

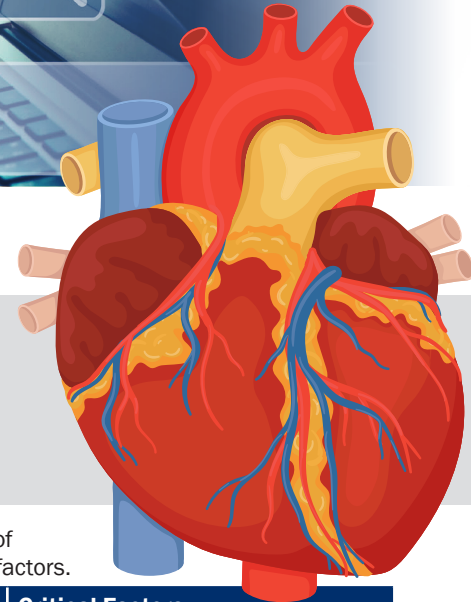


### Learning Series - #33



## Understanding Coronary Artery Disease

**Coronary Artery Disease (CAD)**, also known as ischemic heart disease, is one of the most common and serious heart conditions, affecting millions worldwide and remaining a leading cause of mortality annually. CAD typically develops gradually over time due to lifestyle factors and genetic predisposition. While CAD itself is not congenital, certain congenital heart defects can increase the risk of developing CAD later in life. CAD is more prevalent in older adults, however it can occur at any age. The disease manifests in various forms and involves the narrowing, stiffening, or blockage of coronary arteries due to the buildup of atherosclerotic plaques, which restrict blood flow to the heart muscle. Without treatment, CAD can lead to angina, heart attacks, or sudden cardiac death.



Understanding the structure and branching of the coronary arteries is essential when assessing the risk of coronary artery disease (CAD). Below is a chart that outlines the key coronary arteries along with critical factors.

Main Vessel	Origin	Major Branches	Critical Factors
<b>Left Main Coronary Artery (LMA)</b>	Arises from the left side of the aorta, above the left cusp of the aortic valve.	<ul style="list-style-type: none"> <li><b>Left Anterior Descending (LAD) Artery:</b> supplies the front of the left side of the heart.</li> <li><b>Left Circumflex (LCx) Artery:</b> supplies the lateral and back portions of the heart.</li> </ul>	<ul style="list-style-type: none"> <li>Blockage in the LMA poses a <b>high risk</b> due to the large area of heart muscle it supplies.</li> <li>Significant stenosis can cause severe or fatal heart attacks.</li> </ul>
<b>Left Anterior Descending (LAD) Artery</b>	Branches from the Left Main Coronary Artery.	<ul style="list-style-type: none"> <li><b>Diagonal branches:</b> supply the front and sides of the left ventricle.</li> <li><b>Septal perforators:</b> supply the interventricular septum.</li> </ul>	<ul style="list-style-type: none"> <li>Critical for supplying the heart's main pumping chamber.</li> <li>A proximal blockage is often referred to as the "widow maker" due to its high mortality risk.</li> <li>Blockages often lead to severe heart attacks.</li> </ul>
<b>Left Circumflex (LCx) Artery</b>	Branches from the Left Main Coronary Artery.	<ul style="list-style-type: none"> <li><b>Obtuse Marginal (OM) branches:</b> supply the lateral wall of the left ventricle.</li> <li><b>Left atrial circumflex:</b> supplies the left atrium.</li> </ul>	<ul style="list-style-type: none"> <li>Affects the side and back of the heart.</li> <li>Blockages can lead to <b>silent ischemia</b> (less obvious symptoms).</li> </ul>
<b>Right Coronary Artery (RCA)</b>	Arises from the right side of the aorta, above the right cusp of the aortic valve.	<ul style="list-style-type: none"> <li><b>Posterior Descending Artery (PDA):</b> supplies the back of the heart.</li> <li><b>Right Marginal Artery:</b> supplies the right ventricle.</li> </ul>	<ul style="list-style-type: none"> <li>Blockages can result in <b>inferior wall heart attacks</b>.</li> <li>Risk of arrhythmias and right-sided heart failure.</li> </ul>
<b>Posterior Descending Artery (PDA)</b>	Branches from the Right Coronary Artery (RCA) in most people, or from the LCx in others (left-dominant circulation).	Supplies the back of the heart.	<ul style="list-style-type: none"> <li>Affects the back of the heart.</li> <li>Riskier in <b>left-dominant</b> circulation, where LCx provides critical blood flow.</li> </ul>
<b>Right Marginal Artery</b>	Branches from the Right Coronary Artery (RCA).	Supply the lateral and posterior walls of the left ventricle.	<ul style="list-style-type: none"> <li>Blockages can cause ischemia in the <b>right ventricle</b>, which can lead to complications such as <b>right-sided heart failure or arrhythmias</b>.</li> </ul>
<b>Obtuse Marginal (OM) Arteries</b>	Branches from the Left Circumflex Artery.	Supply the lateral and posterior walls of the left ventricle.	<ul style="list-style-type: none"> <li><b>Isolated blockages</b> may have fewer symptoms but can still pose a risk for heart issues.</li> </ul>



