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A Comprehensive Guide to Coronary Artery Disease

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Abstract— *Coronary Artery Disease (CAD) remains one of the foremost causes of death and disability worldwide, driven largely by the progressive development of atherosclerotic plaques that narrow or obstruct the coronary arteries. This reduction in coronary blood flow compromises myocardial oxygen supply and can manifest clinically as stable or unstable angina, myocardial infarction, heart failure, arrhythmias, or even sudden cardiac death. Although significant advancements in diagnostic modalities, interventional procedures, and pharmacotherapeutic strategies have improved clinical outcomes, the global burden of CAD continues to rise. One of the major contributors to this persistent burden is inadequate public awareness regarding risk factors, early symptoms, preventive measures, and the importance of timely medical attention. Strengthening public understanding and promoting early lifestyle interventions are therefore essential to reducing CAD-related morbidity and mortality and improving overall cardiovascular health worldwide.*

Keywords— *Angina; Atherosclerosis; Cardiovascular risk factors; Coronary artery disease; Heart health; Myocardial infarction; Prevention; Public awareness.*

I. Introduction

Coronary artery disease (CAD), also called coronary heart disease (CHD) or ischemic heart disease (IHD), is the most common cardiovascular condition, caused by atherosclerotic plaque buildup in the heart's arteries that limits blood flow to the heart muscle. CAD can lead to stable or unstable angina, myocardial ischemia, and heart attack (myocardial infarction)(1).

What is coronary artery disease?

Coronary artery disease occurs when plaque made of cholesterol, lipids, and other substances builds up in the coronary arteries, narrowing or blocking them and reducing blood flow to the heart, which can lead to angina or heart attacks as shown in Fig. 1

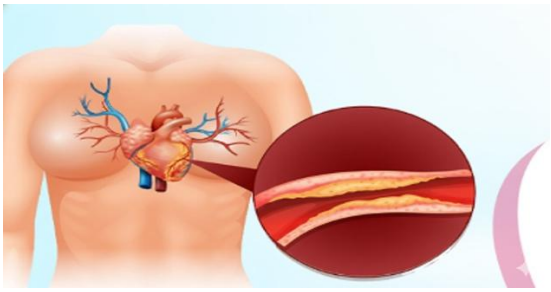

Fig. 1. Progression of Atherosclerosis in a Coronary Artery

Heart disease is a broad term for conditions affecting the heart's muscles, valves, or electrical system, while coronary artery disease (CAD) specifically involves the narrowing or blockage of coronary arteries(2,3). CAD often occurs alongside other cardiovascular disorders, complicating diagnosis and treatment.

Types of coronary artery disease

The two main forms of coronary artery disease are:

- Stable ischemic heart disease: Stable coronary artery disease (chronic CAD) gradually narrows the coronary arteries, reducing blood flow to the heart and causing angina during exertion, but with lifestyle changes(4), medication, and regular care, it can often be managed to prevent heart attacks shown in Fig.2

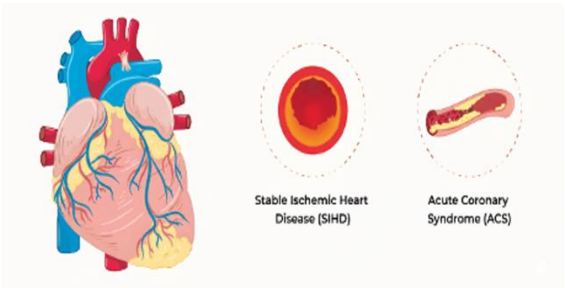

Fig. 2. Anatomical representation of the heart and compromised coronary artery flow

- Acute coronary syndrome: Unstable coronary artery disease is a medical emergency in which a plaque suddenly ruptures, forming a blood clot that blocks blood flow to the heart, leading to a heart attack.

II. Causes of Coronary Artery Disease

Coronary artery disease is primarily caused by atherosclerosis, the gradual buildup of cholesterol and fatty

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substances (atheroma or plaque) in the coronary artery walls, which can also affect other arteries in the body(5, 6).

