

Acute Coronary Syndrome (ACS)

Cardiovascular System (Medical Students)

Learning Objectives

After studying this topic, you should be able to:

- Define Acute Coronary Syndrome (ACS).
 - Understand the pathophysiology of plaque rupture and thrombosis.
 - Classify ACS into unstable angina, NSTEMI, and STEMI.
 - Recognize risk factors and clinical presentation.
 - Interpret ECG findings and cardiac biomarkers.
 - Understand emergency management and reperfusion strategies.
 - Recognize complications and secondary prevention.
 - Apply knowledge through clinical case scenarios.
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Definition

Acute Coronary Syndrome (ACS) refers to a **spectrum of clinical conditions caused by acute reduction or complete interruption of coronary blood flow**, usually due to **rupture or erosion of an atherosclerotic plaque with superimposed thrombus formation**, resulting in myocardial ischemia or infarction.

ACS includes:

- Unstable Angina (UA)
 - Non-ST Elevation Myocardial Infarction (NSTEMI)
 - ST-Elevation Myocardial Infarction (STEMI)
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Epidemiology

- One of the leading causes of death worldwide.
- STEMI accounts for approximately **25–40%** of ACS presentations.
- NSTEMI is becoming more common due to widespread use of high-sensitivity troponin assays.

- Incidence increases with:
 - Older age
 - Male sex
 - Diabetes mellitus
 - Smoking
 - Hypertension
 - Dyslipidemia
 - Chronic kidney disease
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Coronary Anatomy

Left Main Coronary Artery (LMCA)

Branches into:

- Left Anterior Descending (LAD)
 - Left Circumflex (LCX)
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Left Anterior Descending (LAD)

Supplies:

- Anterior wall
- Interventricular septum
- Apex
- Anterior left ventricle

Proximal LAD occlusion is commonly called the "**widow-maker**" lesion.

Left Circumflex (LCX)

Supplies:

- Lateral wall
 - Posterolateral left ventricle
 - Left atrium
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Right Coronary Artery (RCA)

Supplies:

- Inferior wall
 - Right ventricle
 - SA node ($\approx 60\%$)
 - AV node ($\approx 80\text{--}90\%$)
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Pathophysiology

Normal Atherosclerotic Plaque

Stable plaque consists of:

- Lipid core
 - Fibrous cap
 - Smooth muscle cells
 - Inflammatory cells
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ACS Development

1. Endothelial injury
 2. LDL accumulation
 3. Foam cell formation
 4. Plaque formation
 5. Plaque rupture or erosion
 6. Platelet adhesion
 7. Platelet activation
 8. Thrombus formation
 9. Coronary artery obstruction
 10. Myocardial ischemia/infarction
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Classification of ACS

Type	Coronary Occlusion	Troponin	ECG
Unstable Angina	Partial/intermittent	Normal	ST depression, T-wave inversion, or normal
NSTEMI	Usually partial	Elevated	ST depression, T-wave inversion, or nonspecific changes
STEMI	Usually complete	Elevated	Persistent ST elevation in contiguous leads (or STEMI-equivalent patterns)

Difference Between ACS Types

Unstable Angina

- No myocardial necrosis
 - Troponin normal
 - Ischemia only
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NSTEMI

- Partial coronary occlusion
 - Myocardial necrosis
 - Troponin elevated
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STEMI

- Complete coronary occlusion
 - Transmural infarction
 - Requires immediate reperfusion
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Risk Factors

Non-Modifiable

- Age

- Male sex
 - Family history
 - Genetic predisposition
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Modifiable

- Smoking
 - Hypertension
 - Diabetes mellitus
 - Dyslipidemia
 - Obesity
 - Sedentary lifestyle
 - Chronic kidney disease
 - Stress
 - Poor diet
 - Excess alcohol
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Clinical Presentation

Chest Pain

Typical features:

- Sudden onset
- Severe central chest pressure
- Crushing or squeezing pain
- Retrosternal
- Radiates to:
 - Left arm
 - Jaw
 - Neck
 - Shoulder
 - Back

Usually lasts:

- 20 minutes

Not relieved by:

- Rest
 - Nitroglycerin (often only partial or no relief)
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Associated Symptoms

