ST – Elevation Myocardial Infarction

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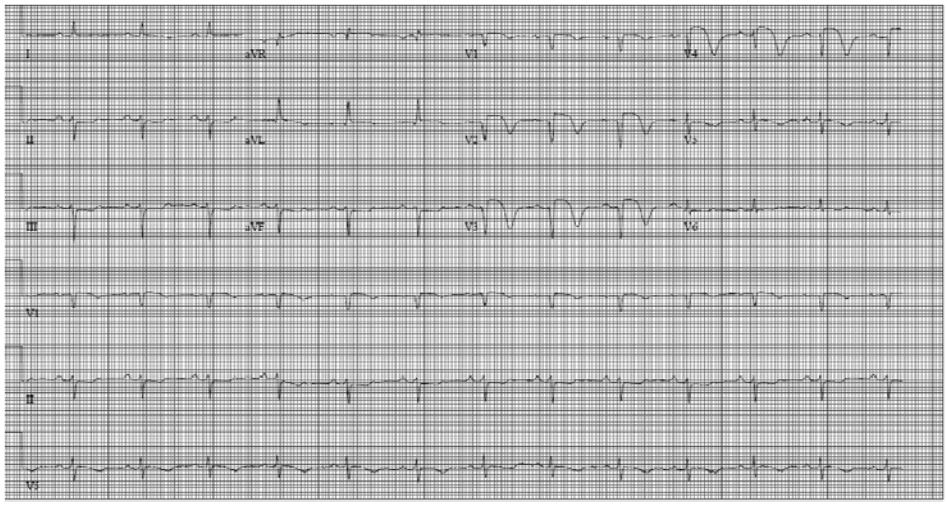
Outline

- **Case Presentation**
- **STEMI Incidence and Mortality**
- **STEMI Diagnosis**
- **STEMI Pathogenesis and Therapy**
- **Conclusion of Case**

Case Presentation

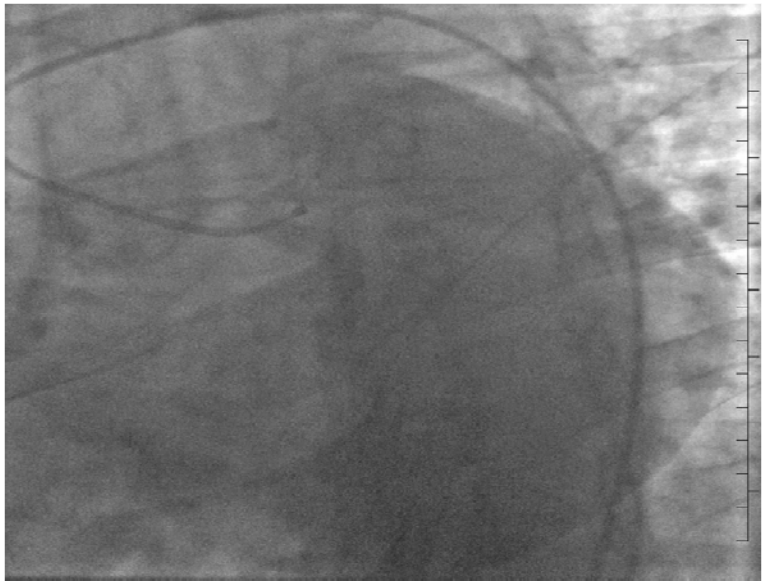
- 46 year old male with no significant past medical history
- Family history of early myocardial infarction
  - Brother at 35 years old
- Sudden onset chest pain, nausea and emesis
- EKG

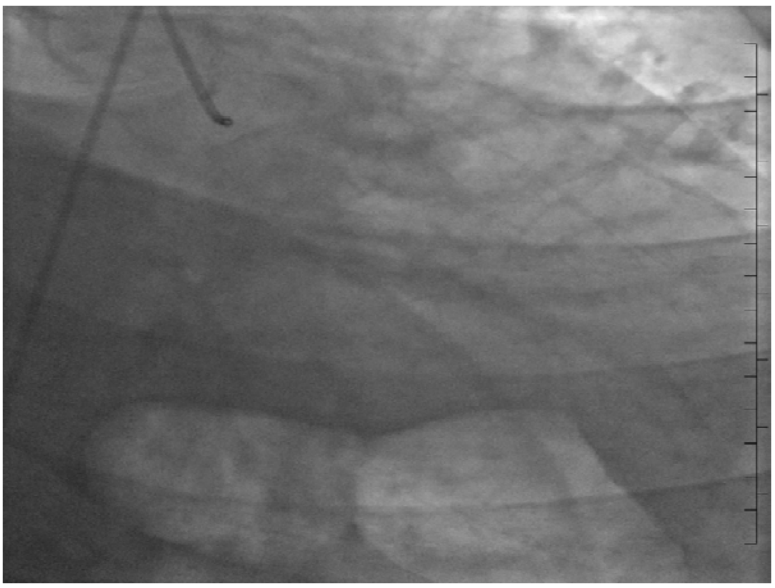
Case Presentation



Case Presentation

- **325 mg aspirin, 600 mg clopidogrel and heparin**
- **Transferred for emergent angiography**





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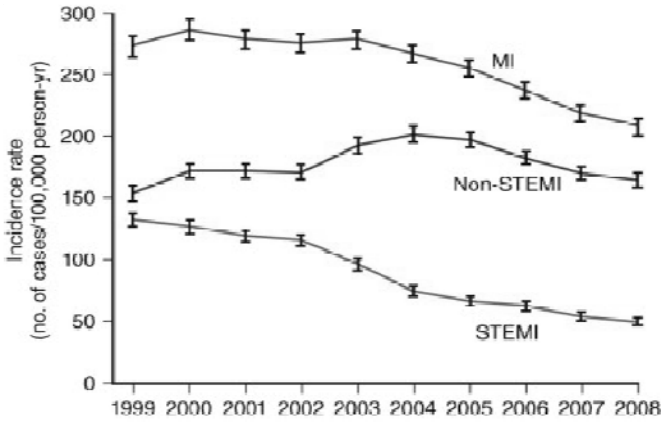
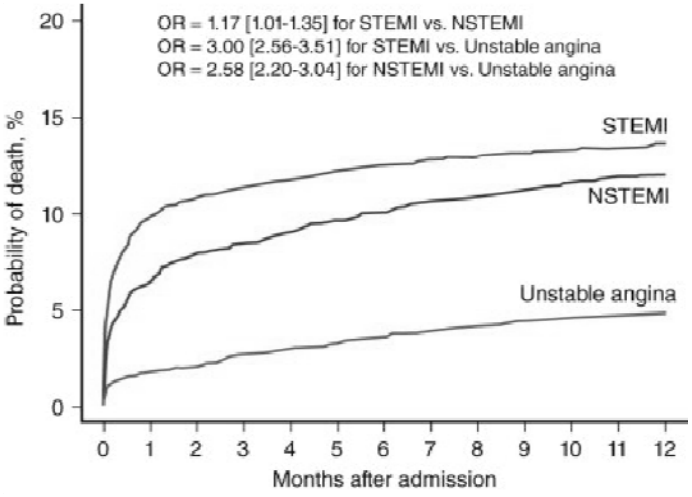
STEMI Incidence and Mortality



62% reduction in STEMI between 1999 and 2008

Yeh et al. 2010 NEJM 362(23): 2155-2165.

