population		
	Female	Male	
Ischemic heart disease	112(85)	187(128)	Ischemic heart disease
Cerebrovascular disease	75(79)	90(99)	Cerebrovascular disease
Rheumatic heart disease	10(5)	11(5)	Rheumatic heart disease
Hypertension	15(13)	18(14)	Hypertension
Aortic aneurysms	1(2)	2(4)	Aortic aneurysms
Peripheral vascular disease	<1(1)	<1(1)	Peripheral vascular disease
Others	5(9)	10(12)	Others
Endocarditis	1(1)	1(1)	Endocarditis
Total cardiovascular diseases	225(200)	321(273)	Total cardiovascular diseases

The heart diseases are becoming common cause of death among the younger generations as well which is a critical parameter [19]

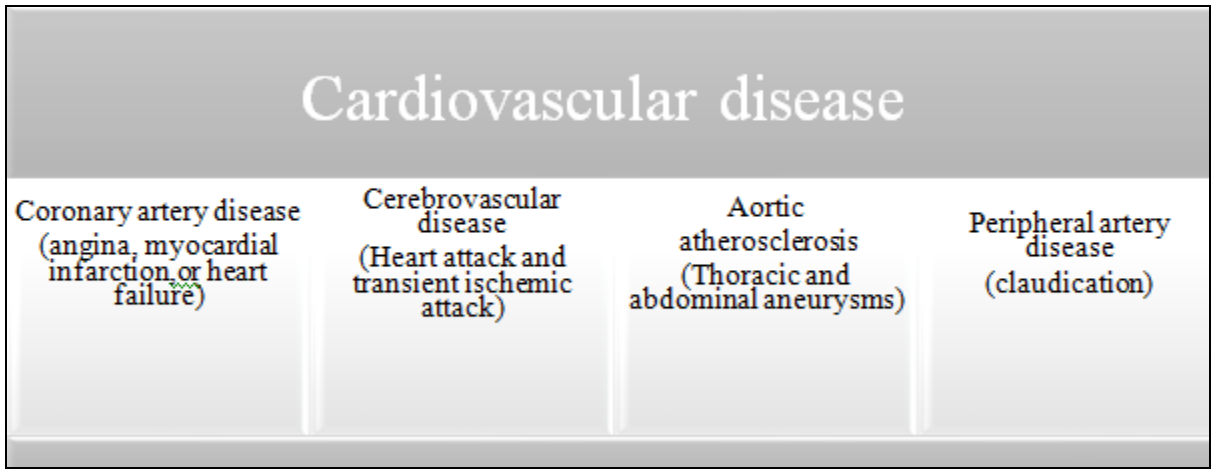

FIG. 3: CARDIOVASCULAR DISEASE CLASSIFICATION

Hypertension: A persistent condition known as hypertension is a significant risk factor to heart disease. Systolic and diastolic blood vessel pressures of at least 140 and 90 mmHg, respectively, are indicative of persistently heightened blood vessel pressure. On an international scale, there were an estimated 1.4 billion hypertension patients in 2010, and by 2025, that number is anticipated to increase to 1.6 billion. Hypertension is a major risk factor for cardiovascular disease, which was responsible for 44% of non-communicable illness fatalities in 2016. These statistics depict the severity of hypertension both now and in the future [20]. Furthermore, because blood pressure usually increases with age, it has been predicted that as life expectancy increases, so will the prevalence of hypertension and the usage of high-dose antihypertensive medications to treat it. The incidence of hypertension and chronic hypertension varies with age and gender, with the latter having a lasting effect on health. According to a study, excessive daytime drowsiness and self-reported snoring are associated with an elevated risk of hypertension. Recognition of snoring and daytime drowsiness may be useful public health

assessments for the prevention of hypertension in primary care [21].

