CORONARY ARTERY DISEASE
MEANING

- Atherosclerosis: *ather* = fatty mush, *skleros* = hard.
- Atherosclerosis = “hardening of the arteries”
Coronary blood flow

- Coronary Vessels, unlike the rest of the body are perfused during DIASTOLE!
  - Systole:
    - Blood flows from subendocardium to subepicardium
    - Pressure reduces arterial inflow of blood
    - Increases coronary outflow
  - Diastole:
    - Pressure gradient drives blood into the subendocardium
    - Venous output declines
Insufficient blood flow to the heart muscle from narrowing of coronary artery may cause chest pain.

Plaque in coronary artery
Risk factors

- Family History
- Hypertension
- Obesity
- Diabetes
- Smoking
Non modifiable Risk Factors

- Heredity
- Age
- Personality factors
- Gender
Modifiable Risk Factors

- Smoking
- Hypertension
- Elevated serum cholesterol level
- Diabetes
- Obesity
- Physical Inactivity
Contributing Risk Factors

- Response to stress
- Homocysteine Level
- Inflammatory Level
- Menopause
- Type A Behavioural Patterns, TABP
- Hemostatic factors
Novel risk factors

- Homocysteine
- CRP
- Plasma fibrinogen
- Fibrin D dimer
- Lipoprotein
CAUSES OF ACS

- Decrease in the oxygen available to the myocardium
  - Nonobstructive clot on an atherosclerotic plaque.
  - Coronary vasospasm.
  - Atherosclerotic obstruction without clot or vasospasm.
  - Inflammation or infection.
  - Unstable angina due to a non cardiac cause.
  - Thrombus formation with subsequent coronary artery occlusion.
• Initiation of Atherosclerosis
• Leukocyte Recruitment
• Foam-Cell Formation
• Atheroma Evolution and Complications
• Microvessels
• Calcification
• Plaque Evolution
The vulnerable atherosclerotic plaque

- Large lipid core
- Thin fibrous cap
- Rich in macrophages
- Increased MMPs
- Poor in smooth muscle cells
- Low-grade stenosis
Deterioration of a stable atherosclerotic plaque

Exposing the intima to blood

Stimulating platelet aggregation

Local vasoconstriction

Thrombus formation

Partially occluded by the thrombus (manifesting UA/NSTEMI) or totally occluded by a thrombus (STEMI)
Definition

Stable angina pectoris is characterized by chest or arm discomfort that may not be described as pain but is reproducibly associated with physical exertion or stress and is relieved within 5–10 minutes by rest and/or sublingual nitroglycerin.
Unstable Angina is defined as angina pectoris or equivalent ischemic discomfort with at least one of three features:

(1) it occurs at rest (or with minimal exertion), usually lasting >10 minutes;

(2) it is severe and of new onset (i.e., within the prior 4–6 weeks); and/or

(3) it occurs with a crescendo pattern
The diagnosis of NSTEMI is established if a patient with the clinical features of UA develops evidence of myocardial necrosis, as reflected in elevated cardiac biomarkers.
Pathophysiology

A reduction in oxygen supply and/or by an increase in myocardial oxygen demand superimposed on a lesion that causes coronary arterial obstruction, usually an atherothrombotic coronary plaque.

Angina

- Printzmetal's Variant Angina (vasospasm)
  - Supply Ischemia
- Chronic Stable Angina (fixed stenosis)
  - Demand Ischemia
- Unstable Angina (thrombus)
  - Supply Ischemia
(1) plaque rupture or erosion with a superimposed nonocclusive thrombus → NSTEMI may occur with downstream embolization of platelet aggregates and/or atherosclerotic debris;

(2) dynamic obstruction [e.g., coronary spasm, as in Prinzmetal's variant angina (PVA)]

(3) progressive mechanical obstruction [e.g., rapidly advancing coronary atherosclerosis or restenosis following percutaneous coronary intervention (PCI)]

(4) UA secondary to increased myocardial oxygen demand and/or decreased supply (e.g., tachycardia, anemia).
Clinical Presentation

- Typical chest and associated symptoms (not related to trauma):
Atypical symptoms

- Neck, throat, jaw or tooth discomfort
- Shoulder or arm pain
- Numbness or tingling in the chest or related area
- Fullness or burning in the chest
- Epigastric discomfort which is described as indigestion
- Discomfort between scapula or in the midback region
- Dizziness/ light headedness with or without syncope
- Fatigue or weakness not related to neurologic problems
- Palpitation of new onset with no history of dysrhythmia
- Mid back pain (not related to degenerative joint diseases)
Diagnostic Pathways

- Clinical history
- ECG
- Cardiac markers
- Stress testing (coronary imaging is an emerging option).
Location of chest pain during angina or heart attack:
- Upper chest
- Substernal radiating to neck and jaw
- Substernal radiating down left arm
- Susternal radiating down left arm
- Epigastric radiating to neck, jaw, and arms
- Neck and jaw
- Left shoulder and down both arms
- Intrascapular
Electrocardiogram

The Baseline of the ECG

Notice the baseline is depressed. This is seen on the ECG of someone with a “NSTEMI” heart attack.

