Lecture 2: Acute Coronary Syndromes (ACS)

Core Pathophysiology:

"All are characterized by occlusion of flow, not increased O₂ demand"

- Could be:
- Unstable angina: subtotal occlusion Plaque rupture + Platleb aggregation 1.
- NSTEMI: subendocardial occlusion 2.
- STEMI: transmural (full-thickness) occlusion 3.

ACS is NOT a demand issue like stable angina; it's an issue of **supply failure due to clot**.

Platelet Cascade in Thrombus Formation

- Platelet adhesion 1.
- Triggered by endothelial injury \rightarrow exposure of collagen + vWF
- vWF binds Gplb •
- Collagen binds Gpla/lla . 2.
 - Platelet activation
- Platelet activation Releases: ADP: activates more platelets via P2Y12 receptors
- TXA₂: promotes aggregation ($^{\land}$ aspirin target) p by $cox \mid \emptyset$ •
- 5-HT (serotonin): vasoconstriction
- Ca²⁺: for coagulation cascade
- 3. **Platelet aggregation**
- Gpllb/Illa bridges fibrinogen
- Final step → thrombin converts fibrinogen to fibrin
- Thrombin: "a potent platelet activator"

This is primary hemostasis. Get Step 3 = secondary hemostasis (coagulation cascade).

Myocardial Necrosis Progression (based on time after occlusion):

Time	Area Affected
30 min	Subendocardium (first zone affected)
4 h	Subepicardium involvement
6–12 h	Transmural infarction

This is why early intervention is critical.

Unstable Angina (UA)

Also called Crescendo Angina

Suspect if:

- Chronic angina with increasing frequency/duration 1.
- 2. New-onset angina that is severe or occurs at rest
- 3. Rest angina (<48 hours)

Diagnosis:

- Clinical + ECG
- ECG: ST depression, T wave inversion
- Cardiac markers: negative (differentiates from NSTEMI)

Classifications of Unstable Angina:

- Acute: rest pain within last 48h 1.
- 2. Subacute: rest pain occurred within last 48h but not ongoing
- 3. Primary vs. Secondary: secondary can be due to anemia, HTN, thyrotoxicosis, arrhythmia
- 4. Low vs High Risk (see TIMI)

+ High-Risk Features:

A. Rest pain >20 min but <30 min B. Pulmonary edema C. New murmur D. Hypotension E. Bradycardia or tachycardia F. ST changes, LBBB, VT G. Diabetes mellitus (DM)

2 Developing inbo NOTEMI or STEMI

> the only way to differentiate between NSTEMI and UA

IIMI Score for UA/NSTEMI

(Each = 1 point):

- 1. Age ≥ 65
- 2. ≥3 risk factors
- 3. Known CAD with stenosis ≥50%
- 4. ST changes
- 5. ≥ 2 anginal events in past 24-48h
- 6. Aspirin use in last 7 days
- 7. Elevated cardiac markers

→ Score ≥3 = high risk

Treatment of Unstable Angina (UA) & NSTEMI

📳 Initial Management Principles

- 1. CCU Admission
- Monitor vitals, ECG, arrhythmias
- 2. Aggressive Medical Therapy
 - Treat like MI, EXCEPT for thrombolysis/fibrinolytics

ysis/fibrinolytics doit have a true occlusion, 1 risk of bleeding

State of the second sec

Medication Class	Examples / Notes
Antiplatelets	Aspirin + P2Y12 inhibitor (e.g., clopidogrel)
Anticoagulants	Heparin (usually LMWH like enoxaparin)
Beta-blockers	First-line unless contraindicated (e.g., bradycardia, asthma)
Statins	Atorvastatin (intensity matters!)

Always assess for bleeding risks, especially with aspirin.

Symptom-Relieving Therapy

Drug	Mechanism	
Nitrates	Vasodilation $\rightarrow \downarrow$ preload $\rightarrow \downarrow O_2$ demand	
GPIIb/IIIa inhibitors	e.g., Tirofiban, esp. if high-risk or undergoing PCI	
Morphine	(Not mentioned here, but used for severe unrelieved chest	
	pain)	

% Cardiac Catheterization / Revascularization

Indicated if:

- Symptoms persist >48h despite meds
- High TIMI risk score
- Recurrent ischemia/arrhythmia
- \checkmark PCI or CABG may be required depending on coronary anatomy.

nost-Acute Management:

Continue:

- Aspirin
- Statins
- β-blockers
- Nitrates
- Reduce modifiable risk factors

III Invasive vs Conservative Management Strategy (Bottom right chart):

- Invasive = early cath for all high-risk
- Conservative = meds only unless symptoms recur or worsen Used based on TIMI risk and clinical judgment

Clinical Tip:

Even if cardiac markers are negative and ECG is non-diagnostic, persistent symptoms, age, risk factors or TIMI score ≥3 justify more aggressive management.