STEMI Incidence and Mortality



United States in-hospital mortality is 5-6%, 1 year mortality 7 to 18%*

Ndrepepa et al. 2009, Cardiology 113(3):198-206.

*O'Gara et al. 2013 ACC/AHA STEMI Guideline.

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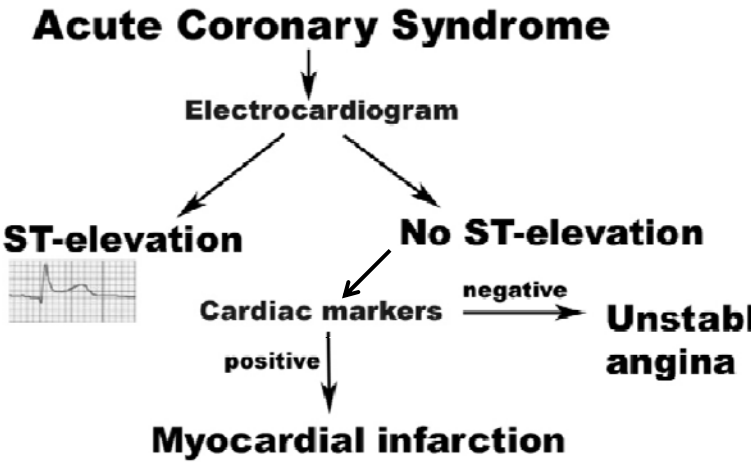
STEMI Diagnosis

- Symptoms Concerning for Myocardial Ischemia
  - Chest pain, shortness of breath, anginal equivalent
- Persistent ST Elevation
  - ≥ 1 mm ST elevation in ≥ 2 continuous leads
    - V2-V3; ≥ 2 mm in men, ≥ 1.5 mm in women
  - LBBB
  - ST depression in V1-V4
  - Question? *Consider urgent echocardiogram*
- Subsequent Release of Biomarkers

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

STEMI Diagnosis



Adapted from Alpert et al. 2000, JACC 36(3): 959-69.

STEMI Diagnosis

- Posterior Myocardial Infarction

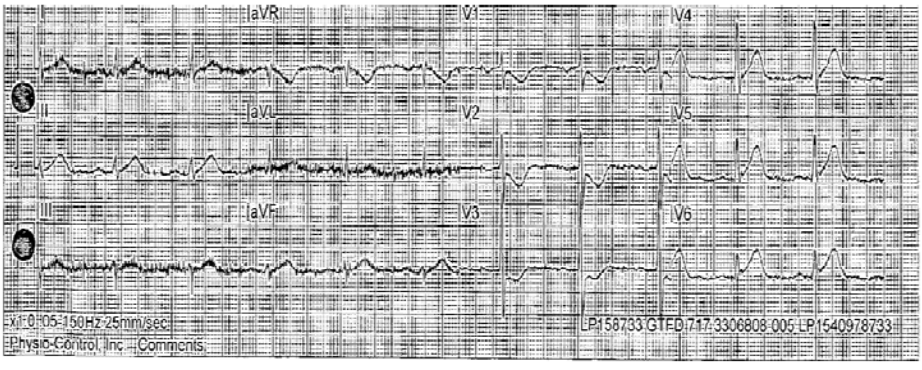
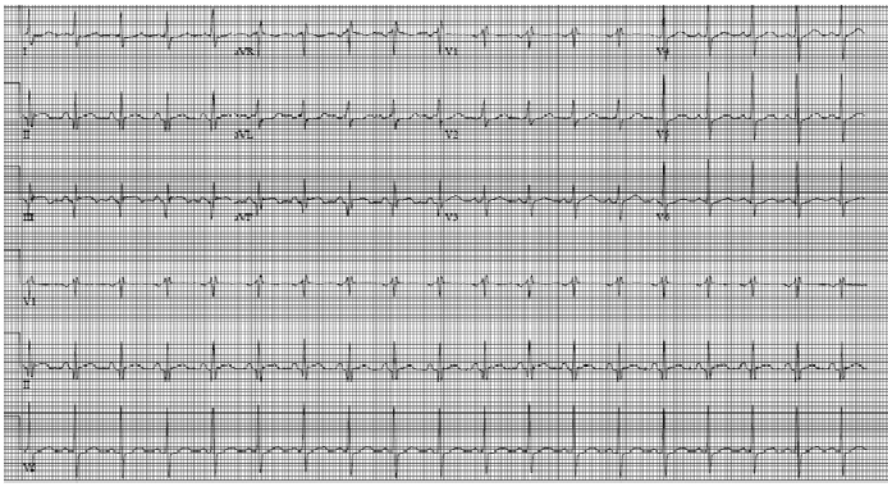


Image from Wikipedia

STEMI Diagnosis

- Inferior Myocardial Infarction



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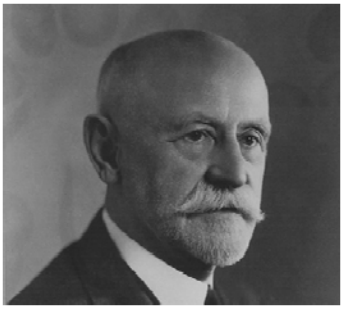
STEMI Therapy



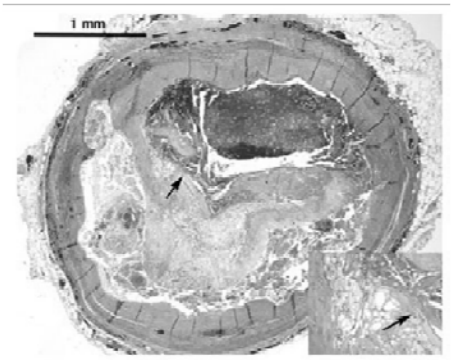
James B Herrick
1861 – 1954

"The importance of absolute rest in bed for several days is clear"