Normal ECG

ST segment

STEMI

NSTEMI/UA
Electrocardiogram

ST-depression
ST-segment depression in nstemi

T-inversion
T-wave inversion in nstemi
Biochemical cardiac markers

- Creatine kinase (CK-MB)
- Troponin I and T and/or
- Myoglobinlin
Treatment

- Initial treatment should begin with the platelet cycloxygenase inhibitor aspirin.
- The typical initial dose is 325 mg/d, with lower doses (75–162 mg/d) recommended for long-term therapy.
Antiplatelet drugs

- ADP antagonists (Thienopyridines)
  - Ticlopidine
  - Clopidogrel
  - Prasugrel

- COX inhibitors
  - Aspirin

- Phosphodiesterase inhibitors
  - Dipyridamole

- GP IIb/IIIa Inhibitors
  - Tirofiban
  - Eptifibatide
  - Abciximab
Aspirin

- Inhibits cyclooxygenase-1
  - Decreases production of thromboxane A2
  - Decreases expression of GP IIb/IIIa receptor

- Adverse effects
  - Bleeding
  - Stop 7 days before certain major surgical procedures

- Drug Interactions
  - Additive bleeding
    - P2Y12 receptor antagonists
    - Warfarin
    - NSAIDs
  - Dose: 325 mg acutely and for 1 year post event, THEN 81 mg daily
Arachadonic acid

NSAIDs

COX-1
- Cytoprotective prostaglandins (platelet aggregation, gastrointestinal mucosal integrity, renal function)

NSAIDs and selective COX-2 inhibitors

COX-2
- Inflammatory prostaglandins (pain, inflammation, mitosis, growth)
Acetylation of prothrombin, antithrombin

Aspirin

Acetylation of fibrinogen, GP IIb/IIIa receptor

Thrombin

Collagen

Platelet activation

Receptor

Phospholipids

Non-COX-1 pathway

COX-1

AA

TXA₂

TXA₂

GP IIb/IIIa activation, aggregation, clot formation

Gq, G₁₂

Key: AA—arachidonic acid; COX—cyclooxygenase; TXA₂—thromboxane A₂; GP—glycoprotein
Glycoprotein IIb/IIia Receptor Antagonists

- Prevents adhesion of platelets
- Small molecule inhibitors
  - Eptifibatide and Tirofiban
- Clearance through kidney
- Excessive bleeding is managed by discontinuation
- Monoclonal antibody Abciximab (Reopro)
  - Long duration of action, irreversible
  - Excessive bleeding requires exogenous infusion of platelets
Anticoagulant therapy

- Unfractionated heparin (UFH)
- The low-molecular-weight heparin (LMWH), enoxaparin
- The indirect Factor Xa inhibitor, fondaparinux
- Bivalirudin
Heparin & LMWH
Anti-ischemic treatment

- To provide relief and prevention of recurrence of chest pain
- Initial treatment should include
  - bed rest
  - nitrates, and
  - beta blockers
**B-BLOCKERS:**

- **Rx Propranolol** (Inderal)
- **Rx Atenolol** (Tenormin)
- **Rx Metoprolol** (Lopressor)

(Ends in OLOL)

**Action** - Blocks Beta Receptors in The Heart Causing:
- ↓ Heart Rate
- ↓ Force of Contraction
- ↓ Rate of A-V Conduction

**Side Effects:**
- Bradycardia
- Lethargy
- GI Disturbance
- CHF
- ↓ BP
- Depression

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<table>
<thead>
<tr>
<th></th>
<th>Cardioselective</th>
<th>Non-cardioselective</th>
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<tbody>
<tr>
<td>With ISA</td>
<td>Acebutolol*+</td>
<td>Carteolol+++</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Penbutolol+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pindolol*+++</td>
</tr>
<tr>
<td>Without ISA</td>
<td>Atenolol</td>
<td>Carvedilol**</td>
</tr>
<tr>
<td></td>
<td>Betaxolol</td>
<td>Labetalol**</td>
</tr>
<tr>
<td></td>
<td>Bisoprolol</td>
<td>Nadolol</td>
</tr>
<tr>
<td></td>
<td>Metoprolol*</td>
<td>Propranolol*#</td>
</tr>
</tbody>
</table>