Wyocardial Infarction (MI)

General Characteristics

is." a ruptured plague.

- "Thrombotic occlusion of a coronary artery previously narrowed by a therosclerosis."
- ~80% associated with mortality
- Half of deaths are pre-hospital



- Most have:
- Prior angina
- CAD risk factors
- History of arrhythmias

🖓 Clinical Features of MI

- 1. Chest pain:
- Severe, crushing, retrosternal
- May radiate to jaw, neck, arm, epigastrium
- 2. **Can be silent** in:
- Diabetics
- Elderly
- Women
- Postoperative patients
- 3. Associated symptoms:
- Nausea, vomiting
- Sweating, SOB
- Syncope
- 4. **Pain at rest**, especially:
- Early morning
- Lasts >30 min
- 5. Autonomic response:
- Anxious, clammy
- Bradycardia or tachycardia
- Initial normal BP, later drop
- Low-grade fever after 24h due to muscle necrosis
- 6. Presents as:
- Unexplained shock
- Hypertension
- Arrhythmias

/ Diagnosis of MI

Step	Description
1. History	Typical chest pain
2. PE	Often non-specific
3. ECG	STEMI vs NSTEMI distinction

🔍 A. NSTEMI

- ST depression, T wave inversion
- NO Q waves if found this is STEMI

🔍 B. STEMI

- ST elevation (transmural)
- Q wave may develop
- Earliest change = hyperacute T wave

A Q Wave Notes:

- Pathologic Q = **>0.04 sec**, depth ≥25% of R wave
- Seen in ≥2 contiguous leads
- Indicates necrosis
- Found in:
- V1–V3 (anterior MI)

🖋 Cardiac Markers

- 🔷 1. Troponin
- Most specific and sensitive
- Rises 4–6 h after injury
- Peaks at 12–24 h
- Remains elevated for 10–14 days
- X Not useful to detect reinfarction if <2 weeks

🔷 2. CK-MB

- Rises 4–6 h
- Peaks 18–24 h
- Returns to normal in 48–72 h

	•	~				
81	elevation/	δī	depression	/	Turane	inversion



Contiguous Leads in the ECG

Right Coronary

Left Anterior

Inferior

Septal Anterior

II, III, aVF

V1, V2, V3, V4

Used for reinfarction detection

MB2/MB1 ratio >1.5 = positive

3. Myoglobin

- Rises in 1–2 h
- Peaks 6–12 h
- Returns to baseline in 24 h
- every early, but not cardiac-specific : any Muscle injury in the body?

🖊 Other Labs:

- 4. $\mathbf{CBC} \rightarrow \uparrow \mathbf{WBC}, \mathbf{ESR}$
- **Serum glucose** $\rightarrow \uparrow$ even without DM = poor prognosis 5.
- Lipid profile \rightarrow Get within 24h of MI (otherwise inaccurate for weeks) 6.
- **ECHO** \rightarrow Wall motion abnormalities 7.

II ECG Criteria for STEMI Diagnosis



> 3 points -> 98% probability of myocardial infan

ST-e

Sgarbossa ECG Criteria for LBBB

2 points

Discordant STE ≥5mm

Significant ST Elevation (based on age, sex, and leads)

Patient Group	Leads	ST Elevation Cutoff
Men ≥ 40 years	V2–V3	≥ 2 mm
Men < 40 years	V2–V3	≥ 2.5 mm
Women (any age)	V2–V3	≥ 1.5 mm
All patients	Other leads	≥ 1 mm in ≥2 contiguous leads

"Contiguous" = leads looking at the same area: E.g., II + III + aVF = inferior; V1–V4 = anterior

Sgarbossa Criteria for Diagnosing STEMI in LBBB

LBBB makes STEMI diagnosis tricky — these help you rescue MIs that hide behind LBBB

Criterion	ECG Finding	Score	
1. Concordant ST Elevation	≥ 1 mm in leads with upright QRS	5	(
2. Concordant ST Depression	≥ 1 mm in V1–V3	3	V
3. Excessively Discordant STE	≥ 5 mm in leads with downward QRS	2	
		Saarbassa oritari	-

STEMI likely if score ≥3 Sensitivity = 98% Score of 0 does not rule out STEMI

Non-MI Causes of Elevated Troponin

- Tachycardia
- ΡE Cardiac surgery
- Myonecrosis in heart failure
- Myocarditis
- Renal failure
- Shock
- Sepsis
- Always interpret troponin in context!