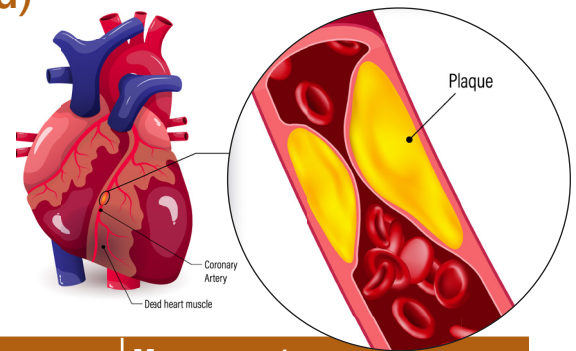
# Learning Series - #33



## Understanding Coronary Artery Disease (cont'd)

**Coronary Artery Disease (CAD)** can manifest in several forms, with varying degrees of severity and complexity.

This chart provides a concise overview of the different types of CAD, their impact, and management strategies. Note that lifestyle modifications and risk factor management are critical components applicable to all types of CAD.



Type of CAD	Description	Impact	Management
<b>Obstructive CAD</b>	Significant narrowing or blockage in one or more of coronary arteries due to atherosclerosis. (usually >50%). Includes <b>Single Vessel Disease (SVD)</b> (blockage in one artery) or <b>Multivessel Disease (MVD)</b> (blockages in multiple arteries).	Can cause angina, heart attacks, and heart disease.	<ul style="list-style-type: none"> <li>• Medications: Aspirin, statins, beta-blockers.</li> <li>• Procedures: Angioplasty, stent placement, CABG.</li> </ul>
<b>Non-Obstructive CAD</b>	Less than 50% narrowing without significant blockages	Symptoms similar to obstructive CAD; but without visible blockages on standard imaging. May still lead to cardiovascular events.	<ul style="list-style-type: none"> <li>• Calcium channel blockers, nitrates, and medications to address endothelial dysfunction.</li> </ul>
<b>Focal CAD</b>	Localized areas of blockage or narrowing in coronary arteries.	Can cause specific chest pain or localized ischemia.	<ul style="list-style-type: none"> <li>• Similar to obstructive CAD, with focus on treating specific areas.</li> <li>• Angioplasty and stenting may be used to address focal blockages.</li> </ul>
<b>Diffuse CAD</b>	Widespread or generalized narrowing affecting larger sections of the coronary arteries.	Can lead to extensive heart muscle damage and ischemia.	<ul style="list-style-type: none"> <li>• Comprehensive approach including statins, anti-anginal drugs, and others.</li> <li>• CABG is often considered for widespread disease.</li> </ul>
<b>Spontaneous Coronary Artery Dissection (SCAD)</b>	Tear in the artery wall causing sudden blockage.	Can cause a heart attack or other severe cardiac events. Often occurs in younger individuals and may be associated with pregnancy, connective tissue disorders, or stress.	<ul style="list-style-type: none"> <li>• Often managed conservatively with medications; invasive procedures like angioplasty or CABG may be used in severe cases.</li> <li>• Long-term follow-up and cardiac rehabilitation are crucial.</li> </ul>

## Learning Series - #33



### Understanding Coronary Artery Disease (cont'd)

#### Complications of CAD

This chart outlines the various complications associated with CAD, offering a comprehensive overview of how the disease can impact cardiovascular health.