ISA = Intrinsinc Sympathomimetic Activity
**Alpha blocking properties
+Minimal ISA   ++Moderate ISA   +++Significant ISA
*Lipid soluble  #Membrane stabilizing
Abbreviations: NE, norepinephrine; Gs, G-stimulatory protein; AC, adenylyl cyclase; PK-A, cAMP-dependent protein kinase; SR, sarcoplasmic reticulum.
# Nitrates

## Nitrate Overview

<table>
<thead>
<tr>
<th>Drug</th>
<th>Indications</th>
<th>Possible Side effects</th>
<th>Some Potential Interactions</th>
<th>Precautions and Contraindications</th>
</tr>
</thead>
</table>
| Isosorbide dinitrate | • Angina pectoris  
                      | • Congestive heart failure  
                      | • Esophageal spastic disorders  
                      | • Hypertensive emergency  
                      | • Acute myocardial ischemia  
                      | • Pulmonary hypertensions  
                      | • Headache  
                      | • Flushing  
                      | • Hypotension  
                      | • Dizziness  
                      | • Nausea / vomiting  
                      | • Alcohol  
                      | • Alteplase  
                      | • Ergot derivatives  
                      | • Heparin  
                      | • Hypotensive agents  
                      | • PDE-5 inhibitors  
                      | **Precautions:**  
                      | • Hypovolemia  
                      | • Hypotension  
                      | • Severe hepatic / renal disease  
                      | • Development of nitrate tolerance  
                      | • Pregnancy / lactation  
                      | **Contraindications:**  
                      | • Hypersensitivity  
                      | • Severe anemia  
                      | • ↑ ICP / glaucoma  
                      | • Concurrent use with PDE-5 inhibitors  
                      | • Pericardial tamponade  

ER: Extended-release; ICP: Intracranial pressure; PDE-5 inhibitors: Phosphodiesterase 5 inhibitor

**INNOVATE RESEARCH & DEVELOPMENT™**
Mechanism of Action of Nitroglycerin

(jeepakistan.blogspot.com)
Calcium Channel Blockers (ccB) slow heart rate and lower blood pressure.

ccB slows the SA-node (sinoatrial node) which initiates heartbeat with electrical impulses.

Calcium affects the heart and blood vessels.

Dilated artery = lower blood pressure.

Slow heart rate allows left ventricle to fill completely and lowers the heart workload.
Verapamil and Diltiazem

Supraventricular arrhythmias
- Atrial fibrillation
- Atrial flutter
- Paroxysmal supraventricular tachycardia

Hypertension

Angina
FIBRINOLYTICS

- Used to lyse the thrombi / clot to recanalize the occluded blood vessel (mainly coronary artery)
- Work by activating the Fibrinolytic system

- STREPTOKINASE
- UROKINASE
- RETEPLASE (analogue of alteplase)
- ALTEPLASE (t- PA )
- TENECTEPLASE
PRINZMETAL'S VARIANT ANGINA (PVA)

- A syndrome of severe ischemic pain that occurs at rest but not usually with exertion and is associated with transient ST-segment elevation.
- This syndrome is due to focal spasm of an epicardial coronary artery, leading to severe myocardial ischemia.
Clinical and Angiographic Manifestations

Blood flow is constricted during an artery spasm.
Treatment of PVA

- Nitrates and calcium channel blockers
- Aspirin may actually increase the severity of ischemic episodes, possibly as a result of the exquisite sensitivity of coronary tone to modest changes in the synthesis of prostacyclin.
- The response to beta blockers is variable.
- Coronary revascularization
Types of Myocardial Infarction: Some slight differences in acute treatment

- Extensive platelet activation
- Better prognosis
- The inopyridines added to acute treatment
- Glycoprotein IIb/IIIa inhibitors added to acute treatment
- Angioplasty may be immediate or delayed

- Extensive fibrin activation
- Worse prognosis
- PCI or bypass is an immediate option
- Fibrinolytics are an option for hospitals without PCI/surgery
Drugs Involved in the treatment of ACS

**NSTEMI**
- Aspirin
- Thienopyridines
- Heparin/LMWH/Argatroban
- Glycoprotein IIb/IIIa receptor antagonists
- Beta Blockers
- Nitroglycerin
- Morphine