F Immediate Management of ACS: MONA

Step	Intervention	Rationale
A	Morphine	Analgesic; \downarrow sympathetic tone ($ m I$ avoid
		in hypotension/RV MI/resp depression)
В	Oxygen (2–4 L/min)	Only if O ₂ sat <90% or hypoxemic
С	Nitrates Vasodilate $\rightarrow \uparrow$ perfusion, \downarrow p	
		(contraindicated in hypotension/RV
		infarct)
D	Aspirin 325 mg	Irreversibly blocks platelet activation via
		COX-1 $\rightarrow \downarrow$ thrombus, stabilizes plaque

Clinical Pearls:

- Time = muscle Every 30 min delay = \uparrow 1-year mortality by 8%
- **PCI (balloon angioplasty)** \downarrow mortality/morbidity more than meds \rightarrow should be done within 90 min

Revascularization: PCI vs Thrombolysis vs CABG

PCI (Percutaneous Coronary Intervention)

Preferred treatment if door-to-balloon time <90 min

- Also preferred if:
- Contraindications to thrombolysis
- High risk of bleeding (e.g., intracranial hemorrhage risk)
- Reduces:
- Mortality more than thrombolytics
- **Recurrent thrombosis**
- If available, PCI is always better than thrombolysis (when feasible)

Thrombolytic Therapy

- Useful if:
- PCI is not available
- Patient presents late
- Best within first 6 hours, but can be given up to 24h (benefit declines with time)
- Risk: higher chance of re-thrombosis

📌 Indications for Thrombolysis

- ST Elevation MI in 2 contiguous leads: 1.
- ≥1 mm in limb leads
- ≥2 mm in precordial leads
- New or presumed new LBBB 2.
- A Can only give thrombolytics if one of the two above is present

X Contraindications to Thrombolysis

Absolute	🕂 Relative
Active internal bleeding	Trauma/surgery >2 wks
Suspected aortic dissection	Active peptic ulcer
History of hemorrhagic stroke	History of ischemic stroke
Recent major brain/spine trauma	Current anticoagulant use
Severe uncontrolled HTN (>220/120)	Diabetic retinopathy, pregnancy, known allergies

/ Thrombolytic Drug Dosing Table

Drug	Dosage & Notes	Co-Therapy
Streptokinase	1.5 million U over 30–60 min	None or IV heparin
Alteplase (tPA)	15 mg bolus \rightarrow 0.75 mg/kg over 30 min, then 0.5 mg/kg over 60 min	IV heparin 24–48 h
Reteplase (rPA)	10 U + 10 U IV bolus (30 min apart)	IV heparin
Tenecteplase (TNK)	Single IV bolus (30–50 mg, weight- based)	IV heparin

🐥 Thrombolytics must be **combined with aspirin** (unless contraindicated)

Complications of STEMI

1. Arrhythmias

Atrial

(Most common complication — due to ischemia or infarcted conduction system)

P Nost common cause of death in pre-hospitalized

Examples Туре Ventricular PVCs, VT, VF (sudden death risk) Atrial fibrillation (seen in ~15% within 24 hrs) Heart blocks 1st, 2nd, and 3rd degree AV block (esp. inferior MI)

🧠 Always check for bradyarrhythmia in inferior MI — may need pacing

2. Pump Failure (Heart Failure) - Nost common cause of deth in hospitalized patients → Graded by Killip Classification

Killip Class	Finding	Interpretation
1	No signs of HF	Best prognosis
II	Mild pulmonary congestion	Crackles, S3
III	Pulmonary edema	Rales + respiratory distress
IV	Cardiogenic shock	Hypotension + hypoperfusion

Killip class > I is a strong predictor of mortality

PCI (IS) thrembolytics (How to choose)?		
par - 0	thrombolyEics	
() Door-ballon time is	() PCI unavailable or	
>90 min	door - Ibaillon trime >90	
(2) Reduction of recorrent	(3) STEMI Starbed ≺3h	
Hnombus	3 No contraindications	
(3) restoring TIME 3 flow	(l) Door to needle	
in 98%	fime T30 min	
* Note: point 2+3 makes	> time from arrival to	
PCT Superior	FR be time of thrombolytics	