Angina Pectoris: The term "angina pectoris" refers to the common chest pain associated with myocardial ischaemia as well as the syndrome that includes obstructive atherosclerotic coronary artery disease, myocardial ischaemia, and chest pain. But as of right now, there isn't a consensus on how to define this disease. An imbalance between myocardial oxygen demand and coronary blood supply causes stable angina [22]. This imbalance is frequently, but not always, linked to the presence of obstructive coronary artery disease. An imbalance in the heart's oxygen supply and demand, commonly referred to as "mixed" angina, can also result from combination processes. Angina symptoms are considered "chronic" and "stable" when they don't change in intensity, compassionate, or triggering contexts for a maximum of two months [13]. For those who have coronary artery disease, stable angina accounts for 58% of cases; it is the most prevalent clinical manifestation of angina. The frequency of it rises with age; in England, it was approximately 8% for men and 3% for women in the 55–64 age range, and 8% for women in the 65–74 age group. Patients who have stable angina have an annual mortality rate of 0–14% due to coronary heart disease [23].

Myocardial Infraction: Myocardial infarction (MI) is also known as heart attacks or ischemic heart disease. When myocardial demand and coronary blood flow are out of balance, it shows up as acute myocardial necrosis [23]. Anxiety, sweating, palpitations, chest pain, and acute coronary syndrome are some of the symptoms of MI. Several significant risk factors include obesity, diabetes, elevated blood pressure, smoking, high density lipoprotein and low high-density lipoprotein, hyperlipoproteinemia, and highcholesterol [24].

Arrythmia: An irregularity in the frequency, rhythm, origin site, conduction velocity, and exciting order of cardiac impulses is referred to as an arrhythmia. Arrhythmias are a common and frequently occurring disease in clinics [26]. As the aging population, arrhythmia has emerged as a significant concern in modern medicine and health economics. Currently, nowadays many medications used in clinics to treat arrhythmia seem to be chemical drugs with distinct therapeutic effects and an immediate onset of action [25].

Coronary Artery Disease: When the myocardium does not receive enough blood or oxygen, the condition is known as coronary artery disease. The cause of it is a mismatch between the supply and demand of oxygen as a result of coronary artery blockage. Usually, the development of plaques that obstruct blood flow in the coronary artery lumen is the cause [27]. The typical classifications for coronary artery coronary heart disease include unstable angina, ST-elevation MI (STEMI), non-ST elevation MI (NSTEMI), acute coronary syndrome (ACS), and stable (SIHD) [28]. Coronary artery disease is the main cause of morbidity and mortality in both men and women, accounting for over one-third of all deaths [26].

Congenital Heart Disease: Congenital heart defects are birth defects that impact the structure or function of the heart. These can include cardiac valve problems, stenosis, anomalies of the heart muscle, and other potentially harmful or deadly conditions. It affects one out of every 100 live births and is among the most prevalent congenital defects [30].

Heart Failure and Stroke: Heart failure (HF) frequently manifests as a multi-organ dysfunctional systemic clinical syndrome with a range of comorbidities [32]. Every year in the United States, about 795,000 people suffer from stroke, with ischemic stroke accounting for 87% of cases. Hypoperfusion throughout the body, including the brain, is a known side effect of heart failure (HF) [33]. Various studies proven that person having Heart failure are at greater risk of developing Ischemic stroke Compared to common population [27].

Cardiovascular Diseases Risk Factors, Symptoms and Treatment: More and more people are at high risk for cardiovascular disease; current cohort studies show that over 70% of those at risk have numerous risk factors, while just 2–7% of the general population have no risk factors at all [35]. The traditional risk factors for cardiovascular disease (CVD) are well-established and include obesity, diabetes, dyslipidaemia, smoking, poor diet, physical inactivity, and high blood pressure. To help stratify risk and tailor preventive measures,

risk scores and clinical risk stratification methods have been developed. Among non-Hispanic Black, Hispanic/Latina, American Indian/Alaska Native, and Asian women, the conventional risk factors for CVD include dyslipidaemia, diabetes, obesity, tobacco use, and hypertension [28].

Frequently, the underlying blood vessel disease has no symptoms. One's heart attack or stroke could be the initial indication of a hidden illness. Heart attack symptoms include pain or discomfort in the arms, left shoulder, elbows, jaw, or back, along with angina in the middle of the chest. The patient may also feel dizzy or faint, have dyspnoea or shortness of breath, feel sick or throw up, get cold sweats, and turn pale.

Men are less likely than women to suffer from nausea, vomiting, dyspnoea, or back or jaw pain. The most common indication of a stroke is sudden paralysis of the face, arm, or leg, usually on one side of the body. Subtle onset of facial, arm, or leg numbness, particularly on one side of the body; disorientation; trouble speaking or understanding speech; trouble seeing with one or both eyes; trouble walking; dizziness and/or loss of balance or coordination; severe headache without apparent cause; and/or fainting or unconsciousness are some other symptoms. Individuals who are having these symptoms ought to get help right away [29].