- Sweating
 - Dyspnea
 - Nausea
 - Vomiting
 - Palpitations
 - Syncope
 - Anxiety
 - Weakness
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Atypical Presentation

Common in:

- Elderly
- Women
- Diabetics

Symptoms may include:

- Epigastric pain
 - Fatigue
 - Dyspnea
 - Syncope
 - Indigestion
 - Isolated nausea
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Physical Examination

May reveal:

- Pallor
- Diaphoresis

- Tachycardia
 - Bradycardia (inferior MI)
 - Hypotension
 - Pulmonary edema
 - Raised JVP
 - New murmur (papillary muscle rupture)
 - Signs of cardiogenic shock
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Initial Assessment

ABCDE Approach

- Airway
 - Breathing
 - Circulation
 - Disability
 - Exposure
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Electrocardiogram (ECG)

Perform and interpret **immediately** in all patients with suspected ACS.

Repeat serial ECGs if the initial ECG is nondiagnostic but suspicion remains high.

STEMI ECG Findings

- ST elevation in contiguous leads
 - Hyperacute T waves
 - Reciprocal ST depression
 - Pathological Q waves (later)
 - New left bundle branch block is **not by itself diagnostic of STEMI**; assess in clinical context.
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NSTEMI ECG Findings

- ST depression
 - T-wave inversion
 - Nonspecific ST-T changes
 - Occasionally normal ECG
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STEMI Localization

Leads	Infarction
V1–V4	Anterior
II, III, aVF	Inferior
I, aVL, V5–V6	Lateral
V7–V9	Posterior
V3R–V4R	Right ventricular

Cardiac Biomarkers

High-Sensitivity Troponin I/T

Gold standard biomarker.

Elevated in:

- NSTEMI
- STEMI

Usually normal in:

- Unstable angina
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CK-MB

Useful for:

- Detecting reinfarction
 - Monitoring recurrent MI
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Laboratory Investigations

- CBC
 - Electrolytes
 - Renal function
 - Blood glucose
 - HbA1c
 - Lipid profile
 - Coagulation profile
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Imaging

Echocardiography

Evaluates:

- Wall motion abnormalities
 - Left ventricular function
 - Valve rupture
 - Ventricular septal defect
 - Pericardial effusion
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Coronary Angiography

Gold standard for coronary anatomy.

Allows:

- Diagnosis
 - PCI
 - Stenting
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Risk Stratification

Common tools:

- GRACE Score
- TIMI Risk Score

Used mainly in:

- NSTEMI
- Unstable angina

Initial Emergency Management

Immediate Priorities

- ABC stabilization
- Cardiac monitor
- IV access
- 12-lead ECG
- Blood tests
- Defibrillator availability if needed

Medical Management

Antiplatelet Therapy

Aspirin

Give immediately unless contraindicated.

P2Y12 Inhibitors

Examples:

- Ticagrelor
- Clopidogrel
- Prasugrel (selected PCI patients)

Used as dual antiplatelet therapy (DAPT) with aspirin when indicated.

Anticoagulation

Options include:

- Unfractionated heparin
- Low-molecular-weight heparin
- Fondaparinux (commonly used in NSTEMI; not as sole anticoagulant during PCI)

Nitroglycerin

Benefits:

- Pain relief
- Coronary vasodilation
- Reduced preload

Contraindications:

- Hypotension
- Right ventricular infarction
- Recent phosphodiesterase-5 inhibitor use (e.g., sildenafil)

Morphine

May be considered for persistent severe pain despite nitrates.

Use cautiously due to potential adverse effects and delayed absorption of oral antiplatelet agents.

Oxygen

Only if:

- SpO₂ <90%
- Hypoxemia
- Respiratory distress

Routine oxygen is **not recommended** in normoxic patients.

High-Intensity Statin

Examples:

- Atorvastatin
- Rosuvastatin

Start as early as appropriate unless contraindicated.

STEMI Management

Primary PCI

Preferred reperfusion strategy.

Recommended within guideline-recommended timeframes after first medical contact when feasible.

Fibrinolytic Therapy

Consider when:

- PCI cannot be performed within recommended time limits.
- Symptom onset is within the accepted treatment window.
- No contraindications exist.