Atherosclerosis is the most frequent cause of an abnormal decrease in cardiac blood flow. Other reasons why the heart's blood flow is abnormally reduced include:

- Coronary artery spasm, which can happen on its own or as a result of using substances like cocaine and nicotine.
- Endothelial dysfunction, which results in less blood flow than the heart requires when a coronary blood artery fails to dilate (widen) in response to a demand for higher blood flow (during exercise, for example).
- Birth malformations, such as anomalies in the coronary arteries
- Coronary artery dissection, which is a rupture of the coronary artery's lining.
- Lupus, or systemic lupus erythematosus
- Arteritis, or inflammation of the arteries
- Physical harm (from radiation therapy or an injury) • A blood clot that entered one of the coronary arteries from a cardiac chamber

Risk Factors for Coronary Artery Disease

Heart disease risk factors increase the likelihood of developing a heart condition and are classified as non-modifiable such as age, sex, family history, and race and modifiable, including obesity, smoking, high blood pressure, high cholesterol, diabetes, poor diet, and physical inactivity.

➢ *Non-modifiable risk factors*

Non-modifiable risk factors are unchangeable, yet it's still vital to recognize them.

- Age: Age increases the risk of heart disease, with the American Heart Association reporting that about 80% of cardiovascular-related deaths occur in individuals aged 65 and older.
- Sex: Heart disease is the leading cause of death for both men and women. While it has traditionally been seen as more common in men, women usually develop it about ten years later but often experience more severe outcomes.
- Family history: Family history is a key non-modifiable risk factor for heart disease. Early-onset heart disease in close relatives increases your risk, making it important to inform your doctor for early screening and preventive care.
- Race: African Americans have a higher risk of developing and dying from heart disease compared to white individuals.

➢ *Modifiable risk factors for heart disease*

Even without control over non-modifiable risk factors, you can lower overall heart disease risk by adopting healthy lifestyle choices.

- High blood pressure (hypertension): Blood pressure is measured as systolic over diastolic pressure, with a healthy reading below 120/80 mmHg. From age 18, it should be checked at every visit or at least every two years. In those over 50, systolic pressure is the key risk factor. Untreated high blood pressure (hypertension) can lead to heart disease, heart attack, or stroke. Learn about its risk factors(7, 8).
- Men, women, and high blood pressure: Before age 45, high blood pressure is more common in men. Between 45 and 64, rates are similar, but after 64, it becomes more prevalent in women.
- Cholesterol: A lipid panel, often part of routine blood tests, measures cholesterol levels including LDL, HDL, triglycerides, and total cholesterol in milligrams per deciliter (mg/dL) (9).
- LDL (bad) cholesterol: LDL cholesterol, which contributes to plaque buildup in arteries, should generally be 100 mg/dL or lower. For those with a history of heart attacks or very high cardiovascular risk, it may need to be below 70 mg/dL.
- HDL (good) cholesterol: HDL cholesterol helps remove cholesterol from the arteries and transport it to the liver for excretion. An HDL level of 60 mg/dL or higher is considered excellent and lowers the risk of cardiovascular disease.
- Triglycerides: Triglycerides, the most common type of fat in the body, are often elevated in people with diabetes and heart disease. Levels should stay below 150 mg/dL.
- Total cholesterol: Total cholesterol, calculated from your triglyceride, HDL, and LDL levels, is considered healthy when it is below 200 mg/dL.
- Diabetes: Diabetes mellitus affects the body's blood sugar control, and high blood sugar can damage nerves controlling the heart and blood vessels(10, 11, 12). Pre-diabetes indicates elevated blood sugar that isn't yet diabetes, but without lifestyle changes, diabetes is likely within ten years.
- Smoking: Smoking is the leading preventable risk factor for heart disease, more than doubling the risk compared to non-smokers. It can reduce life expectancy by 13 years in men and 14 years in women, and even second-hand smoke increases heart disease risk.
- Excessive alcohol use: Excessive alcohol raises triglycerides, blood pressure, and heart disease risk. Women should limit intake to one drink per day, and men to two.
- Obesity, unhealthy diet, and a lack of physical activity: Obesity increases the risk of serious conditions like heart disease. Eating a diet rich in fruits, vegetables, whole grains, and healthy fats, along with regular exercise, can help maintain a healthy weight.