Chest pain, weariness, erratic heartbeats, shortness of breath, and fainting are some of the symptoms of rheumatic heart disease. If left untreated, rheumatic fever can lead to rheumatic heart disease and manifest as fever, joint pain and swelling, nausea, cramping in the stomach, and vomiting.

The risk of cardiovascular disease is strongly impacted by health habits and norms. Stress reduction, increased physical activity, a sensible nutrition, weight control, and smoking cessation are help reduce the risk primary methods that improve the standard of living. CVD and Leading the charge in recognizing healthy lifestyle choices as critical tactics for preventing CVD or treating it when it already exists is the responsibility of doctors and other healthcare providers [19].

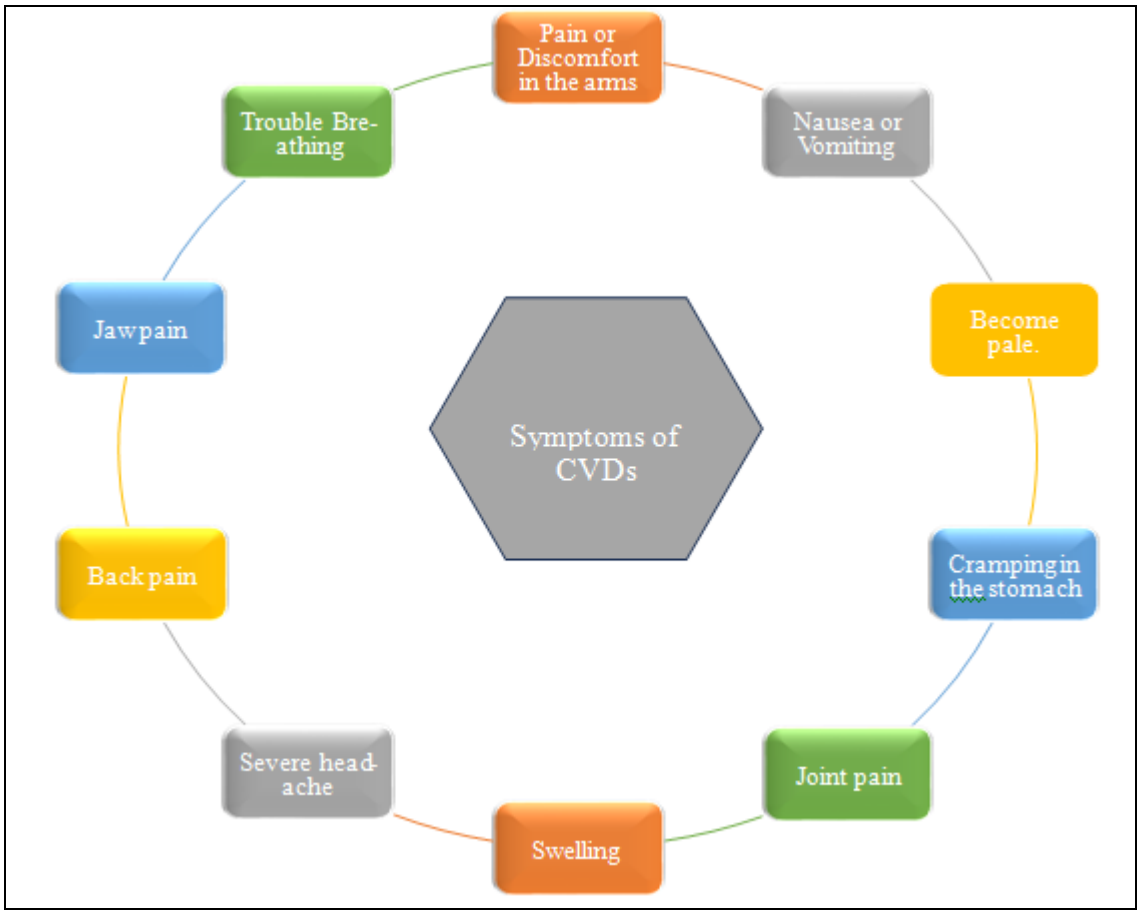

FIG. 5: COMMON SYMPTOMS RELATED WITH CARDIOVASCULAR DISEASES

It is still difficult to assist our patients in adopting healthy lifestyle choices, even after the medical community has made numerous attempts in this regard. Lifestyle modalities will be crucial if we are to meet the 2020 AHA Strategic Plan goals of a 20 percent reduction in CVD [30].