🐌 Limibations of thrombolytics 🕯

[] less effective in TIMI 3 (full restortion of blood flow) ③ 80-30% fail to reperfuse (24 Montality) 3 5-82 reacclusion (3* morbality) (4) 10% die within 1 month after discharge (S) Another heart attack with 6 years in 18% men and 36% women

COMPLICATION OF THROMBOLYTIC THERAPY 1-Hemorrhage <5% 2-Systemic embolization

- 3-CNS bleeding

4-Allergic Reaction 1-3%, anaphylaxis 0.1%

3. Mechanical Complications

Typically occur within first 10 days after MI

Complication	Result
Free wall rupture	Hemopericardium → tamponade (sudden death)
Ventricular septal rupture (VSR)	New harsh systolic murmur + biventricular failure
Papillary muscle rupture	Severe mitral regurgitation (acute HF)

New murmur post-MI = suspect VSR or MR until proven otherwise

4. Pericarditis (Post-MI)

Туре	Timing	Treatment
Early	2–4 days	Aspirin
Late (Dressler's Syndrome)	1–8 weeks	Autoimmune → also treat with aspirin

Avoid NSAIDs and steroids early post-MI — they impair scar healing and ↑ risk of rupture.

5. Left Ventricular Aneurysm

- Forms when infarcted wall stretches
- Can lead to:
- Arrhythmias
- Thrombus formation \rightarrow embolic stroke
- CHF
- Often seen as persistent ST elevation weeks later

6. Recurrent MI / Extension

- Especially if initial thrombus wasn't fully treated
- May be silent if on analgesia or elderly

💎 7. Sudden Death

- Most common cause: ventricular fibrillation
- Often occurs within first 1–2 hours

W Differential Diagnosis of Chest Pain & MI-Like Conditions

1. Differential Diagnoses of Chest Pain

These are non-cardiac or non-MI causes that can mimic angina or STEMI:

System	Examples
Neuromuscular	Cervical radiculopathy, costochondritis
Respiratory	PE, pneumothorax, pleuritis
Gastrointestinal	GERD, esophageal spasm, PUD
Psychiatric	Anxiety, panic attacks
Cardiac (non-MI)	Syndrome X, aortic dissection

Clinical tip:

- Sharp, pleuritic, positional, or reproducible pain = non-ischemic
- MI pain is dull, heavy, and not affected by movement or breathing

TIMI	Risk Score C	the higher the worse'
Risk factor 1- Age>65 2- Age>75 3- Hist of angina 4- Hist of hypertension	Score 2 3 1 1	0
5- Hist of DM	1	
6- Syst BP< 100	3	
7- Heart rate> 100	2	
8- Killip II-IV	2	
9- Ant M or LBBB	1	
10- Dolay troat > 4 hr	1	



* What is TIMI Score? flow	grading assessing how well
blood is perfused after treatement	0 0 0
TIMI (Thrombolysis in Myocardial Infarction) grading system assesses how well blood is restored after treatment:	TIME 3 is achieved at
TIMI 0 (Occlusion): Complete blockage; no blood flow.	Information Subaran in the test
TIMI 1 (Penetration): Blood starts penetrating the blockage but doesn creach the distal vessel.	airfectent ouccess rates by .
• TIMI 2 (Slow Flow): Blood reaches the distal artery but flows sluggishly.	
TIMI 3 (Normal Flow): Full restoration of normal blood flow.	() PCI 98% (2) IMH SU/
Why TIMI 3 Matters?	X (3) Streptokinger: 221
TIMI 3 flow is the goal of reperfusion therapy because it is associated with lower mortality and	
better heart recovery.	

% Invasive Management & Reinfarction Detection

1. Timing of Intervention

"PCI (angioplasty) must be done within 90 minutes (door-to-balloon time)."