**STEMI**
- Aspirin
- Thienopyridines
- Heparin/LMWH/Argatroban
- Fibrinolytics
- Beta Blockers
- Nitroglycerin
- Morphine
Myocardial Infarction:
Non-ST Segment Elevation

(flat) ST depression
Acute Treatment for NSTEMI

- Stop progression of clot formation
  - Anticoagulant:
    - IV Heparin 50 Units/kg 15 Units/kg/hour
  - Antiplatelet:
    - Aspirin 325mg chewed and swallowed
    - Clopidogrel/Prasugrel
    - Glycoprotein IIb/IIIa inhibitors
- Restore myocardial blood flow
  - Percutaneous Coronary intervention (PCI) with angioplasty + stent
  - Coronary artery bypass
  - IV nitroglycerin
  - IV Morphine Sulfate
- Preserve myocardial pump function
  - IV then ORAL beta blockers
Chronic Treatment for NSTEMI

- Stop progression of clot formation
  - Anticoagulant (with evidence of pump dysfunction LVEF<40%):
    - Oral warfarin, Oral Direct Thrombin Inhibitor/ Oral Fxa Inhibitor
  - Antiplatelet: (all NSTEMI patients)
    - Aspirin 325mg daily
    - Clopidogrel or Prasugrel if allergic to ASA or WITH aspirin if stent placed

- Restore myocardial blood flow
  - Oral nitroglycerin
  - Oral beta blockers

- Preserve myocardial pump function
  - Oral beta blockers
  - Oral ACE inhibitors/ Angiotensin Receptor Antagonists
  - Oral Aldosterone Antagonist (spironolactone)
  - Oral HMG-CoA reductase inhibitors (statin)
    - Prevents plaque reformation; stabilizes existing plaques
Myocardial Infarction:
Elevation ST-Segment

Also known as “The Widow Maker”
Process of a STEMI

The most virulent and deadly form of a heart attack

- Acute ischemia
- Activation of the coagulation cascade
  - Thrombosis development
- Cellular necrosis
- Inflammation
- Phagocytosis of infarcted myocytes
- Formation of non-contractile scar tissue
Pathology of STEMI

- Fibrous cap of an atherosclerotic plaque is disrupted
- Exposure of fibrous plaque contents to the blood stream activates the coagulation cascade
- The rough surface and narrow vessel diameter causes turbulent blood flow further activating the coagulation cascade
- Thrombus contains platelets, fibrin, erythrocytes, and leukocyte
Pathology of STEMI
Pathophysiology

- Contractile ability is immediately lost with ischemia
  - One of four abnormal contractile patterns emerge
    - Dyssynchronous contraction
    - Hypokinesis - decrease in amount of contractile shortening
    - Akinesis - Complete cessation of myocardial shortening
    - Dyskinesis - Paradoxical bulging
  - May even effect contractile ability of non-infarcted tissue
- Larger area infarcts result in declines in pump function
  - Stroke volume
  - Cardiac output
  - Blood pressure
- Activates Renin Angiotensin Aldosertone System (RAAS) which:
  - Increases plasma volume
  - Facilitates development of fibrosis
Renin-angiotensin-aldosterone system

- Angiotensinogen → Angiotensin I → Angiotensin II
- Renin
- Decrease in renal perfusion (juxtaglomerular apparatus)
- Lungs
- Kidney
- Surface of pulmonary and renal endothelium: ACE

- Tubular Na⁺ Cl⁻ reabsorption and K⁺ excretion, H₂O retention
- Adrenal gland: cortex
- Renin activity
- Sympathetic activity

- Arteriolar vasoconstriction, increase in blood pressure
- ADH secretion
- Pituitary gland: posterior lobe
- Collecting duct: H₂O absorption

- Water and salt retention. Effective circulating volume increases. Perfusion of the juxtaglomerular apparatus increases.
Ventricular Remodeling

- Following STEMI, the ventricle changes size, shape, and thickness.
  - Influenced by:
    - The load (blood volume) placed on the ventricle
    - Remember the ventricle is already dilated from the STEMI
    - Restoration of blood flow to the infarcted artery
  - Rapidity of treatment affects the ability of the myocardium to at least partially recover.
Clinical features of STEMI

**SUBJECTIVE**
- Accelerating anginal symptoms
- With radiation to left arm
- Epigastric or neck pain in women
- Often described as choking or heavy
- Can also be burning or stabbing sensations
- Diaphoresis (Sweating)
- Drop in blood pressure
- Tachycardia
- Nausea

**OBJECTIVE**
- Anxious Patient
- Rapid heart rate
- My be an irregular or regular ventricular rhythm
- Heart sounds, particularly S1 is muffled
Acute Coronary Syndrome