STEMI Pathogenesis

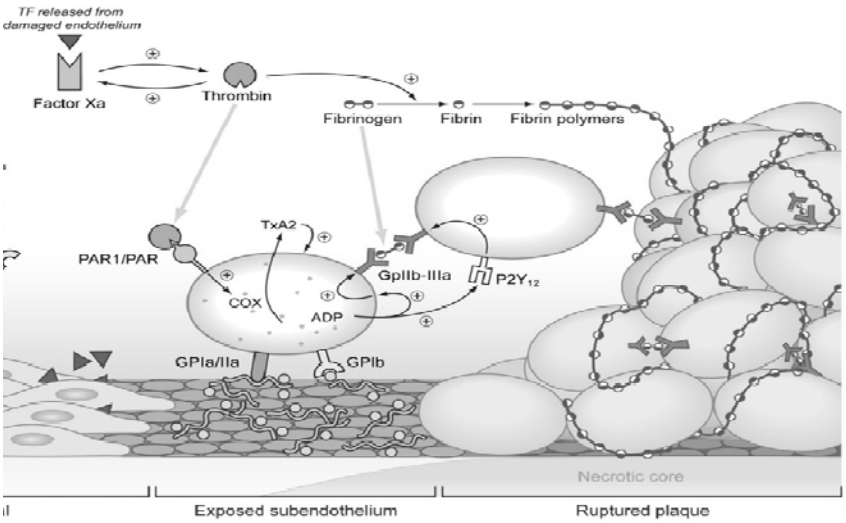
Angiography on 322 patients within 24 hours of myocardial infarction

- **< 4 hrs: 87% had occlusion**
- **> 12 hrs: 65% had occlusion**



DeWood et al. 1980; NEJM 303:897-902.

STEMI Pathogenesis

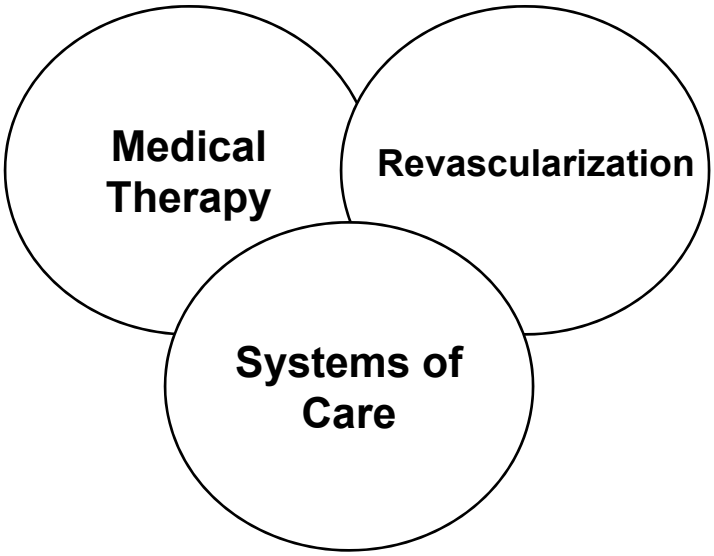


Lilly and Wilensky 2011, Front Pharmacol 2: 61

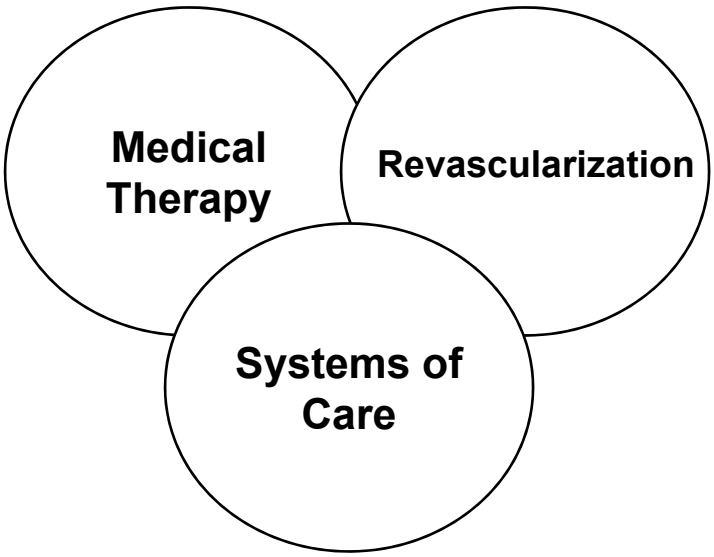
2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction

Developed in Collaboration with American College of Emergency Physicians and Society for Cardiovascular Angiography and Interventions

STEMI Therapy in 2013



STEMI Therapy



STEMI Therapy

- **Medical Antiplatelet**

	COR	LOE
Antiplatelet therapy		
Aspirin		
• 162- to 325-mg load before procedure	I	B
• 81- to 325-mg daily maintenance dose (indefinite)*	I	A
• 81 mg daily is the preferred maintenance dose*	IIa	B
$P2Y_{12}$ inhibitors		
Loading doses		
• Clopidogrel: 600 mg as early as possible or at time of PCI	I	B
• Prasugrel: 60 mg as early as possible or at time of PCI	I	B
• Ticagrelor: 180 mg as early as possible or at time of PCI	I	B

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

STEMI Therapy

- **Medical Anticoagulant therapy**

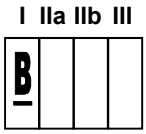
	COR	LOE
Anticoagulant therapy		
• UFH:	I	C
• With GP IIb/IIIa receptor antagonist planned: 50- to 70-U/kg IV bolus to achieve therapeutic ACT‡		
• With no GP IIb/IIIa receptor antagonist planned: 70- to 100-U/kg bolus to achieve therapeutic ACT§	I	C
• Bivalirudin: 0.75-mg/kg IV bolus, then 1.75-mg/kg/h infusion with or without prior treatment with UFH. An additional bolus of 0.3 mg/kg may be given if needed.	I	B
• Reduce infusion to 1 mg/kg/h with estimated CrCl <30 mL/min		
• Preferred over UFH with GP IIb/IIIa receptor antagonist in patients at high risk of bleeding	IIa	B
• Fondaparinux: not recommended as sole anticoagulant for primary PCI	III: Harm	B

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

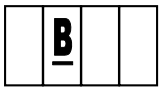
STEMI Therapy

- **Medical Therapy**

A note about beta-blockers



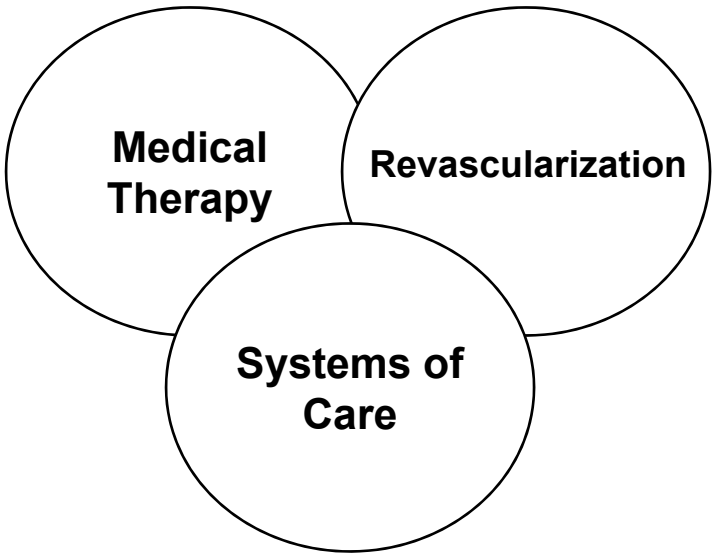
Oral beta blockers should be initiated in the first 24 hours in patients with STEMI who do not have any of the following: signs of HF, evidence of a low output state, increased risk for cardiogenic shock,* or other contraindications to use of oral beta blockers (PR interval >0.24 seconds, second- or third-degree heart block, active asthma, or reactive airways disease).