Complication	Description
<b>Heart Failure</b>	CAD compromises the heart's ability to pump effectively, leading to heart failure.
<b>Arrhythmias</b>	Common types include <b>atrial fibrillation</b> and <b>ventricular tachycardia</b> Damage to the heart's electrical system due to CAD causes abnormal heart rhythms (arrhythmias), leading to: <ul style="list-style-type: none"> <li>• Palpitations, dizziness, fainting</li> <li>• In severe cases, can lead to cardiac arrest</li> </ul>
<b>Sudden Cardiac Death</b>	<ul style="list-style-type: none"> <li>• CAD increases the risk of sudden cardiac death, often triggered by arrhythmias.</li> <li>• This poses a significant risk to individuals with underlying heart disease.</li> </ul>
<b>Myocardial Infarction (Heart Attack)</b>	A severe CAD complication where a coronary artery becomes blocked, leading to irreversible heart muscle damage and potential fatality. <b>Types of Myocardial Infarction:</b> <ul style="list-style-type: none"> <li>• <b>NSTEMI (Non-ST-Elevation MI):</b> <ul style="list-style-type: none"> <li>◦ Partial artery occlusion due to plaque rupture and thrombus formation.</li> <li>◦ Leads to subendocardial infarction with elevated troponin levels.</li> <li>◦ ECG may show normal, inverted-T, or ST-depression.</li> </ul> </li> <li>• <b>STEMI (ST-Elevation MI):</b> <ul style="list-style-type: none"> <li>◦ Complete occlusion of the artery lumen, leading to transmural infarction.</li> <li>◦ Elevated troponin levels and abnormal ECG showing ST-elevation or hyperacute T-waves.</li> </ul> </li> </ul>
<b>Angina Pectoris</b>	CAD frequently manifests as chest pain or discomfort due to reduced blood flow to the heart muscle. <b>Types of Angina:</b> <ul style="list-style-type: none"> <li>• <b>Stable Angina:</b> <ul style="list-style-type: none"> <li>◦ Triggered by physical exertion or emotional stress, symptoms subside with rest or medication.</li> </ul> </li> <li>• <b>Unstable Angina:</b> <ul style="list-style-type: none"> <li>◦ More severe, may occur at rest or with minimal exertion. Higher risk of heart attack.</li> </ul> </li> <li>• <b>Variant (Prinzmetal's) Angina:</b> <ul style="list-style-type: none"> <li>◦ Less common, occurs due to temporary coronary artery spasm, often while at rest.</li> </ul> </li> </ul>
<b>Acute Coronary Syndrome (ACS)</b>	Group of acute conditions caused by a sudden reduction or blockage of blood flow to the heart includes: <ul style="list-style-type: none"> <li>• Unstable angina</li> <li>• Myocardial infarction (heart attack)</li> <li>• Sudden cardiac arrest</li> </ul>
<b>Stroke &amp; Peripheral Artery Disease</b>	<ul style="list-style-type: none"> <li>• CAD increases stroke risk due to: <ul style="list-style-type: none"> <li>◦ Shared risk factors (e.g., hypertension, diabetes)</li> <li>◦ Atherosclerosis affecting brain arteries</li> <li>◦ Atrial fibrillation and other arrhythmias, causing embolic strokes</li> </ul> </li> <li>• May affect arteries outside the heart, leading to peripheral artery disease (PAD).</li> </ul>