Electrocardiogram

ST-elevation

No ST-elevation

Cardiac markers

negative

Unstable angina

positive

Myocardial infarction

STEMI

Q-wave MI

NSTEMI

non-Q-wave MI
MYOCARDIAL INFARCTION (STEMI)
DEFINITION

- A dynamic process by which one or more regions of the heart experience a severe and prolonged decrease in oxygen supply because of insufficient coronary blood flow; subsequently, necrosis or death to the myocardial tissue occurs.
Clinical features

- Chest pain

- Chest pain associated with heart attack

- Usual distribution of pain with myocardial ischemia

- Less common sites of pain with myocardial ischemia

- Right side

- Epigastrium

- Back

- Jaw
Clinical features

• Diaphoresis, cool clammy skin, facial pallor.
• Hypertension or hypotension and Bradycardia or tachycardia
• Premature ventricular and/or atrial beats
• Palpitations, severe anxiety, dyspnea
• Disorientation, confusion, restlessness
• Fainting, marked weakness
• Nausea, vomiting, hiccups
Atypical symptoms

- Epigastric or abdominal distress
- Dull aching or tingling sensations
- Shortness of breath
- Extreme fatigue
MYOCORDIAL INFARCTION (MI)
CORONARY OCCLUSION
"HEART ATTACK"

Pain:
- sudden onset
- substernal
- crushing
- tightness
- severe
- unrelieved by nitro
- may radiate to:
  - back
  - neck
  - jaw
  - shoulder
  - arm

dyspnea
syncope (↓ bp)
nausea
vomiting
extreme weakness
diaphoresis
denial is common
HR

TX:
- O
- IV
- Meds
- monitor
- Dietary restrictions
- NA
- cholesterol
- caffeine
- surgery
- pacemaker
Physical Signs

- Fourth and third heart sounds
- Decreased intensity of the first heart sound
- Paradoxic splitting of the second heart sound
- A pericardial friction rub (transmural STEMI)
- Temperature elevations up to 38°C.
Diagnostic Evaluation

(1) ECG
(2) serum cardiac biomarkers
(3) cardiac imaging
(4) nonspecific indices of tissue necrosis and inflammation
Physical Examination

- muffling of sounds
- presence of gallop
- arrhythmia, and
- accentuation of pulmonary second sound
WHO criteria for diagnosis of MI:

It requires at least two of the following three elements:

- A history of ischemic type chest discomfort
- Evolutionary changes on serially obtained ECG tracing
- Typical rise and fall in serum cardiac markers
ECG Changes

- ST segment depression and T wave inversion indicate a pattern of ischemia.
- ST elevation indicates an injury pattern.
- Q waves indicate tissue necrosis and are permanent.

Evolution of STEMI:

1. Before infarction
2. Hyperacute T
3. T inversion
4. Coronary T
5. Q waves

Minutes → Hours
Hours → 1 day
1 week
Months
<table>
<thead>
<tr>
<th>ECG leads showing changes</th>
<th>Location of infarct</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1-V3</td>
<td>Anteroseptal</td>
</tr>
<tr>
<td>V4- V6, L1 and aVL</td>
<td>Anterolateral</td>
</tr>
<tr>
<td>aVF,L2 and L3, ST depression in V1 and V2</td>
<td>Inferior wall</td>
</tr>
<tr>
<td>Presence of tall R wave and upright T waves in V1 and V2</td>
<td>True posterior infarct</td>
</tr>
<tr>
<td>ST elevation in Rt sided chest leads and Q waves (V3R, V4R)</td>
<td>Right ventricular infarct</td>
</tr>
</tbody>
</table>
Cardiac Markers

• Nonspecific markers
  – lactate dehydrogenase
  – aspartate aminotransferase
  – myoglobin

• Specific cardiac markers
  – Troponin (troponin C, troponin I and troponin T).
  – Creatine kinase (CK)
The graph shows the concentration of various biomarkers over time from the onset of infarction. The x-axis represents hours from the onset of infarction, while the y-axis represents the concentration of each biomarker relative to the upper limit of normal. The biomarkers include:

- **Myoglobin**
- **Total CK**
- **CK-MB**
- **LDH**
- **Troponin I**

The concentration spikes and declines over the course of several hours, indicating the time frame during which each biomarker is most useful for diagnosing myocardial infarction.
• **Chest xray:** Prominent pulmonary vascular markings on x-ray indicate left ventricular failure. Chest film helps to exclude other causes of chest pain such as pneumothorax, pulmonary infarction with effusion, aortic dissection and skeletal fractures.