III. Symptoms of Coronary Artery Disease

The severity of coronary artery disease symptoms depends on the extent of arterial blockage. Early recognition is important for timely treatment. Common symptoms include:

Angina (chest pain or discomfort): A common symptom, angina is felt as chest pain, pressure, or tightness, often triggered by physical activity or emotional stress, and may radiate to the arms, neck, back, or jaw.

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Shortness of Breath: Reduced blood flow to the heart can impair its pumping ability, causing shortness of breath during activity or, in severe cases, even at rest.
Fatigue: Low blood oxygen levels can cause overall tiredness, especially during physical activity.

Arm, Neck, Jaw, or Back Pain: Pain may radiate from the chest to other areas of the upper body, which can be easily overlooked or mistaken for other issues as shown in Fig.3

Fig. 3. Coronary Artery Occlusion due to Plaque and Blood Clot

Treatment / Management

Treatment of coronary artery disease depends on the patient's symptoms and clinical status and may involve medications or procedures like coronary artery stenting. For stable angina, outpatient treatment aims to reduce symptoms and prevent further complications. Pain is managed with antianginal drugs such as beta-blockers, calcium channel blockers, and nitro-glycerine. Beta-blockers reduce heat stress by lowering blood pressure and oxygen demand while affecting heart rate and contractility Aspirin or clopidogrel reduce platelet aggregation in CAD, while ACE inhibitors and angiotensin II blockers lower blood pressure, ease heart stress, and improve survival in patients with heart failure(19, 20).

IV. Prevention

Prevention plays a major role in the management of coronary artery disease.

➢ *Primary Prevention*

Early identification and prevention have lowered CAD morbidity and mortality. Patients and doctors should assess risk together using the Pooled Cohort Equation (PCE) to calculate 10-year ASCVD risk annually for ages 40–75 without CAD and every 4–6 years for ages 20–39. Based on 10-year ASCVD scores, risk is classified as low (<5%), borderline (5–7.5%), intermediate (7.5–20%), or high (>20%). Reducing cardiovascular risk involves lifestyle changes healthy diet, exercise, and quitting smoking and controlling hypertension, diabetes, and high cholesterol. In 2020, the American Heart Association introduced "Life's Simple 7" to lower cardiovascular risk and improve overall heart health(13, 14).

- *Diet:*

Diet plays a key role in reducing coronary artery disease risk. The ACC/AHA 2019 recommends a plant-based Mediterranean diet rich in fruits, vegetables, legumes, nuts, whole grains, and seafood. Replacing saturated fats with mono- and polyunsaturated fats lowers cardiovascular risk, while reducing sodium (as shown in the DASH study) lowers blood pressure and cardiovascular events. In contrast, sugar-sweetened and artificial sweeteners increase diabetes risk, and high trans-fat intake raises 10-year ASCVD risk(15).

- *Exercise, physical activity, and weight loss:*

Regular physical activity reduces CAD risk. Adults should aim for at least 150 minutes of moderate-intensity exercise or 75 minutes of vigorous-intensity exercise per week. Moderate activities include brisk walking, biking (5–9 mph), active yoga, and recreational swimming, while vigorous activities include jogging, running, fast cycling (>10 mph), tennis, and swimming. A BMI of 25–29.8 kg/m² is considered overweight, and ≥30 kg/m² is obese. Both increase ASCVD risk(16, 17, 18). Annual BMI checks and lifestyle changes calorie reduction, weight loss, 200–300 minutes of weekly physical activity, and participation in weight-maintenance programs are recommended, as weight loss improves ASCVD risk.

- *Tobacco Use:*

Tobacco smoking, a major preventable cause of CAD and death, should be assessed at every adult's healthcare visit. Clinicians should provide brief cessation counselling and offer behavioural support, nicotine replacement therapies (patches, gums, lozenges, inhalers, nasal sprays), or medications like varenicline and bupropion.