It is reasonable to administer intravenous beta blockers at the time of presentation to patients with STEMI and no contraindications to their use who are hypertensive or have ongoing ischemia.

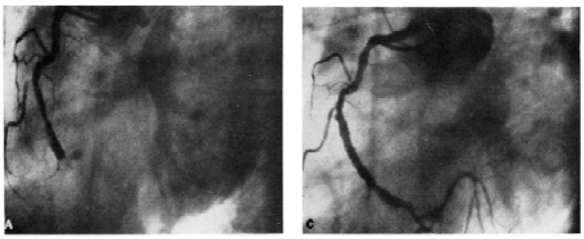
O'Gara et al. 2013 ACC/AHA STEMI Guideline.

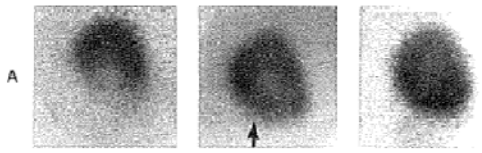
STEMI Therapy



STEMI Therapy

- **Revascularization**





Pharmacological or Mechanical Revascularization

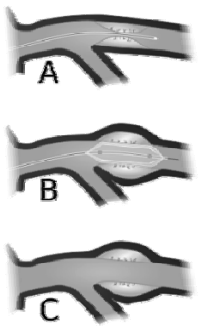
Restore Flow

Myocardial Salvage

Markis et al. NEJM 1981 305: 777-82
Rentrop et al., Circulation 1981 63: 307-317

STEMI Therapy

- **Revascularization with Primary PCI**



	COR	LOE
Ischemic symptoms <12 h	I	A
Ischemic symptoms <12 h and contraindications to fibrinolytic therapy irrespective of time delay from FMC	I	B
Cardiogenic shock or acute severe HF irrespective of time delay from MI onset	I	B
Evidence of ongoing ischemia 12 to 24 h after symptom onset	IIa	B
PCI of a noninfarct artery at the time of primary PCI in patients without hemodynamic compromise	III: Harm	B

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

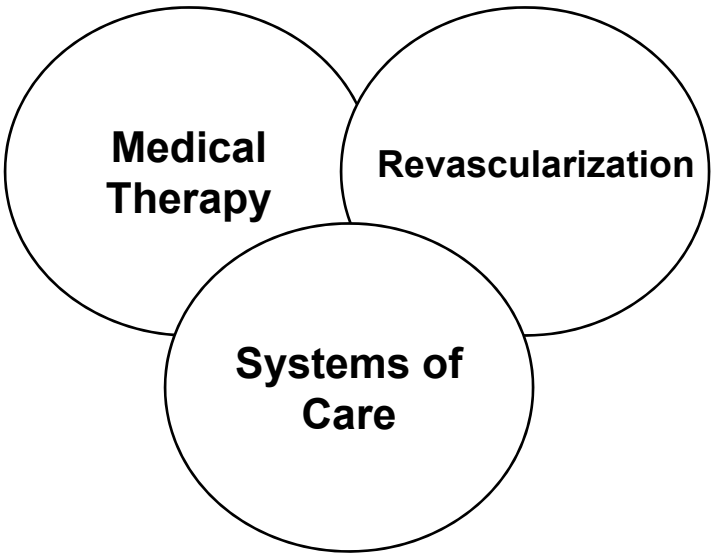
STEMI Therapy

- **Greater than 120 minute delay to primary PCI?**
  Consider Fibrinolysis

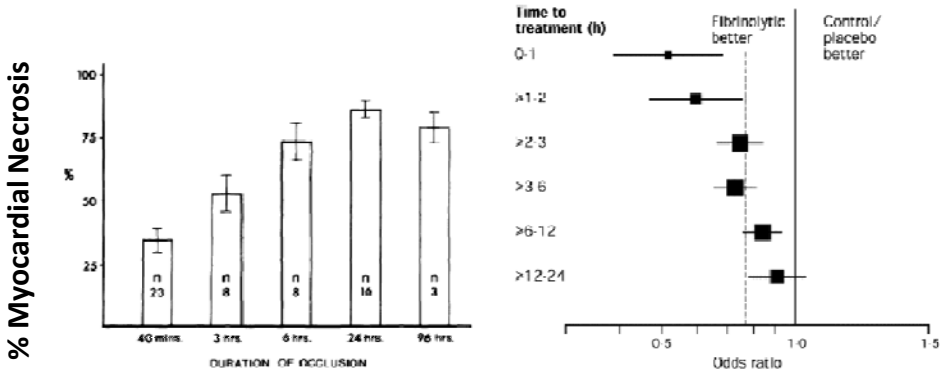
	COR	LOE
Ischemic symptoms <12 h	I	A
Evidence of ongoing ischemia 12 to 24 h after symptom onset and a large area of myocardium at risk or hemodynamic instability	IIa	C
ST depression, except if true posterior (inferobasal) MI is suspected or when associated with ST elevation in lead aVR	III: Harm	B

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

STEMI Therapy



STEMI Therapy



Time is Myocardium!!

Boersma et al. 1996 Lancet 348: 771-75.
Reimer et al. 1977. Circulation 56:786-794.