• **Echocardiogram:**
  - used to evaluate ventricular function.
  - used to assist in diagnosing an MI, especially when the ECG is nondiagnostic.
Other Findings

- Elevated CRP and lipoprotein
- Abnormal coagulation studies
- Elevated white blood cell (WBC) count and sedimentation rate
- Radionuclide imaging allows recognition of areas of decreased perfusion.
- PET determines the presence of reversible heart muscle injury and irreversible or necrotic tissue; extent to which the injured heart muscle has responded to treatment can also be determined.
Emergency department

- Goals:
  - control of cardiac discomfort,
  - rapid identification of patients who are candidates for urgent reperfusion therapy,
  - triage of lower-risk patients to the appropriate location in the hospital, and
  - avoidance of inappropriate discharge of patients with STEMI.
- **Aspirin**: Rapid inhibition of cyclooxygenase-1 in platelets followed by a reduction of thromboxane A$_2$

- **Supplemental O$_2$**: when hypoxemia is present, O$_2$ should be administered by nasal prongs or face mask (2–4 L/min) for the first 6–12 h after infarction
Control of Discomfort

- Sublingual nitroglycerin
- Morphine
- Intravenous beta blockers
Management Strategies:

Initial 12-lead ECG $\rightarrow$ ST-segment elevation of at least 2 mm in 2 contiguous precordial leads and 1 mm in 2 adjacent limb leads is present $\rightarrow$ a patient should be considered a candidate for reperfusion therapy

- Gold hour = first 60 mts. Total ischemic time : 120 mts
Primary Percutaneous Coronary Intervention

PCI, usually angioplasty and/or stenting without preceding fibrinolysis, referred to as primary PCI

- It is effective in restoring perfusion in STEMI when carried out on an emergency basis in the first few hours of MI.
• Advantage:
  – patients who have contraindications to fibrinolytic therapy
  – More effective than fibrinolysis in opening occluded coronary arteries
Fibrinolysis

- Ideally initiated within 30 min of presentation (door-to-needle time 30 min).
- Goal of fibrinolysis is prompt restoration of full coronary arterial patency.
Fibrinolytic agents

- Tissue plasminogen activator (tPA), streptokinase, tenecteplase (TNK), and reteplase (rPA)
  - First generation drugs- streptokinase, urokinase
  - Second generation- TPA, anioylated plasminogen streptokinase
  - Third generation- reteplase, TNK
- These drugs are promoting the conversion of plasminogen to plasmin, which subsequently lyses fibrin/thrombi.
CONTRAINDICATIONS OF FIBRINOLYSIS

- History of cerebrovascular hemorrhage, a nonhemorrhagic stroke or other cerebrovascular event within the past year
- Suspicion of aortic dissection
- Active internal bleeding (excluding menses)
- Advanced age associated with an increase in hemorrhagic disorders
Relative contraindications:

- Current use of anticoagulants (INR- 2)
- A recent (<2 weeks) invasive or surgical procedure or prolonged (>10 min) cardiopulmonary resuscitation
- Known bleeding disorders
- Pregnancy
- A hemorrhagic ophthalmic condition (e.g., hemorrhagic diabetic retinopathy)
- Active peptic ulcer disease
- A history of severe hypertension that is currently adequately controlled.
- Because of the risk of an allergic reaction, patients should not receive streptokinase if that agent had been received within the preceding five days to two years.
Cardiac Rehabilitation

- Medically supervised program consisting of exercise training, education on heart healthy living, and counseling to reduce stress and help patients return to an active lifestyle and recover more quickly.
Complications

- Ventricular Dysfunction and Congestive Heart Failure

  - STEMI
  - Left ventricle begins to dilate results from expansion of the infarct
  - Overall chamber enlargement
  - Resulting in disproportionate thinning and elongation of the infarct zone
  - Lengthening of the noninfarcted segments occurs

- Heart Failure
EARLY COMPLICATIONS

- Hypovolemia
- Cardiogenic Shock
- Right Ventricular Infarction
- Arrhythmias
- Ventricular Premature Beats
- Ventricular Tachycardia and Fibrillation
- Sinus Bradycardia
LATE COMPLICATIONS

- Left Ventricular Aneurysm
- Dressler’s syndrome
- Shoulder hand syndrome
BIBLIOGRAPHY

Non ST elevation MI (NSTEMI)

- Myocyte Death: + cardiac biomarkers
- No ST elevation, may have ST depression/TW inversion
**Inferior MI**: 2, 3, avF