Examples:

- Tenecteplase
- Alteplase

Absolute contraindications include:

- Previous intracranial hemorrhage
- Active bleeding
- Suspected aortic dissection

- Certain intracranial neoplasms or vascular malformations
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NSTEMI Management

Treatment includes:

- Dual antiplatelet therapy
 - Anticoagulation
 - High-intensity statin
 - Beta-blocker (if appropriate)
 - Early invasive strategy for intermediate/high-risk patients
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Percutaneous Coronary Intervention (PCI)

Procedures:

- Balloon angioplasty
- Drug-eluting stent placement

Advantages:

- Lower mortality in STEMI
 - Better vessel patency
 - Reduced recurrent ischemia
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Coronary Artery Bypass Grafting (CABG)

Indications:

- Left main coronary artery disease
 - Triple-vessel disease
 - Failed PCI
 - Complex coronary anatomy
 - Selected diabetic patients with multivessel disease
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Complications of ACS

Early Complications

Arrhythmias

- Ventricular fibrillation
 - Ventricular tachycardia
 - Bradyarrhythmias
 - AV block
 - Atrial fibrillation
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Heart Failure

Due to:

- Large infarction
 - LV dysfunction
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Cardiogenic Shock

Characterized by:

- Hypotension
 - Poor perfusion
 - High mortality
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Mechanical Complications

- Papillary muscle rupture → acute mitral regurgitation
 - Ventricular septal rupture
 - Free-wall rupture → cardiac tamponade
 - Left ventricular aneurysm (late)
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Other Complications

- Pericarditis
 - Left ventricular thrombus
 - Stroke
 - Recurrent MI
 - Sudden cardiac death
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Secondary Prevention

Long-term management includes:

- Aspirin (long-term unless contraindicated)
 - P2Y12 inhibitor for the recommended duration after ACS/PCI
 - High-intensity statin
 - ACE inhibitor/ARB when indicated
 - Beta-blocker after MI unless contraindicated
 - Cardiac rehabilitation
 - Smoking cessation
 - Diabetes control
 - Blood pressure control
 - Weight reduction
 - Regular exercise
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Prognostic Factors

Poor prognosis associated with:

- Cardiogenic shock
 - Reduced ejection fraction
 - Extensive anterior MI
 - Diabetes mellitus
 - Chronic kidney disease
 - Delayed reperfusion
 - Advanced age
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Comparison: Unstable Angina vs NSTEMI vs STEMI

Feature	Unstable Angina	NSTEMI	STEMI
Troponin	Normal	Elevated	Elevated
ST Elevation	No	No	Yes
Myocardial Necrosis	No	Yes	Yes
Coronary Occlusion	Partial	Usually partial	Usually complete
Emergency PCI	No	Risk-dependent	Yes

Comparison: PCI vs Fibrinolysis

Feature	PCI	Fibrinolysis
Reperfusion	Mechanical	Pharmacological
Success Rate	Higher	Lower
Bleeding Risk	Lower intracranial bleeding	Higher intracranial bleeding
Preferred	Yes	If PCI unavailable in time

Comparison: Stable Angina vs ACS

Feature	Stable Angina	ACS
Pain	Predictable	Unpredictable
Duration	<10–15 min	Usually >20 min
Rest Relief	Yes	Often no
Troponin	Normal	May be elevated
Plaque	Stable	Ruptured/eroded

Mini Case Examples

Case 1: STEMI

Presentation: A 56-year-old man presents with crushing chest pain for one hour, diaphoresis, and nausea. ECG shows ST elevation in leads V2–V5, and troponin is elevated.

Diagnosis/Management: Acute anterior STEMI. Arrange immediate primary PCI, administer

dual antiplatelet therapy, anticoagulation, high-intensity statin, and other guideline-directed therapy as appropriate.

Case 2: NSTEMI

Presentation: A 72-year-old woman with diabetes develops prolonged chest discomfort and dyspnea. ECG demonstrates ST-segment depression, and high-sensitivity troponin is elevated.

Diagnosis/Management: NSTEMI. Initiate medical therapy, perform risk stratification (e.g., GRACE score), and plan early invasive evaluation if indicated.