- *Hypertension management:*

Hypertension is defined as a systolic BP ≥130 mm Hg or diastolic BP ≥80 mm Hg. Stage 1 is 130–139/80–89 mm Hg, and stage 2 is ≥140/90 mm Hg.

Hypertension treatment is guided by the 10-year ASCVD risk score. Adults with stage 1 hypertension (130–139/80–89 mm Hg) and <10% risk should start with lifestyle changes, while those with ≥10% risk also require medication. Stage 2 hypertension (≥140/90 mm Hg) warrants both pharmacological therapy and lifestyle interventions.

Lifestyle changes, including diet and exercise, help lower blood pressure. A DASH-style diet rich in fruits, vegetables, whole grains, and low-fat dairy can reduce systolic BP by ~11 mm Hg, while cutting sodium by 1000–1500 mg/day and boosting potassium intake to 3500–5000 mg/day can each lower it by ~5 mm Hg.

Weight loss and regular exercise help lower blood pressure. Losing 1 kg can reduce systolic BP by 1 mm Hg. Aerobic exercise (90–150 minutes/week) or dynamic resistance training (six exercises, three sets of 10 reps) can lower it by 5–8 mm Hg, while isometric exercises like handgrip training can reduce systolic BP by ~4 mm Hg.

Limiting alcohol intake also lowers blood pressure. Men should have no more than two drinks per day, and women no more than one, which can reduce systolic BP by about 4 mm Hg.

- *Type 2 Diabetes mellitus (DM):*

Type 2 diabetes mellitus, defined by HbA1c >6.5%, is strongly linked to sedentary lifestyle, diet, physical activity, and body weight, and affects 90–95% of U.S. adults with diabetes. It is a major cardiovascular risk factor. Management includes a heart-healthy diet (Mediterranean or DASH), ≥150 minutes/week of moderate-to-vigorous exercise, weight loss for overweight individuals, and first-line metformin therapy. If

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HbA1c remains >7%, SGLT-2 inhibitors or GLP-1 agonists may be added to reduce ASCVD risk.

- *Statin use:*

patients aged 40–75 with type 2 diabetes, a moderate-intensity statin is recommended regardless of cholesterol or ASCVD risk. Those with LDL ≥190 should receive a high- or maximum-intensity statin. Statin intensity is also guided by 10-year ASCVD risk: high risk (>20%) warrants maximum-intensity therapy to lower LDL by >50%, intermediate risk (7.5–20%) recommends moderate-intensity to reduce LDL by ≥30%, and borderline risk (5–7.5%) should prompt discussion if risk-enhancing factors exist.

Coronary artery calcium (CAC) scoring can refine statin decisions for borderline or intermediate-risk patients: CAC <0 allows holding therapy, CAC >100 favors starting, and CAC 1–99 supports use, especially if ≥55 years old. For ages 20–39, lifetime CAD risk assessment encourages lifestyle changes; statins may be considered if LDL ≥160 with a strong family history of premature ASCVD. For patients >75, statin initiation or continuation should be individualized through shared decision-making, considering risk factors and potential side effects.

- *Aspirin:*

Aspirin reduces cardiovascular risk by inhibiting platelets, but its use for primary prevention is now more cautious. ACC/AHA 2019 suggests considering low-dose aspirin (75–100 mg) for adults 40–70 with significant cardiovascular risk and low bleeding risk, after a careful individualized risk–benefit assessment.

➢ *Secondary Prevention*

Secondary prevention aims to halt disease progression and prevent further damage in patients with cardiovascular disease, including coronary, cerebrovascular, or peripheral arterial disease. It involves lifestyle measures healthy diet, exercise, and smoking cessationsimilar to primary prevention.

Pharmacological therapy is emphasized: low-dose aspirin is strongly recommended unless contraindicated, with clopidogrel 75 mg daily for that intolerant to aspirin. Blood pressure should be controlled using lifestyle and medications, metformin remains first-line for diabetic patients, and high-intensity or maximally tolerated statins are recommended to achieve LDL <70 mg/dL, regardless of baseline lipid levels.