TABLE 2: TABLE SHOWING THE ACTIVE INGREDIENT, DOSAGE FORM AND THEIR USE [31, 32]

S. no.	Active ingredient	Dosage form	Use
1	Amiodarone	Oral Intravenous	Ventricular arrhythmias, Supraventricular arrhythmias
2	Digoxin	Oral Intravenous	Atrial fibrillation, Heart failure, Atrial flutter
3	Dobutamine	Intravenous	Inotropic support
4	Milrione	Intravenous	Short term management of severe heart failure, Acute decompensated heart failure
5	Quinidine	Oral Intravenous	Conversion of atrial fibrillation
6	Amlodipine	Oral	Chronic stable angina, Prinz metal's angina
7	Amlodipine + atenolol	Oral	Chronic stable angina, Hypertension
8	Atenolol	Oral	Angina pectoris
9	Diltiazem	Oral	Angina pectoris
10	Felodipine	Oral	Angina pectoris
11	Glyceryl nitrate	Oral Intravenous Sublingual Transdermal topical/cutaneous	Angina pectoris, Unstable angina
12	Isosorbide dinitrate	Oral intracoronary	Angina pectoris, Congestive heart failure, Percutaneous transluminal coronary angioplasty, Left ventricular failure
13	Isosorbide mononitrate	Oral	Angina pectoris
14	Nicorandil	Oral	Stable angina
15	Nifedipine	Oral	Angina pectoris, Prinzmetal's angina
16	Trimetazidine	Oral	Stable angina
17	Verapamil	Oral	Angina pectoris
18	Amlodipine + benazepril	Oral	Hypertension
19	Amlodipine + enalapril	Oral	Refractory hypertension
20	Amlodipine +lisinopril	Oral	Mild to Moderate hypertension
21	Captopril + hydrochlorothiazide	Oral	Hypertension
22	Enalapril	Oral Intravenous	Hypertension, heart failure, Asymptomatic left ventricular dysfunction
23	Enalapril + hydrochlorothiazide	Oral	Hypertension, Chronic heart failure
24	Lisinopril	Oral	Hypertension, Heart failure, Acute myocardial infraction
25	Lisinopril + hydrochlorothiazide	Oral	Hypertension
26	Perindopril	Oral	Hypertension, Heart failure, Stable coronary artery disease
27	Perindopril + indapamide	Oral	Essential hypertension
28	Ramipril	Oral	Hypertension, Prophylaxis of CV events in high-risk patients, Congestive heart failure, heart failure, post myocardial infraction
29	Ramipril + hydrochlorothiazide	Oral	Essential hypertension
30	Atenolol + chlortalidone	Oral	Hypertension
31	Atenolol + nifedipine	Oral	Angina pectoris, Hypertension
32	Bisoprolol	Oral	Chronic heart failure, angina pectoris, Hypertension
33	Carvedilol	Oral	Hypertension, Heart failure, Left ventricular dysfunction post myocardial infraction
34	Labetalol	Oral Intravenous	Hypertension, Emergency treatment of hypertension, Hypertension in pregnancy, Hypertension after myocardial infraction, Hypotensive anesthesia
35	Metoprolol	Oral Intravenous	Hypertension, Angina pectoris, Cardiac arrhythmias, Heart failure, Acute myocardial infraction
36	Nebivolol	Oral	Hypertension, Chronic heart failure
37	Nebivolol +	Oral	Hypertension

	hydrochlorothiazide		
38	Propranolol	Oral Intravenous	Hypertension, Angina pectoris, Cardiac arrythmias, Post myocardial infraction, Proliferating infantile hemangioma, Emergency treatment of cardiac arrythmias
39	Levamlodipine	Oral	Hypertension
40	Amlodipine + losartan	Oral	Mild to Moderate hypertension
41	Candesartan	Oral	Hypertension
42	Losartan	Oral	Hypertension, Chronic heart failure
43	Olmesartan	Oral	Hypertension
44	Telmisartan	Oral	Hypertension, Cardiovascular risk reduction