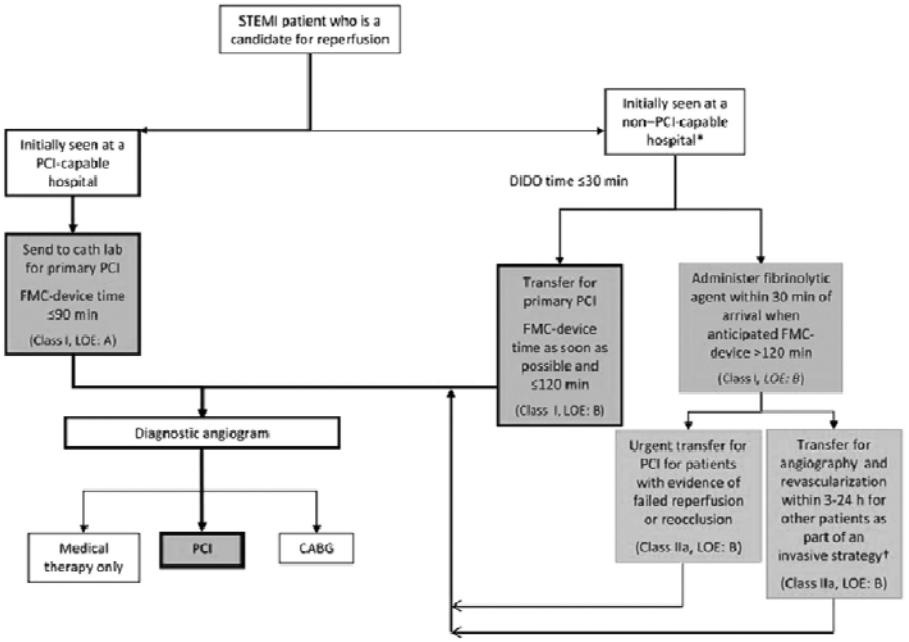
STEMI Therapy

- **Systems of Care**

All communities should create and maintain a regional system of STEMI care that includes assessment and continuous quality improvement of EMS and hospital-based activities. Performance can be facilitated by participating in programs such as Mission: Lifeline and the D2B Alliance.

O'Gara et al. 2013 ACC/AHA STEMI Guideline.

STEMI Therapy



O'Gara et al. 2013 ACC/AHA STEMI Guideline.

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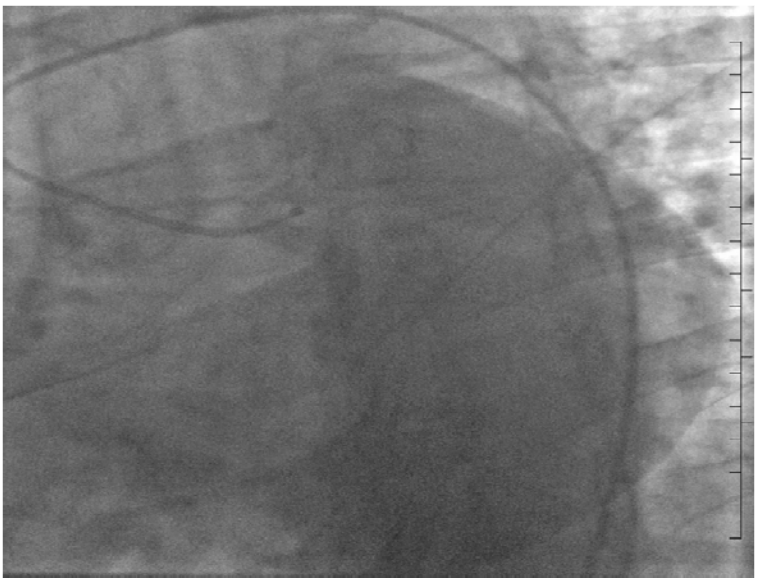
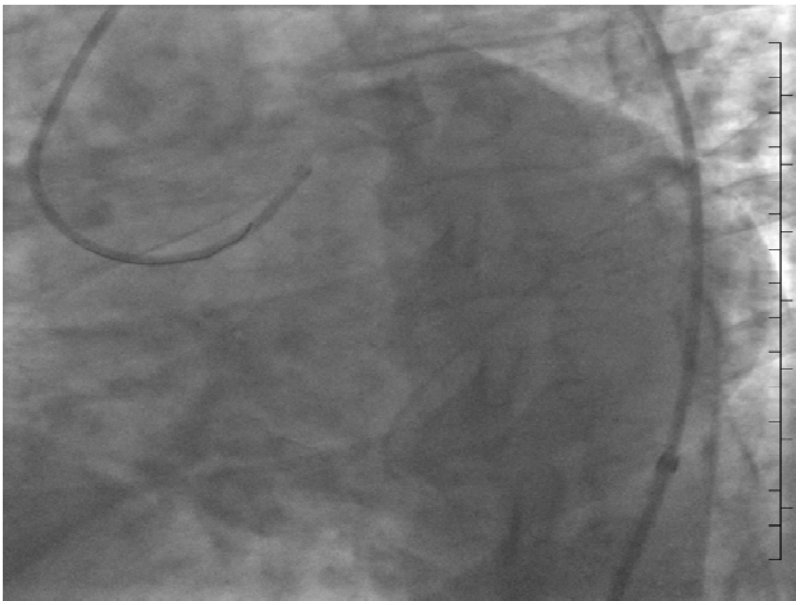
Case Conclusion





Case Conclusion

- 46 year old male chest pain, anterior ST Elevations
- Underwent emergent angiography
- Drug Eluting Stent placed to LAD
- Uncontrolled Diabetes discovered during admission
- Discharged 3 days later
- Ejection Fraction 30% at 3-months follow up

Summary

- **STEMI: Decreasing Incidence, High Mortality**
- **Plaque Rupture or Erosion**
- **Interpreting the EKG and Early Diagnosis is Key!!**
- **We can Reduce Mortality**
- **Morbidity Remains an Issue**
- **New Guidelines: Minimize Treatment Delay!**

Unstable Angina and Non-ST Elevation Myocardial Infarction:

Diagnostic and Therapeutic Management Based on Current Knowledge and Clinical Judgment

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Section of Interventional Cardiology
The Ohio State University Wexner Medical Center

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

I. Pathophysiologic Mechanisms

II. Diagnosis

III. Prognosis

IV. Management

V. Prevention

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

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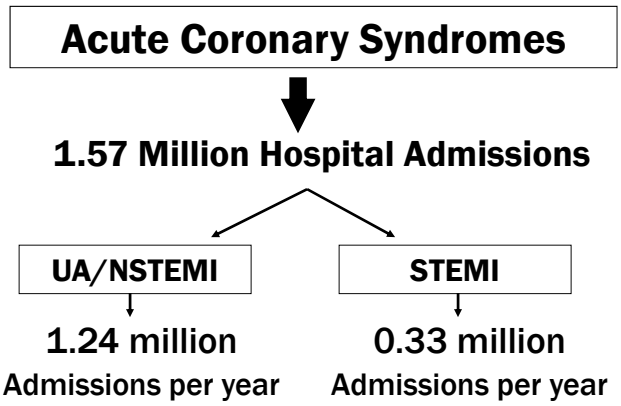
Hospitalizations in the U.S.A. due to Acute Coronary Syndromes



Heart Disease and Stroke Statistics – 2007 Update. *Circulation.* 2007;115:69–171.