<table>
<thead>
<tr>
<th>Name:</th>
<th>HR 100bpm</th>
<th>QRS 0.092s</th>
<th>Normal sinus rhythm</th>
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<td>PR 0.148s</td>
<td>65° 66° 100°</td>
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<tr>
<td>Age</td>
<td>40</td>
<td>QT/QTc 0.342s/0.441s</td>
<td>ST elevation consider inferior injury or acute infarct</td>
</tr>
<tr>
<td>ID</td>
<td>81 May 07</td>
<td>P-QRS-T Axes:</td>
<td></td>
</tr>
</tbody>
</table>

![ECG Image]

**x1.0 85-150Hz 25mm/sec**

P/N 805319
Anterior MI: V1-V6
Lateral MI: I, AVL, V5, V6
New Left Bundle Branch Block

For MI with LBBB: STE at least 1mm concordant with QRS OR ST depression at least 1mm in V1, V2 or V3

QRS ≥ 120 ms, ST and T wave opposite to QRS
Posterior MI

- ST depressions V1-V4
- Tall R in V2,V3
- Posterior leads V7-V9
- STE
- IMI may also be present
Posterior MI

Isolated acute posterior wall MI
Symmetric TW inversions V2, V3

Biphasic TW in V2, V3
Right Ventricle MI: Right side leads
ECG: Most important test in ACS

Within 10 min of arrival with suspected ACS

Serial ECGs essential!

Localizes diseased artery/myocardium

Dictates management in the ER
Cardiac Biomarkers: Troponin

Most specific for myocyte injury
- Rise @ 3 hours, elevated 7-10 days
- Not sensitive < 6 hours after onset of pain
- Tn T → skeletal muscle disease & renal failure
- Tn I → preferred marker
- Predictor of outcome
- Single normal troponin does NOT exclude ACS.
CK/CK MB

CK is in many tissues → not sensitive or specific

CK MB

mostly in heart, can be increased in skeletal muscle diseases
low sensitivity early (< 3 hours from symptom onset)
Sensitivity increases with time –
Rise within 3-8 hours, peak 20 hours, decline – in 3 days
Cardiac Biomarkers: Myoglobin

- High sensitivity early on, low specificity
- Rises in 2 hours, peak at 7 hours and returns to baseline in 24 hours
- 100% negative predictive value for AMI
- Useful for triage of patients at low risk
## Treatment

Match treatment to risk: More aggressive in high-risk, unstable patients

**IV O2 monitor**

<table>
<thead>
<tr>
<th>Anti-platelet</th>
<th>Aspirin</th>
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<td>Clopidogrel</td>
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<td>GP 2b/3a inhibitors</td>
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<td>Anti-thrombin</td>
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<td>Limiting Infarct Size</td>
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<td>ACE inhibitors</td>
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<td>Reperfusion therapies</td>
<td>Percutaneous Coronary Intervention</td>
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<td>CABG</td>
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</table>
Antiplatelet Agents: Aspirin

Reduces mortality by 22% – 325 mg in acute presentation – Only contraindicated when there is a TRUE allergy to aspirin

Avoid enteric coated forms in the acute presentation
Antiplatelet Agents: Clopidogrel

Adenosine diphosphate receptor antagonists – CURE trial: With aspirin, 20% decrease in MI, death, stroke in UA/NSTEMI

Give early in cases of non invasive management/PCI

Loading dose 300-600 mg then 75 mg/day –

Try to hold 5 days prior to CABG due to bleeding risk: debatable
Glycoprotein 2b/3a Inhibitors

Inhibits platelet aggregation through multiple mechanisms

Highest risk UA/NSTEMI patients – undergoing PCI (dynamic changes on EKG, elevated biomarkers, electrical instability)

40% reduced risk of death or AMI in 30 days –

Abciximab → only if PCI is planned –

Eptifibatide or Tirofiban → no PCI planned –

Initiate in conjunction with a cardiologist –
Anti Thrombin: Unfractionated Heparin

Prevents propagation of thrombus, antiplatelet –
Additive benefit with Aspirin and/or Clopidogrel: 56% – reduced risk of death/AMI in UA patients

Recommended in ALL ACS patients –
Bolus: 60 units/kg (maximum 5,000 units) –
Infusion 12 units/kg/hr (maximum 1,000 units/hr) –
Advantages – reversible & titratable –

Disadvantages – variable onset & bioavailability; – constant monitoring of aPTT
Anti Thrombin: Low Molecular Weight Heparin (LMWH)

Enoxaparin most common –
In UA/NSTEMI risk of death, AMI or – recurrent angina 15% lower in those who received enoxaparin rather than UFH (in combination with ASA) without increase in major bleeding complications.