Case 3: Unstable Angina

Presentation: A 65-year-old man experiences chest pain at rest lasting 15 minutes. ECG shows T-wave inversion, but serial troponin measurements remain normal.

Diagnosis/Management: Unstable angina. Begin guideline-directed antiplatelet and anti-ischemic therapy, monitor closely, and assess the need for coronary angiography.

Case 4: Cardiogenic Shock

Presentation: A 70-year-old patient develops hypotension, cool extremities, pulmonary edema, and altered mental status following a large anterior MI.

Diagnosis/Management: Cardiogenic shock complicating ACS. Provide urgent hemodynamic support, immediate reperfusion when appropriate, and intensive care management.

Case 5: Papillary Muscle Rupture

Presentation: Three days after an inferior STEMI, a patient develops acute pulmonary edema and a new loud systolic murmur. Echocardiography reveals severe acute mitral regurgitation.

Diagnosis/Management: Papillary muscle rupture. This is a surgical emergency requiring stabilization and urgent cardiothoracic surgical intervention.

High-Yield Exam Pearls

- **Plaque rupture with thrombus formation** is the most common mechanism of ACS.

- **STEMI** usually results from **complete coronary artery occlusion**, whereas **NSTEMI** usually involves **partial occlusion**.
 - **High-sensitivity troponin** is the preferred biomarker for myocardial injury.
 - Obtain a **12-lead ECG immediately** in all patients with suspected ACS.
 - **Primary PCI** is the preferred reperfusion strategy for STEMI when available within guideline-recommended timeframes.
 - **Do not administer routine oxygen** to normoxic ACS patients.
 - **Nitroglycerin is contraindicated** in **right ventricular infarction**, hypotension, and recent phosphodiesterase-5 inhibitor use.
 - **Dual antiplatelet therapy (DAPT)** is a cornerstone of ACS treatment unless contraindicated.
 - **Cardiogenic shock** is the leading cause of in-hospital death following acute myocardial infarction.
 - Mechanical complications such as **papillary muscle rupture, ventricular septal rupture, and free-wall rupture** typically occur within the first week after MI and require urgent recognition.
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Mnemonics

ACS Initial Assessment – "ABCDE"

- **A** – Airway
 - **B** – Breathing
 - **C** – Circulation
 - **D** – Disability
 - **E** – Exposure
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Major ACS Risk Factors – "SMASHED"

- **S** – Smoking
 - **M** – Metabolic disease (Diabetes)
 - **A** – Age
 - **S** – Sedentary lifestyle
 - **H** – Hypertension
 - **E** – Elevated cholesterol
 - **D** – Diet/Obesity
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Mechanical Complications – "RUPTURE"

- **R** – Rupture of papillary muscle
 - **U** – Unstable ventricular septum (VSD)
 - **P** – Pericardial tamponade (free-wall rupture)
 - **T** – Thrombus (LV)
 - **U** – Uncontrolled heart failure
 - **R** – Recurrent MI
 - **E** – Embolic events
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Quick Revision Summary

- **Acute Coronary Syndrome (ACS)** comprises **unstable angina, NSTEMI, and STEMI**, usually caused by **atherosclerotic plaque rupture and thrombus formation**.
- **STEMI** requires **immediate reperfusion**, preferably with **primary PCI**.
- **NSTEMI** and **unstable angina** require **risk stratification** and individualized invasive management.
- Diagnosis relies on **clinical presentation, serial ECGs, high-sensitivity troponin measurements, and coronary angiography** when indicated.
- Initial treatment includes **dual antiplatelet therapy, anticoagulation, high-intensity statin therapy, nitrates when appropriate, and oxygen only if hypoxemic**.
- Major complications include **arrhythmias, heart failure, cardiogenic shock, ventricular septal rupture, papillary muscle rupture, free-wall rupture, and recurrent ischemia**.
- Long-term management focuses on **secondary prevention**, including **lifestyle modification, risk factor control, evidence-based medications, and cardiac rehabilitation**.
- **Key Principle:** Rapid recognition, prompt diagnosis, early reperfusion when indicated, and guideline-directed medical therapy are essential to minimize myocardial damage, reduce mortality, and improve long-term cardiovascular outcomes.