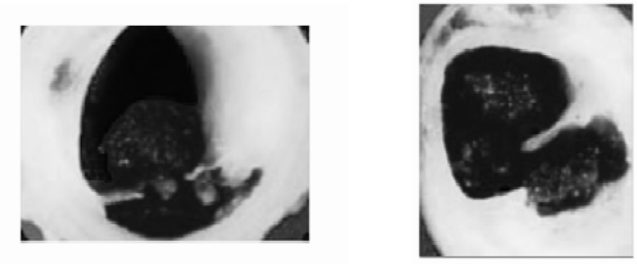
Common Pathophysiologic Mechanisms

- **UA and NSTEMI are acute coronary syndromes (ACS) characterized as a general rule by a significant decrease in blood supply to the myocardium.**
- **Most common cause for the decrease in myocardial perfusion is by a non-occlusive thrombus (with potential distal embolization) that has developed on a disrupted atherosclerotic plaque resulting in luminal narrowing.**
- **UA and NSTEMI pathogenesis and clinical presentations are similar differing in severity with NSTEMI resulting in myocardial damage releasing detectable quantities of a marker of myocardial injury.**

Less Common Causes of UA/NSTEMI

- Occlusive thrombus with collateral vessels
- Non–plaque thromboembolism (atrial fibrillation; LV thrombus)
- Dynamic obstruction (coronary spasm; vasoconstriction)
- Coronary arterial inflammation
- Coronary artery dissection
- Mechanical obstruction to coronary flow
- Hypotension, tachycardia, anemia, other

Acute Coronary Syndromes



ECG:

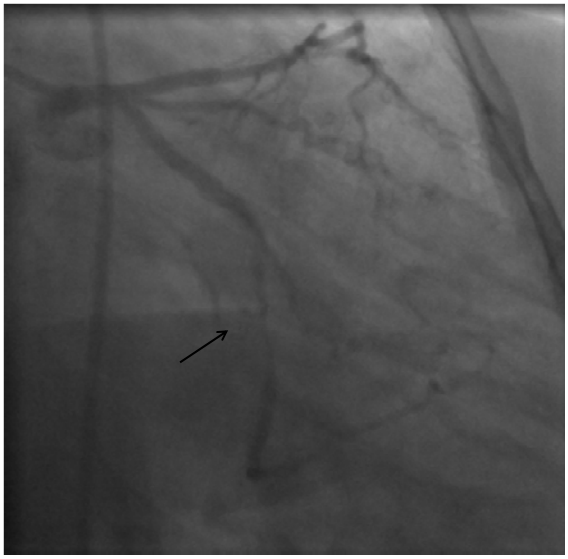
No ST Elevation → Unstable Angina

No ST Elevation → NSTEMI (Non-Q wave MI)

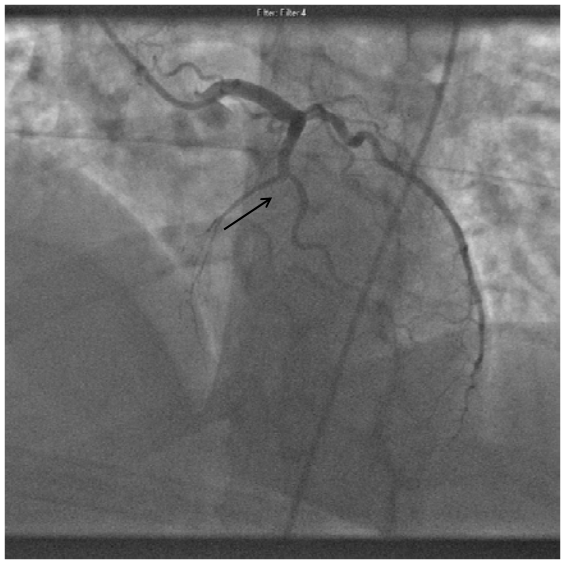
ST Elevation → STEMI (Q wave MI)

Modified from Anderson JL, et al. *JACC*. 2007;50:e1-e157.

Non ST-Elevation Myocardial Infarction
Left Circumflex Artery Stenosis



ST-Elevation Myocardial Infarction
Left Anterior Descending Artery Acute Total Occlusion



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

I. Pathophysiologic Mechanisms

II. Diagnosis

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IV. Management

V. Prevention

Clinical Presentation

- Chest pain or severe epigastric pain typical of myocardial ischemia or infarction:
  - Chest pressure, tightness, heaviness, cramping, burning, aching sensation
  - Unexplained indigestion, belching, epigastric pain
  - Radiating pain in neck, jaw, shoulders, back, or arm(s)
- Associated dyspnea, nausea/vomiting or diaphoresis

Electrocardiogram

- ST segment depression
  - 1 mm ≥ 2 contiguous leads
- T-wave inversion

Cardiac Biomarkers

- Troponin I or T
- CK, CK-MB
- Myoglobin
- Other

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

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TIMI Risk Score for UA/NSTEMI

Assessing Death, Myocardial Infarction or Urgent Revascularization

HISTORICAL	POINTS
Age ≥ 65	1
≥ 3 CAD risk factors (FHx, HTN, ↑ chol, DM, active smoker)	1
Known CAD (stenosis ≥ 50%)	1
ASA use in past 7 days	1
PRESENTATION	
Recent (≤24h) severe angina	1
↑ cardiac markers	1
ST deviation ≥ 0.5 mm	1
RISK SCORE = Total Points (0 - 7)	

RISK OF CARDIAC EVENTS (%) BY 14 DAYS IN TIMI 11B

RISK SCORE	DEATH OR MI	DEATH, MI OR URGENT REVASC
0/1	3	5
2	3	8
3	5	13
4	7	20
5	12	26
6/7	19	41

Antman, et al. *JAMA.* 2000;284:835–42.

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

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Anti-Platelet Therapy

Aspirin 162 mg to 325 mg

I	IIa	IIb	III
A			

PLUS:

- Before PCI:
  - Clopidogrel 600 mg (LOE: B) or
  - Ticagrelor 180 mg (LOE: B) or
  - GP IIb/IIIa inhibitor: eptifibatide or tirofiban (LOE: A)
- At the time of PCI (if not initiated):
  - Clopidogrel 600 mg (LOE: A) or
  - Ticagrelor 180 mg (LOE: B) or
  - Prasugrel 60 mg (LOE: B)* or
  - GP IIb/IIIa inhibitor: including abciximab (LOE: A)

***Do not give if:**
- <60 kg
- >75 years old
- h/o TIA/CVA

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

GP IIb/IIIa Inhibitor
Upstream vs. Time of Angiogram

- **ACUITY Timing Trial[1] (n=9207)**
  - **No difference in ischemia end-points**
  - **30-day major bleeding in upstream (6.1%) vs. deferred (4.9%)**

- **EARLY ACS[2] (n=9492)**
  - **No difference in ischemia end-points**
  - **5 day non-life-threatening bleeding and transfusion with upstream**

[1]Stone GW, et al. *JAMA*. 2007;297:591–602.
[2]Giugliano RP, et al. *NEJM*. 2009; 360:2176-90.