Strategies to prevent heart disease.

Heart disease is a leading cause of death. While factors like age, sex, and family history cannot be changed, you can take many steps to reduce your risk. Here are eight tips to improve heart health:

❖ Don't smoke or use tobacco

Quitting smoking or avoiding tobacco and second-hand smoke protects your heart. Tobacco damages blood vessels and raises blood pressure and heart rate. Heart disease risk begins to drop within a day of quitting and falls by half after one year, regardless of past smoking history

❖ Get moving: Aim for at least 30 to 60 minutes of activity daily

Regular daily exercise reduces heart disease risk by helping control weight and lowering the likelihood of high blood pressure, high cholesterol, and type 2 diabetes. Aim for at least 150 minutes of moderate aerobic exercise or 75 minutes of vigorous activity weekly, plus two strength-training sessions. Even short or light activities like walking, gardening, or taking the stairs benefit heart health, with greater gains from longer, more intense, or more frequent exercise(21).

❖ Eat a heart-healthy diet

A heart-healthy diet protects the heart, improves blood pressure and cholesterol, and reduces type 2 diabetes risk. It emphasizes vegetables, fruits, beans, lean meats, fish, low-fat dairy, whole grains, and healthy fats like olive oil and avocado. Examples include the DASH and Mediterranean diets. Limit salt, sugar, refined carbs, alcohol, processed foods, saturated fats (red meat, full-fat dairy, palm/coconut oil), and trans fats (fried foods, chips, baked goods).

❖ Maintain a healthy weight

Being overweight, especially around the waist, increases heart disease risk by contributing to high blood pressure, high cholesterol, and type 2 diabetes. A BMI ≥25 indicates overweight, and waist measurements above 40 inches for men or 35 inches for women signal higher risk. Losing 3–5% of body weight can improve triglycerides, blood sugar, and diabetes risk, with greater weight loss further lowering blood pressure and cholesterol.

❖ Get quality sleep

Not getting enough sleep increases the risk of obesity, high blood pressure, heart attack, diabetes, and depression. Adults generally need at least seven hours per night, with children needing more. Maintain a consistent sleep schedule and a dark, quiet bedroom(22, 23). If you still feel tired, consult a healthcare provider to check for conditions like obstructive sleep apnea, which can raise heart disease risk. Treatment may include weight loss and using a CPAP device to keep the airway open during sleep.

❖ Manage stress

Chronic stress can raise blood pressure and contribute to heart disease, especially if managed with unhealthy habits like overeating, smoking, or drinking. Healthy ways to cope include exercise, relaxation techniques, mindfulness, yoga, and meditation. If stress is overwhelming, seek a healthcare checkup, as anxiety or depression linked to heart disease risk may require treatment.

❖ Get regular health screening tests

High blood pressure and high cholesterol can harm the heart and blood vessels, but without testing(24), you may not know you have them. Regular screenings help identify these conditions and guide necessary actions.

- Blood pressure: Begin in childhood; from age 18, check at least every two years, annually if you have risk factors or are over 40.
- Cholesterol: Start between ages 9–11, repeat every five years; ages 45–65 for men and 55–65 for women, screen every 1–2 years; annually after 65.
- Type 2 diabetes: Screen at 45 or earlier with risk factors, then every three years.

❖ Take steps to prevent infections.

Infections can affect heart health for example; gum disease may increase heart and blood vessel risk. Brush and floss daily

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and get regular dental checkups(25). Vaccines also protect the heart by preventing infections: yearly flu shots, COVID-19 vaccines, pneumococcal vaccines, and Tdap (tetanus, diphtheria, pertussis) are recommended.

Coronary artery disease, caused mainly by atherosclerosis, leads to narrowing of the coronary arteries and is a major cause of global morbidity and mortality. Early detection of risk factors like hypertension, diabetes, high cholesterol, smoking, and sedentary lifestyle is crucial. While CAD cannot always be fully reversed, lifestyle changes, medications, and timely interventions can slow its progression and reduce the risk of heart attacks, improving long-term

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