Artificial Intelligence in Diagnosis of Cardiovascular Diseases: Modern clinical cardiology has advanced considerably over the years, the from the breakthrough of transcatheter aortic valve replacement (TAVR) and percutaneous coronary intervention (PCI) to the popularization of antiplatelet medicines and predictive heart failure treatment methods. Artificial intelligence (AI) may help physicians improve the identification and treatment of cardiovascular diseases. By enhancing quality control and serving as educational resources to broaden the expertise of medical professionals, incorporating AI into workflows can help standardize the calibre of care provided to patients. Gaining knowledge about this new technology can help one anticipate how artificial intelligence (AI) may be used in standard clinical procedures. CVDs are becoming more common in today's society, much like it her illness like diabetes and cancer, and it continues to the primary cause of death. Clinicians can use the results of certain AI processed algorithms of EGCs on current big data, used, based on groundbreaking reports, to improve diagnosis of hypertrophic cardiomyopathy, atrial fibrillation, pulmonary hypertension, and heart failure [33].

AI in Pulmonary Hypertension: Pulmonary hypertension (PH) is a condition characterized by a resting mean pulmonary artery pressure of at least 25 mm Hg. It is often linked to Parkinson's disease, with symptoms including exercise-induced dyspnoea, syncope, angina, weakness, and exhaustion. PH's progressive clinical course includes decreased exercise tolerance and dyspnoea. Common diagnostic tools include electrocardiography, chest radiography, and echocardiography. For PH, cardiac magnetic resonance imaging (CMR) is the recommended course of treatment. The gold standard for detecting early heart failure is echocardiography, however it is insufficient for a diagnosis. Advancements in machine learning and computational image analysis may help predict right-sided heart failure and death [34].

AI in Heart Failure: Asymptomatic left ventricular systolic dysfunction (ALVSD) increases the risk of heart failure and all-cause mortality, impacting one-four to two-point two percent of the general population. AI-ECG has been suggested as a helpful component for left ventricular dysfunction screening, as 2-dimensional speckle-tracking echocardiography (2D-STE) is not suitable for quantifying LVEF. AI algorithms can help with early diagnosis of patients with low EF based on their ECG, confirming its value in identifying left or right ventricular dysfunction.[35]

AI in Cardiomyopathy: Hypertrophic cardiomyopathy (HCM) is a leading cause of sudden cardiac death in young adults. Today's risk algorithms produce risk estimations that are insufficiently precise to take into consideration the varying impact sizes of various risk variables. Although the gold standard for diagnosing and assessing HCM is echocardiography, it is unclear how to best detect HCM in asymptomatic individuals. However, almost 90% of individuals with an HCM diagnosis have abnormal electrocardiograms. 12-lead electrocardiography, or ECG is a practical, quick, and inexpensive non-invasive way to screen for the illness [36].

AI in Coronary Artery Disease: Alopecia, face wrinkles, and earlobe creases are among the facial traits that clinical evidence indicates are associated with poor cardiovascular health and an increased risk of coronary artery disease. A self-reported smartphone application might evaluate CAD risk in high-risk regions prior to a doctor's consultation, and clinical research indicates that specific deep

learning algorithms have showed potential for disease diagnosis and prediction based on facial pictures. Face characteristics like alopecia, facial wrinkles, and earlobe creases are associated with poor cardiovascular health and higher CAD risk [37].

Recent Advances in Cardiovascular Research: Advancements in the pharmaceutical research are happening day by day. Some recent advancement in the cardiovascular diseases have discussed in the below table.