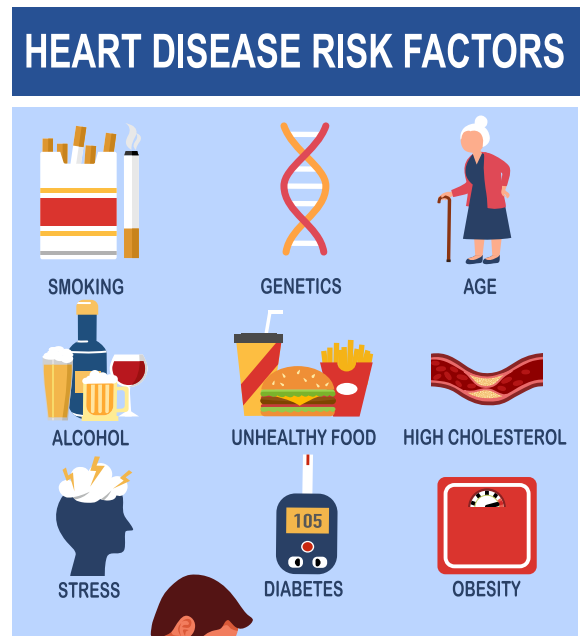
# Learning Series - #33

## Understanding Coronary Artery Disease (cont'd)

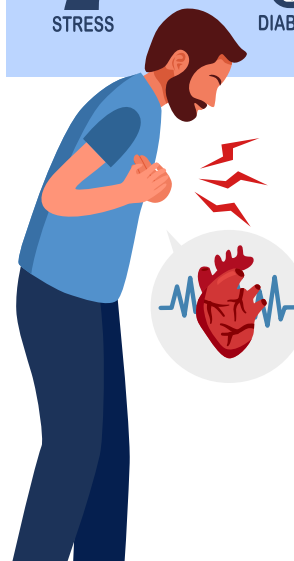
### Risk Factors

Risk Factor	High Risk Threshold
<b>Age</b>	Men ≥45 years and Women ≥55 (risk increases continuously with age)
<b>Gender</b>	Men at higher risk; women's risk increases post-menopause
<b>Family History premature CAD</b>	Male first-degree relative < 55 years. Female first-degree relative <65 years.
<b>Total Cholesterol</b>	≥ 240 mg/dL and above
<b>HDL Cholesterol</b>	< 40 mg/dL
<b>LDL Cholesterol</b>	≥ 160 mg/dL
<b>Apolipoprotein B (Apo-B)</b>	≥ 130 mg/dL (High risk)
<b>Lipoprotein(a) [Lp(a)]</b>	Elevated levels (≥ 30 mg/dL is considered high risk)
<b>Blood Pressure</b>	≥ 140/90 mm Hg (Hypertension Stage 2)
<b>Smoking</b>	Current or recent history of smoking
<b>Diabetes</b>	Hemoglobin A1c levels above 6.5%
<b>Obesity</b>	Excess body weight, particularly abdominal obesity
<b>Physical inactivity</b>	Lack of regular exercise
<b>Unhealthy diet</b>	Diets high in saturated and trans fats, cholesterol, sodium, and refined sugars
<b>Excessive alcohol consumption</b>	Heavy and regular intake
<b>Stress</b>	Chronic stress
<b>Sleep Apnea</b>	Untreated sleep apnea - the heart must work harder
<b>Coronary Artery Calcium (CAC)</b>	Presence of calcium in coronary arteries on imaging, indicating atherosclerosis risk

### HEART DISEASE RISK FACTORS



- SMOKING
- GENETICS
- AGE
- ALCOHOL
- UNHEALTHY FOOD
- HIGH CHOLESTEROL
- STRESS
- DIABETES
- OBESITY





# Learning Series - #33



## Understanding Coronary Artery Disease (cont'd)

### Diagnostic Tests

In diagnosing CAD, typically follow a step-by-step approach, starting with noninvasive tests before considering invasive procedures. This comprehensive list outlines various diagnostic tests for CAD, arranged in a sequential order reflecting their typical utilization in clinical practice.