Anti-Coagulation

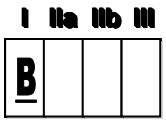
Initiate as soon as possible after presentation with one of the following:

- Unfractionated Heparin
- Enoxaparin

- Bivalirudin

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Beta-Blocker Therapy



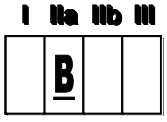
Oral beta-blocker therapy should be initiated within the first 24 h for patients who do not have 1 or more of the following:

1. signs of heart failure
2. evidence of a low-output state
3. increased risk for cardiogenic shock*
4. other relative contraindications (PR interval >0.24 s, 2nd or 3rd degree AV block, active asthma/reactive airway disease)

*** > 70 years, SBP < 120 mmHg, heart rate >100 or < 60 bpm**

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Beta-Blocker Therapy



Reasonable to administer IV beta blockers at the time of presentation for hypertension who do not have 1 or more of the following:

1. signs of heart failure
2. evidence of a low-output state
3. increased risk for cardiogenic shock*
4. other relative contraindications (PR interval >0.24 s, 2nd or 3rd degree AV block, active asthma/reactive airway disease)

*** > 70 years, SBP < 120 mmHg, heart rate >100 or < 60 bpm**

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Initial Invasive (Coronary Angiogram) Versus Conservative Strategy

Invasive

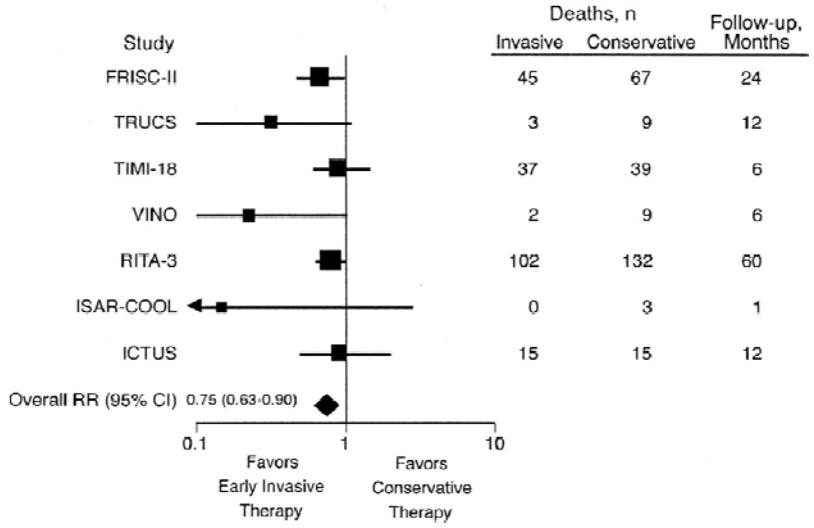
- Recurrent angina/ischemia at rest despite medical therapy
- Elevated cardiac biomarkers (TnT or TnI)
- New ST-segment depression
- Heart failure or new/worsening mitral regurgitation
- High-risk findings from noninvasive testing
- Hemodynamic instability
- Sustained ventricular tachycardia
- PCI within 6 months
- Prior CABG
- High risk score (e.g., TIMI, GRACE)
- Reduced left ventricular function (LVEF < 40%)

Initial Invasive (Coronary Angiogram) Versus Conservative Strategy

Conservative

- Low risk score (e.g., TIMI, GRACE)
- Patient/physician preference in the absence of high-risk features

All-Cause Mortality for Initial Invasive Versus Conservative Therapy
2 Year Follow-up

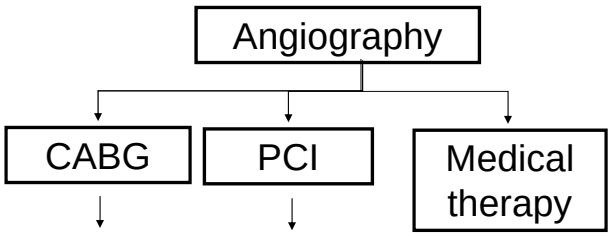


Bavry AA, et al. JACC. 2006;48:1319–25.

After Coronary Angiogram
Management Options

- **Medical therapy**
- **Coronary revascularization**
  - **Percutaneous coronary intervention (PCI)**
  - **Coronary artery bypass surgery**
  - **Hybrid procedure (LIMA to LAD and PCI to all other vessels)**

Anti-Platelet and Anti-Coagulation Therapy After Angiography



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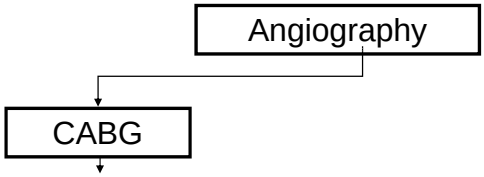
Wright RS, et al. *JACC* . 2011;57:1920-1959.
Modified from Anderson JL, et al. *JACC*. 2007;50:e1-e157.

Anti-Platelet and Anti-Coagulation Therapy After Angiography



- Con't Aspirin (Class I)
- **Cont UFH (Class I)**
- D/C **C**lopidogrel **or Ticagrelor ≥ 5 days and Prasugrel ≥ 7 days prior to CABG (Class I)**
- D/C IV GP IIb/IIIa 4 h prior to CABG (Class I)
- D/C enoxaparin 12 to 24 h prior to CABG **(Class I)**
- **D/C fondaparinux 24 hours before CABG (Class I)**
- **D/C bivalirudin 3 hours before CABG**

Jneid H., et al. *Circulation*. 2012;126:875-910.
Wright RS, et al. *JACC* . 2011;57:1920-1959.
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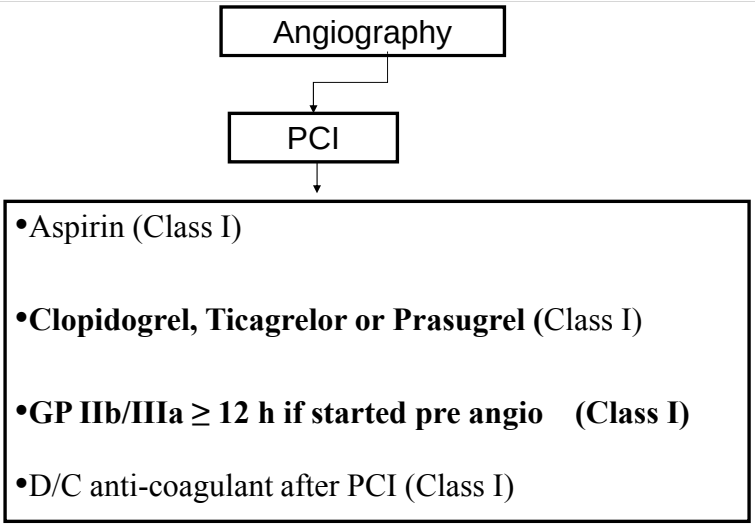
Anti-Platelet and Anti-Coagulation Therapy After Angiography