Advantages: Greater bioavailability, more – reliable anticoagulation, less injections

Disadvantages: Caution with renal failure, – CABG in 24 hours → UFH
Limiting Infarct Size: Nitrates

Coronary vasodilation, pain relief, – hypertension management
Recommended use up to 48 hours in AMI, – recurrent ischemic, CHF, Hypertension

Give sublingual/spray q5 minutes x 3 → – persistent pain → nitroglycerin infusion 10 mcg/minute

Titrate to blood pressure reduction not – symptom resolution
Limiting Infarct Size: Nitrates/Morphine

Contraindications: Hypotension, severe – bradycardia, Right Ventricular infarct, recent Phosphodiesterase Inhibitors

Use cautiously in patients with inferior – MI because they may be preload dependent!

When nitrates do not resolve – symptoms use morphine
Beta Blockers

Reduced myocardial oxygen demand

Give within 12 hours of infarction, either oral or intravenous

Relative contraindications:

Acute heart failure
Bradycardia < 60
sbp<100
2nd/3rd AV block
PR> 0.24 sec
COPD, asthma
peripheral hypoperfusion
ACEI

Reduced LV dilatation and CHF • Decreased mortality in Acute MI • STEMI or Heart Failure: within 24 hours • UA/NSTEMI: Recommended for hypertension in reduced EF/CHF when nitrates and beta blockers don’t work • Contraindications: bilateral renal artery stenosis, renal failure.
Fibrinolytics

Dissolve fibrin, improves mortality •

Indications: •
ST elevation at least 1mm in two or more contiguous leads •
Symptoms < 12 hours •
Symptoms consistent with acute myocardial infarction •
No contraindications •

Fibrinolytics are particularly effective within the first six hours after pain onset in those with new LBBB and STEMI AND TRUE POST MI
Upto 1% can have ICH •
Fibrinolytics

**Streptokinase**: reduces mortality significantly (ISIS-1), lowest cost.

**Alteplase (tPA)**: better outcome than streptokinase because it can be administered faster—early administration has mortality benefit.

More likely to cause intracranial hemorrhage so in those that are high risk consider streptokinase.

**Tenecteplase and Retevase**: no difference between these and tPA in efficacy. Institution specific.
Contraindications to Fibrinolysis

Prior hemorrhagic stroke •
Known malignant intracranial neoplasm •
Ischemic stroke within 3 months •
Suspected aortic dissection or pericarditis •
Active or recent internal bleeding/bleeding diathesis (excluding menses) •
Severe closed head or facial trauma within 3 months •
Recent major surgery ( < 3 weeks) •
Uncontrolled Hypertension: systolic BP ≥180/100 •
Revascularization: PCI/CABG

Coronary angioplasty with or without stenting
Preferred compared to Fibrinolytics -- better outcome.

Depends on whether it is available at your facility and how quickly the patient can get to the cath lab
Summary

Clinical features of acute coronary syndrome

Aspirin & analgesia

ECG

ST elevation or new LBBB or true posterior MI

Normal

Consider alternative diagnoses

ST depression or T inversion

No

Raised troponin?

Yes

Unstable angina

STEMI

NSTEMI
ACS Treatment

History, Physical, EKG

ST elevation MI or new LBBB
- Aspirin
- Nitroglycerin/Morphine
- Beta Blockers
- Heparin
- Emergent PCI (GP 2b/3a inhibitors)
- Fibrinolytics

Non diagnostic or ischemic EKG
- Aspirin
- Nitroglycerin/Morphine
- Beta Blockers
- Heparin

Early Intervention (If PCI → GP 2b 3a inhibitors)

Medical Management (Consider 2b/3a Inhibitors or clopidogrel)
STEMI

- ST segment elevations
- T wave changes
- Q wave development
HEART-TRIPLE BYPASS

- Superior vena cava
- Aorta
- Bypass grafts x3
- Pulmonary artery
- Atheroma
- Grafted vessel 'bypasses' the part of the coronary artery which is narrowed with atheroma
- Right coronary artery
- Left coronary artery
Long Term Care

- Smoking Cessation and lifestyle modifications.
- Aspirin, Beta Blockers and Clopidogrel will be indefinite.
- Lipid lowering medication along with diet modifications.
References

Antman E et al The TIMI Risk Score for Unstable Angina/Non–ST Elevation MI JAMA 200; 284 (7) 835-842


Cameron, Peter et al. Textbook of Adult Emergency Medicine, 3rd Edition. Section 5.1 and 5.2.