Test	Description	Key Features
<b>Electrocardiogram (ECG or EKG)</b>	Noninvasive test assessing the heart's electrical activity. The benchmark for identifying cardiac irregularities	Detects ischemia, arrhythmias, and various cardiac disorders such as CAD, atrial fibrillation, and myocardial infarction.
<b>Blood Tests</b>	Analyzes markers like troponin and CK-MB to assess heart muscle damage.	Helps diagnose CAD by evaluating biomarkers associated with myocardial injury.
<b>Exercise Stress Test (EST)</b>	Evaluates heart function during physical exertion.	Detects abnormalities indicative of CAD by monitoring the heart's response to stress. The test involves increasing exercise intensity on a treadmill or stationary bike while continuously monitoring ECG changes, heart rate, and blood pressure.
<b>Echocardiogram</b>	Uses sound waves to create images of the heart's structure and function.	Identifies poor blood flow areas. Measures <b>ejection fraction</b> <ul style="list-style-type: none"> <li>• Normal Range: 55-70%.</li> <li>• Low: &lt; 40% (indicative of heart failure).</li> </ul>
<b>Stress Echocardiogram</b>	Combines echo with exercise or medication to stress the heart.	Enhances CAD diagnosis by observing how the heart functions under stress conditions. It provides additional information on wall motion abnormalities that may not be evident at rest
<b>CT Coronary Angiography (CCTA)</b>	Noninvasive imaging for detailed visualization of coronary arteries.	<ul style="list-style-type: none"> <li>• First-line test for CAD diagnosis.</li> <li>• Detects plaque and stenosis.</li> <li>• High diagnostic accuracy.</li> <li>• <b>CAD-RADS</b> Reporting system is used with CCTA to assess CAD, See Table 1 and 2</li> </ul>
<b>Coronary Calcium Scan (CAC)</b>	Specialized CT scan assessing calcium deposits in coronary arteries.	Quantifies calcium deposits using the Agatston score. A higher score indicates a greater risk of cardiovascular events
<b>Myocardial Perfusion Imaging (MPI)</b> • SPECT • PET	Assesses blood flow to the heart muscle during rest and stress.	Detects reduced perfusion areas. <ul style="list-style-type: none"> <li>• <b>SPECT</b>: Uses gamma rays to create images.</li> <li>• <b>PET</b>: Uses positron-emitting radiotracers for higher resolution images.</li> </ul>
<b>Cardiac Magnetic Resonance Imaging (MRI)</b>	Uses magnetic fields and radio waves for detailed heart imaging.	Provides detailed structural and functional images of the heart, including assessment of ejection fractions and identification of myocardial scarring or ischemia.
<b>Coronary Angiography</b>	Invasive procedure for detailed images of coronary arteries.	Direct visualization of blockages; guides interventions such as stenting or bypass surgery based on the severity of coronary artery disease.
<b>Fractional Flow Reserve (FFR)</b>	Invasive measurement during angiography to assess the severity of coronary artery narrowing.	Measures the pressure difference across a coronary lesion to guide treatment decisions.



# Learning Series - #33



## Understanding Coronary Artery Disease (cont'd)

### Grading Scales for Coronary Artery Assessment

This chart provides a clear overview of key metrics used to assess the extent coronary artery disease measured through various diagnostic tests such as coronary CT angiography (CCTA), CT fractional flow reserve (CT-FFR), myocardial CT perfusion (CTP), and coronary artery calcium scoring (CAC).

**Table 1**

Parameter	Severity Levels	Description
<b>Stenosis Severity:</b> Shows the percentage of arterial narrowing.		
	0%	No visible stenosis
	1-24%	Minimal stenosis
	25-49%	Mild stenosis
	50-69%	Moderate stenosis
	70-99%	Severe stenosis
	100%	Occluded
<b>Plaque Burden:</b> Categorizes the extent of plaque in the arteries.		
	P1	Mild plaque
	P2	Moderate plaque
	P3	Severe plaque
	P4	Extensive plaque
<b>Ischemia:</b> The presence or absence of ischemia based on CT-FFR or MPI test results.		
	I+ ( $\leq 0.75$ )	Positive for ischemia
	I $\pm$ (0.76-0.80)	Borderline ischemia
	I- ( $\geq 0.80$ )	Negative for ischemia
	MPI Interpretation based on perfusion defects: <ul style="list-style-type: none"> <li>• Reversible: stress-induced ischemia</li> <li>• Fixed: possible infarction/scar</li> <li>• Partially reversible: mixed viable/scar tissue</li> </ul> Risk categories: <ul style="list-style-type: none"> <li>• Low: &lt;5% myocardium affected</li> <li>• Intermediate: 5-10% myocardium affected</li> <li>• High: &gt;10% myocardium affected</li> </ul> NOTE: MPI assessment considers defect size, severity, location, and clinical context. Quantitative scoring may also be used.	
<b>Calcium Score (CAC):</b> Measures the amount of calcified plaque.		
	0	No calcification
	1-99	Mild calcification
	100-399	Moderate calcification
	$\geq 400$	Severe calcification
<b>Segment Involvement Score (SIS):</b> Measures the number of arterial segments affected by disease on coronary CTA		
	0	No segment involved
	1-2	1-2 segments involved (mild plaque burden)
	3-4	3-4 segments involved (moderate plaque burden)
	$\geq 5$	5 or more segments involved (severe plaque burden)



# Learning Series - #33



## Understanding Coronary Artery Disease (cont'd)

The chart below represents **CAD-RADS (Coronary Artery Disease Reporting and Data System)**, a standardized system developed to consistently interpret CT Coronary Angiography (CCTA) results and provide guidance on management strategies. This simplified version highlights key categories, descriptions, and recommendations.