If unavailable \rightarrow **Give thrombolytics** if within 12h, ideally \leq 6h

Clinical rule:

Time from symptoms	Best Treatment
≤90 min	PCI
>90 min, <12h	Thrombolysis (unless contraindicated)

2. When to Choose CABG Over PCI

Indications for CABG:

- 1. Left main disease
- 2. **Triple-vessel disease**, especially with \downarrow EF
- 3. Failure of PCI
- 4. Severe proximal LAD involvement
- 5. Diabetic patients with complex anatomy

Scale of the second sec

3. Signs of Reinfarction or MI Extension

Sign	Interpretation
Recurrent chest pain	Consider reinfarction
New ST elevation	Extension or new MI
New wall motion defect on ECHO	Indicates additional ischemic damage
Re-rise of CK-MB	B <mark>est marker for reinfarction</mark>
Troponin stays elevated for 10–14 days \rightarrow not useful in early detection of reinfarction	

14. When to Suspect MI Extension or Failure of Treatment

- Ongoing angina despite nitrates + morphine
- Persistent ST elevation
- Hypotension, S3 gallop, pulmonary congestion
- Arrhythmias (esp. VF/VT)
- No enzyme fall after 48–72h
- LVEF declining or newly akinetic area on ECHO

lpha If your patient is not improving after thrombolytics — assume treatment failure or extension!

𝔐 ACS Cheat Sheet — Lecture 2

V1. Core Pathophysiology

Туре	Description	Flow	Troponin	ECG
UA	Plaque rupture, no necrosis	\downarrow	×	ST depression, T \downarrow
NSTEMI	Subendocardial necrosis	\downarrow		ST depression, T \downarrow
STEMI	Transmural necrosis, full occlusion	×		ST elevation ± Q wave

ACS = thrombus-related occlusion (not supply/demand mismatch like stable angina)

2. Cardiac Markers

Marker	Rise	Peak	Duration	Use
Troponin I/T	4–6h	12–24h	10–14 days	Best for diagnosis
СК-МВ	4–6h	18–24h	2–3 days	Best for reinfarction
Myoglobin	1–2h	6–12h	<24h	Early but non-specific

📈 3. ECG Criteria for STEMI

Group	Leads	Cutoff
Men ≥40	V2–V3	≥ 2 mm
Men <40	V2–V3	≥ 2.5 mm
Women (any)	V2–V3	≥ 1.5 mm
All patients	Any 2 contiguous leads	≥ 1 mm

🔺 4. Sgarbossa Criteria (LBBB + Suspected MI)

Finding	Criteria	Points
ST elevation concordant	≥ 1 mm in lead with positive QRS	5
ST depression concordant	≥ 1 mm in V1–V3	3
ST elevation discordant	≥ 5 mm in lead with negative QRS	2

STEMI likely if total score ≥3

5. Immediate ACS Management (MONA)

Step	Drug	Notes
м	Morphine	For pain; avoid if hypotensive or RV
		infarct
0	Oxygen	Only if O ₂ <90%
N	Nitrates	Avoid in hypotension or RV infarct
Α	Aspirin	325 mg — cornerstone antiplatelet

🖴 6. PCI vs Thrombolysis

Factor	PCI	Thrombolytics
Preferred when	Door-to-balloon <90 min	PCI unavailable
Mortality	$\downarrow\downarrow\downarrow$	\checkmark
Reocclusion	Low	Higher (up to 30%)
Contraindications	Few	Many (bleeding risk!)

Thrombolytic Drugs & Doses

Drug	Regimen
SK	1.5 million U over 30–60 min
tPA	Bolus + infusion x 90 min
rPA	10 U + 10 U bolus
ТNК	Weight-based single bolus

× 7. Thrombolysis Contraindications

Absolute:

- Active bleeding
- Suspected aortic dissection
- Hemorrhagic stroke hx
- Recent major trauma/brain/spinal surgery
- Uncontrolled HTN >220/120

A Relative:

- Recent trauma/surgery
- Active PUD
- Diabetic retinopathy
- Current anticoagulant use

8. Risk Stratification: TIMI Score

Point for		
Age ≥ 65		
≥3 CAD risk factors		
Prior CAD with ≥50% stenosis		
Aspirin in last 7 days		
ST deviation		
≥2 anginal events in last 24h		
Elevated markers		

Score \geq 3 = High risk \rightarrow cath indicated

9. Post-MI Complications

System	Complication	Timing
Electrical	VT/VF, AV block	Early hours
Mechanical	Septal rupture, MR, tamponade	Day 3–7
Inflammatory	Early pericarditis, Dressler's	Day 2–8 wks
Failure	Killip II–IV CHF	First 48h
Others	LV aneurysm, recurrent MI	Weeks–months

10. How to Spot Reinfarction

Clue	Why it matters
Recurring chest pain	Suggests ischemia
New ECG changes	ST changes = new infarct
Re-rise in CK-MB	Best lab marker
New wall motion abnormality	Seen on ECHO