TABLE 3: RECENT FORMULATIONS AND INNOVATION

S. no.	Drug	Formulation	Innovation
1	Canagliflozin	Nanocrystal sublingual tablet	Increase permeability using sodium caprate[38]
2	Ivabradine hemisulphate	Sustained released	Increased bioavailability[39]
3	Isoliensinine	Nanoparticle through peg-plga	Increased therapeutic potential[40]
4	Ivabradine nebivolol	Coen capsulated liposomes	Combinationof two Ingredients [41]
5	Propranolol hydrochloride	Tablet in capsule system	Using statistical optimization for chronotherapeutic drug delivery for pulsed release [42]
6	Pigoliftozone & eprosartan mesylate	Nano-transferosomes	Concomitant therapy against diabetes & hypertension [43]
7	Doxazosin mesylate	Fast disintegrating tablet of nanosuspension	Nano technology [44]
8	Levothyroxine sodium	Tablet	3d printing technology
9	Sildefil citrate	Transdermal hydrogel	Niosomal delivery [45]
10	Nifedipine	Fixed dose combination	Combination patch [46]
11	Atenolol	Mucoadhesive microsphere	Oral dispersible in pediatric [47]
12	Valsartan	Niosomal suspension	Niosomal delivery [48]
13	Losartan potassium & glipizide	Transdermal patch	Combination patch [49]
14	Losartan	Tablet	Oral disintegration in paediatric
15	Sidnefil citrate	Film	Taste masking, orodispersible tablet & improved Bioavailability [50]
16	Bosentan	Orodispersible tablet	Enhanced dissolution [51]
17	Lercanidipine	Transdermal delivery	Vesicular elastic carriers [52]
18	Rosuvastatin, amlodipine, valsartan, ezetimibe	Tablet	Combination of four [53]
19	Valsartan	Mini tablet	Floating bio adhesive compressive coated [54]
20	Propranolol hydrochloride	Tablet	Mucoadhesive buccal Tablet [55]
21	Losartan & hydrochlorothiazide	Floating tablet	Gastro-retentive bilayer Tablet [56]
22	Valsartan	Fast disintegrating tablet	Pediatric hypertension treatment [57]
23	Bisoprolol fumarate	Tablet	Modified release [58]
24	Nifedipine	Tablet	Acute treatment of severe hypertension [59]
25	Sildenafil citrate	Mini tablet	Immediate release [60]

Cardiovascular Imaging: The two primary methods used in medical imaging, including cardiac applications, are machine learning (ML) and deep learning (DL). Usually based on test inputs, machine learning makes predictions based on data which has been used to predict future prognostic or diagnostic results. The core element of machine learning is that a collection of weak base classifiers can be integrated to create a single strong classifier with the appropriate weighting. This leads to the production of different cluster classifier predictions and a weighted distribution. The predictions are then integrated using a weighted majority vote, and the final classifier is a continuous estimate of projected risk [61]. As medical technology has advanced, so too has the potency to observe the heart and its arteries noninvasively. Among other elements of monitoring cardiovascular illness, several cardiac imaging modalities are now essential in the practice of mainstream cardiovascular medicine for the diagnosis, treatment, and direction of invasive treatments.

Among these modalities are:

1. Computed tomography,
2. Magnetic resonance imaging,

3. Nuclear scintigraphy,
4. Echocardiography, and
5. Myocardial perfusion imaging.

Cardiac angiography with coronary catheterization remains the gold standard imaging method for viewing the coronary arteries. Each modality can be applied separately or in combination, depending on the intended diagnostic needs. These studies are now commonly utilized in conjunction with taking a patient's history, conducting physical examinations, and ordering laboratory tests, and they have come to characterize the practice of modern cardiovascular medicine. In addition, it is now commonly acknowledged that there are appropriateness standards for the use of different imaging techniques when determining which imaging modality is optimal to use for a given patient in order to minimize patient risk and maximize cost and diagnostic efficacy. A class of minimally invasive imaging tests known as cardiac imaging produces images of the heart and surrounding anatomy to assist medical professionals in diagnosing issues.

Here are a few varieties of cardiac imaging [62].

1. CAC Test
2. Cardiac Catheterization
3. Cardiac Computed Tomography Angiography (CCTA)
4. Chest X-Ray
5. Echocardiogram (Echo)
6. Electrocardiogram (ECG or EKG)
7. Exercise Stress Test
8. Holter Monitor
9. Cardiac MRI
10. Myocardial Perfusion Imaging (Nuclear Stress) Test
11. Positron Emission Tomography (PET)
12. Radionuclide Angiography (MUGA Scan)
13. Single Photon Emission Computed Tomography (SPECT)
14. Tilt-Table Test
15. Transoesophageal Echocardiography (TEE)

Cardiac MRI: This test uses radio waves and a magnetic field to produce images of the heart. Heart MRIs can show tissue and vasculature with more contrast than CT scans [62].