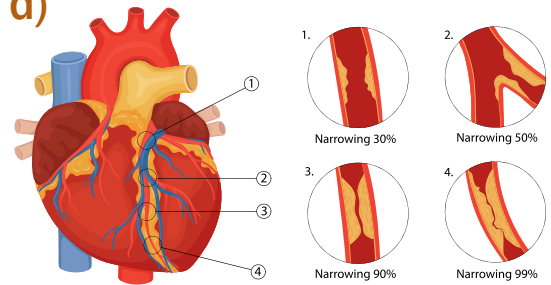


Table 2

CAD-RADS Category	Stenosis	Description	Plaque burden	Further investigation
<b>0</b>	0%	No stenosis or plaque.	N/A	None
<b>1</b>	1-24%	Minimal non-obstructive CAD.	P1 or P2	None
			P3 or P4	None
<b>2</b>	25-49%	Mild non-obstructive CAD	P1 or P2	Risk factor modification and preventative medical therapy.
			P3 or P4	Aggressive risk factor modification and preventative medical therapy.
<b>3</b>	50-69%	Moderate stenosis	P1, P2, P3, P4	Consider functional assessment (CT-FFR, CTP or stress test) Aggressive risk factor modification and preventative medical therapy.
			If Modifier I+	Consider ICA, especially if frequent symptoms persist after guideline directed medical therapy.
<b>4A</b>	(≥70%) or multiple with one ≥50%.	Severe stenosis	P1, P2, P3, P4	Consider ICA or functional assessment Aggressive risk factor modification and preventative medical therapy.
<b>4B</b>	Left main ≥50% or 3 vessel obstructive ≥70%			
<b>5</b>	100% stenosis	Total coronary occlusion	P1, P2, P3, P4	Consider ICA, Functional and or viability assessment Aggressive risk factor modification and preventative medical therapy.
<b>CadRads N</b>	Non-diagnostic study	Obstructive CAD cannot be excluded		Additional evaluation needed

- **Functional Assessment includes: CT-FFR, CTP, EST, Stress echo, SPECT, PET, Cardiac MRI or invasive FFR.**
- **ICA: Invasive coronary angiography may be favoured if high grade stenosis (>90%) , high risk plaque features or I+(presence of lesion specific ischemia on CT FFR or perfusion defects by CTP) or concordant ischemia by other EST and a candidate for revascularization if persistent symptoms despite optimal medical therapy.**



# Learning Series - #33

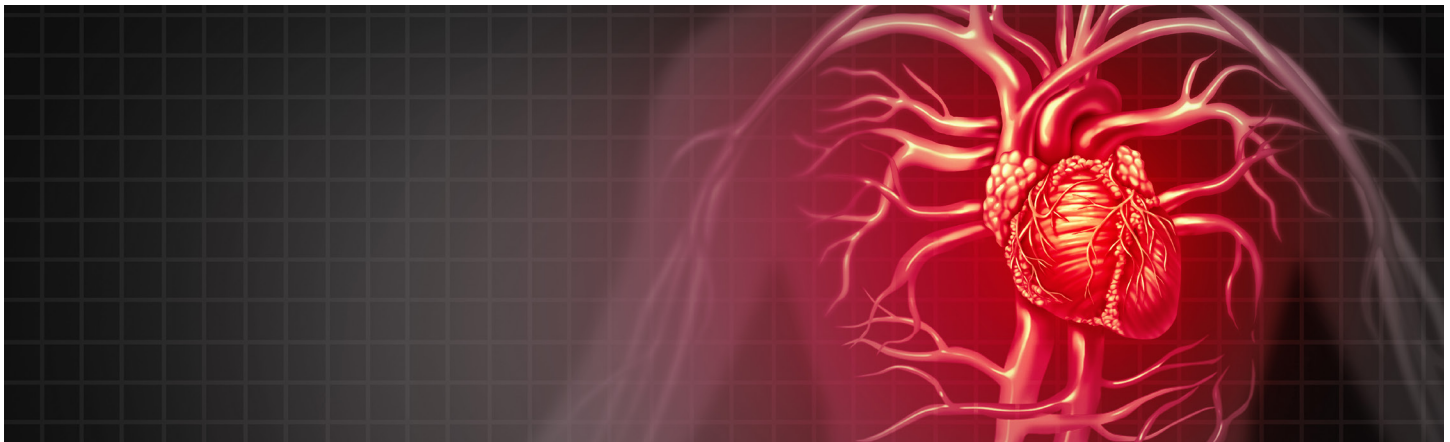


## Understanding Coronary Artery Disease (cont'd)

### Interventions and Management of Coronary Artery Disease

CAD is managed through a combination of invasive procedures, long-term medical therapies, and structured rehabilitation programs. The choice of treatment depends on the severity of the disease, the individual's overall health and risk factors. Below is a summary of the key interventions and management strategies for CAD.

Intervention/Management	Description	Goal/Indications
<b>Percutaneous Coronary Intervention (PCI)</b>	Minimally invasive procedure using balloon angioplasty and stent placement to relieve coronary artery stenosis and restore blood flow.	For individuals with symptomatic CAD or high-risk coronary anatomy.
<b>Coronary Artery Bypass Grafting (CABG)</b>	Surgical revascularization by creating bypass grafts (using patient's own vessels or synthetic conduits) to bypass blocked coronary arteries.	Ideal for patients with complex CAD, left main disease, or multivessel involvement not suitable for PCI.
<b>Long-Term Medical Therapy</b>	Continuation of guideline-directed medical therapy including antiplatelets, statins, antihypertensives, antianginals, and glucose-lowering agents.	To maintain cardiovascular stability and reduce the risk of recurrent cardiac events in established CAD patients.
<b>Routine Follow-Up Care</b>	Regular follow-ups for risk assessment, medication adjustments, lifestyle counseling, and monitoring CAD progression.	Enables timely interventions and helps reduce the risk of adverse cardiovascular events.
<b>Cardiac Rehabilitation</b>	Structured programs that involve exercise, education, and counseling for lifestyle improvement.	Aims to enhance cardiovascular health and quality of life after





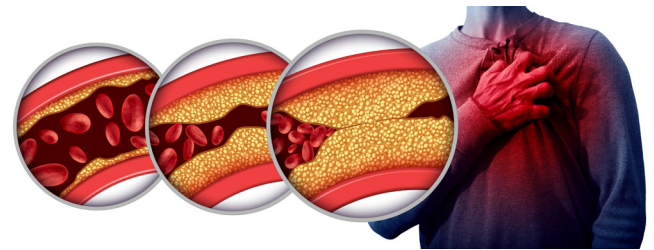
## Learning Series - #33



# Understanding Coronary Artery Disease (cont'd)

## Underwriting Consideration

In underwriting, coronary artery disease (CAD) presents significant risks and must be carefully evaluated to predict potential complications and their impact on mortality and long-term health outcomes. Key considerations help to assess how CAD and related factors could affect an individual's life expectancy. Here's an expanded look into these underwriting considerations:



### 1. Extent and Severity of CAD

- Questions to Consider:
  - How many arteries are affected? (Single vs. multi-vessel disease)
  - Which vessels are narrowed? (Major vessels like the left main artery carry higher risk)
  - What is the degree of stenosis? (>70% indicates significant risk)

### 2. Presence of Comorbidities

- Questions to Consider:
  - Are there other health conditions? (e.g., diabetes, hypertension)
  - Are there lifestyle risk factors? (e.g., smoking, obesity)

### 3. Age and Gender

- Key Points:
  - Risk increases with age.
  - Men are at higher risk at younger ages; women's risk rises post-menopause.

### 4. Family History

- A strong family history of CAD or cardiovascular diseases increases baseline risk.

### 5. Lifestyle Factors

- Key Considerations:
  - **Smoking:** Major risk factor for CAD.
  - **Diet:** High-fat diets increase risk; healthy diets lower it.
  - **Physical Activity:** Regular exercise improves heart health.
  - **Alcohol Consumption:** Moderate intake may be protective; heavy drinking increases risk.

### 6. Treatment and Management

- Questions to Consider:
  - What treatments have been received? (Surgical or medication)
  - Is the applicant compliant with treatment?
  - Have risk factors been managed effectively?

### 7. Ejection Fraction and Symptoms

- Key Points:
  - A low ejection fraction (<40%) indicates higher mortality risk.
  - Ongoing symptoms (e.g., angina, shortness of breath) are important for assessing risk.