Chest X-Ray: The heart, lungs, and chest bones can all be seen on a chest X-ray. But it leaves out pictures of the interior structure of the heart. The location, size, and shape of the heart, lungs, and certain blood veins can all be seen on a chest X-ray [63].

Myocardial Perfusion Imaging: Myocardial perfusion imaging (MPI), a non-invasive imaging technique, can be used to assess the efficiency of blood flow through your heart muscle. It might show areas of the heart muscle where blood flow is inadequate. It might also show how well the cardiac muscle pumps blood. This analysis is also known as a nuclear stress test [62].

Echocardiogram: High frequency sound waves, or ultrasound, are utilized in ECG to produce images of your heart. The examination is also known as echocardiography or diagnostic cardiac ultrasonography. Transthoracic, transoesophageal, stress, and three-dimensional echocardiograms have been among the numerous kinds of echocardiograms.

Single Photon Emission Computed Tomography (SPECT): It generates radioactive tracers into your blood to synthesize images of your heart. Medical practitioners utilize SPECT to diagnose coronary artery disease and detect heart attacks. The heart's operation and blood flow can be seen via a myocardial perfusion scan, or SPECT.

Cardiac Computed Tomography Agiography (CCTA): A non-invasive procedure called a cardiac CT angiography (CCTA) scan uses X-rays to create images of your heart and blood vessels. A three-dimensional (3D) image of your heart is produced by combining the images on a computer. The presence and percentage of narrowing

(stenosis) in the coronary arteries and blood vessels that supply blood to the heart and other parts of the body can be determined with the use of a CCTA scan. Multidetector CT scans, also called MDCT scans, are quick and extremely detailed. Even with reduced radiation exposure, they can generate better image.

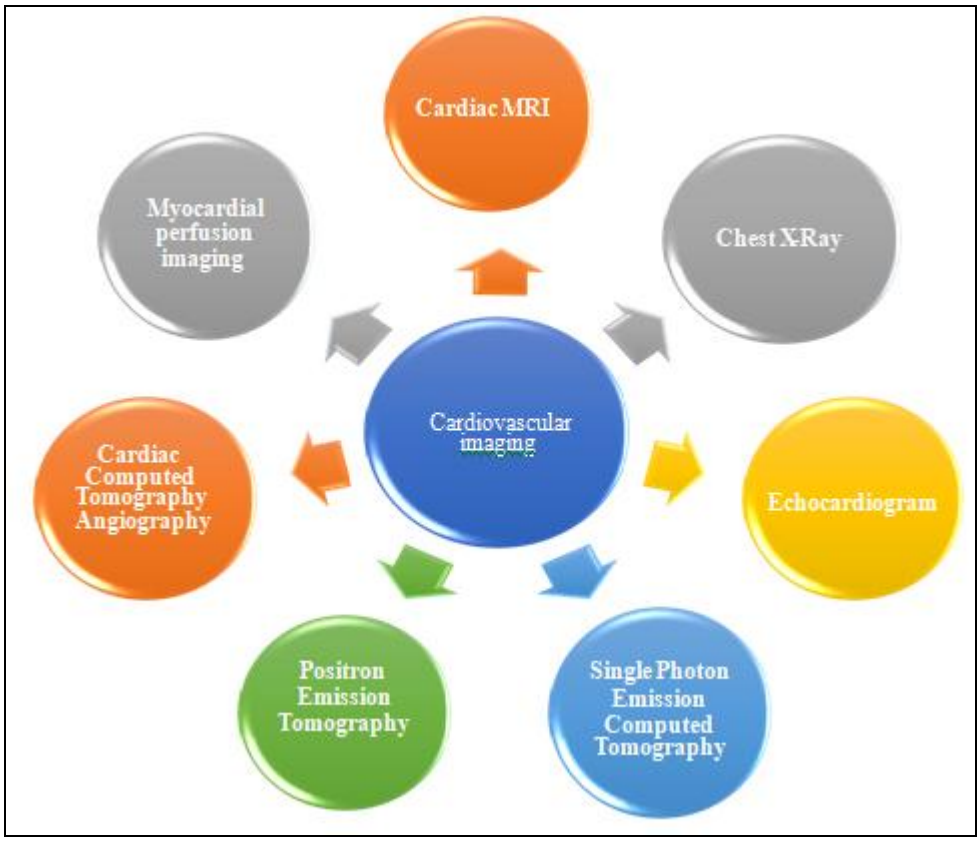

FIG. 6: MOST WIDELY USED CARDIAC IMAGING TECHNIQUES

Positron Emission Tomography (PET): The process creates images of your heart by using radioactive tracers, or radionuclides. To diagnose coronary artery disease (CAD) and damage from a heart attack, medical professionals use cardiac PET scans. Damaged and healthy heart muscle can be seen on PET scans. Also, percutaneous coronary intervention (PCI) such as angioplasty and stenting, coronary artery bypass surgery (CABG), or another procedure, may be beneficial for you, and PET scans can assist in determining this [64].

Future Perceptive: Building solid relationships with our patients is crucial, but navigating CVD risk communication can be challenging. When cardiovascular risk levels are revealed and widespread effect to at-risk patients, accuracy and awareness are raised. This involves amending complex evidence into readily understood language, tailoring the message to each patient's particular situation, cultural beliefs, and values, and evaluating their comprehension of the steps that must be taken to lower risks. In order to confirm current findings and assess the effects of current CVD risk communication strategies on long term behaviour change and important clinical outcomes, like lower hospitalization and cardiovascular death rates, more high quality randomised controlled trials are needed in the future. Finding the essential elements would benefit from qualitative research on people's opinions of cardiovascular imaging risk communication technique. Future advancements in scientific knowledge of disease mechanisms are probably going to increase support for preventative interventions. There is also likely to be a greater understanding of the elements affecting individual and societal attitudes and behaviours related to health maintenance [65].

However, it is unclear whether or to what degree future political and socioeconomic developments in various cultures and regions of the worlds will support an environment where healthy lifestyles can take root. Likewise, the novel cardiovascular

function design formulations will improve disease diagnostics and treatment. This thorough research examines cutting-edge methods for diagnosing CVDs, including nanotechnology-based therapies and crucial components for identifying risk factors, developing treatment plans, and monitoring the progression of patients with chronic CVDs. The development of nano-carriers that can both image and treat patients has involved extensive research. By examining new and creative methods for CVD diagnosis using nanoparticles (NPs). Chronic diseases such as cardiovascular disease have a long etiology and treatment options vary greatly depending on the condition and stage of the disease.

To study the prevalence, incidence, mortality, and progression of cardiovascular disease-related risk factors and events, large cohorts are set up. Lack of data on how the national incidence and risk factors for CVD have changed over time. To record alterations in cardiometabolic risk variables and events that are population-based. Creation of a reliable system for monitoring cardiovascular risk factors, mortality, and events. Inadequate implementation of heart disease prevention and treatment in basic and secondary care settings. The healthcare system's capacity to manage CVD in basic and secondary care settings and to put primary and primary preventative strategies into action. Invest in human resources to increase the supply of skilled labour. The standard of cardiovascular care in India, including diagnosis, treatment, and other areas [66].

CONCLUSION: The globe is now in a situation where improved illness management necessitates the use of cutting-edge diagnostic methods and therapies due to the worldwide emergency of cardiovascular diseases. With 17.9 million deaths from cardiovascular diseases (CVD) in 2019, CVD is the world's leading cause of mortality and morbidity. A healthy diet, obesity, stress-free living, lifestyle management, getting enough sleep, and other factors that impact a person's heart health are some of the factors that assist control the prevalence of cardiovascular illnesses. Better therapeutic practices result from an understanding of the existing state of affairs and the demands of the future. However, increasing the numbers of mortality due to cardiovascular disease is serious condition in which hypertension, heart failure and coronary artery diseases are the leading causes. By the year 2030 the numbers in the patients diagnosed with cardiovascular diseases will increase by twelve times of the numbers of 2019, which make the disease more severe. The review's objective is to highlight the disease's epidemiology, severity, and management standards. However, the general population's limited resources make it difficult for them to contend with the sickness, which raises death rates. Reducing complex information to simple language, tailoring messaging to each person's unique situation, cultural values, and beliefs, and evaluating patient comprehension to improve precision and awareness are all necessary for effective CVD risk communication.

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