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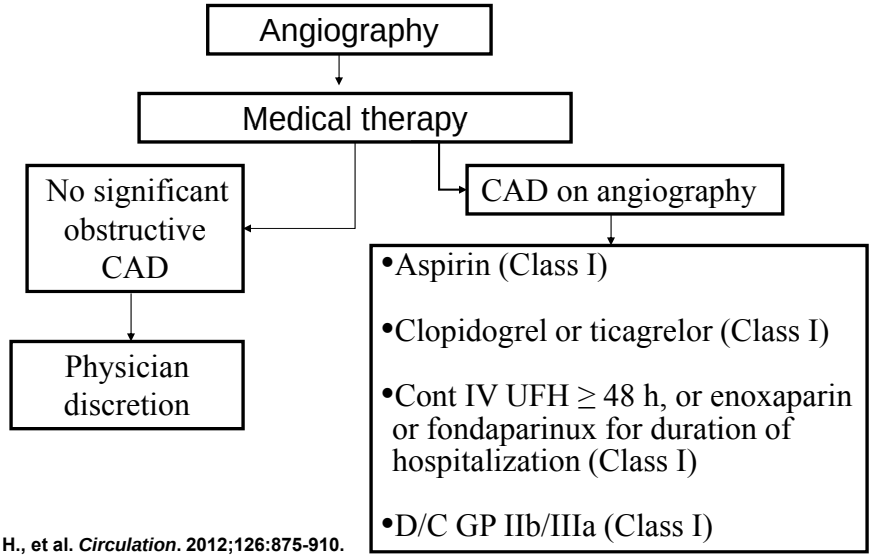
Anti-Platelet and Anti-Coagulation Therapy After Angiography



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

I. Pathophysiologic Mechanisms

II. Diagnosis

III. Prognosis

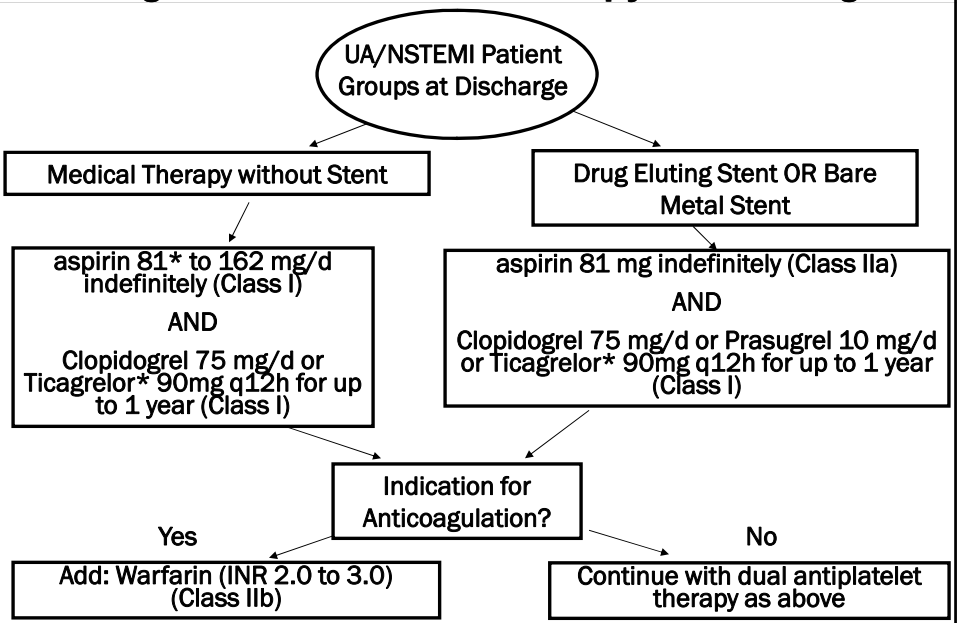
IV. Management

V. Prevention

Prevention

- Medical therapy
  - Anti-platelet
  - Statin
  - Beta-blocker
  - ACE inhibitor
- Management of other diseases (HTN, DM, etc)
- Exercise and Diet
- Tobacco cessation
- Other

Long-Term Anti-Platelet Therapy at Discharge



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Modified from Anderson JL, et al. *JACC*. 2007;50:e1-e157.

Altered Clopidogrel Metabolism

- **Clopidogrel conversion to active form via CYP 2C19; mutations in CYP 2C19 may results in lower active form of the drug**
- **Tests available to identify CYP2C19 genotype; however, insufficient evidence to recommend routine testing**
- **Consider higher clopidogrel dose regimen (150 mg daily) in poor metabolizers; however, appropriate dose not established**
- **Consider other anti-platelet medications**
- **Proton pump inhibitor – clopidogrel interaction?**

ACCF/AHA Clopidogrel Clinical Alert. *JACC.* 2010;56:321–41.

Lipid Management

Achieve an LDL-C <100 mg/dL

- Further titration to < 70 mg/dL is reasonable (*Class IIa, Level of Evidence: A*)

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Beta-Blocker Therapy

Beta blockers are indicated for all patients recovering from UA/NSTEMI especially with LV systolic dysfunction unless contraindicated.

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
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ACE-Inhibitor

ACE inhibitors should be given and continued indefinitely for patients with HF, LVEF <40%, hypertension, or diabetes mellitus.

ACE inhibitors are reasonable for patients recovering from UA/NSTEMI in the absence of LV dysfunction, hypertension, or diabetes mellitus.

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
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Heart Outcomes Prevention Evaluation
HOPE Trial

- **Patients with CAD or high-risk of developing CAD (n=9,297)**
  - **52% prior MI, 25% UA**
- **No LV dysfunction or heart failure**
- **Ramipril 10 mg/day vs placebo**
- **Primary end point (myocardial infarction, stroke, or CV death):**
  - **14.0% ramipril vs 17.8% placebo (p<0.001)**
  - **statistically lower for all individual endpoints**

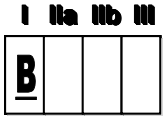
Yusuf S, et al. *N Engl J Med* 2000;342:145–53.

Blood Pressure Control

Blood pressure control according to JNC 7 guidelines is recommended (i.e., BP <140/90 mm Hg or <130/80 mm Hg if the patient has diabetes mellitus or chronic kidney disease).

JNC 7; Chobanian AV, et al. JAMA 2003;289:2560-72.
2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Diabetes Mellitus



Diabetes management should include lifestyle and pharmacotherapy measures to achieve a near-normal HbA1c level of <7%.

2012 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2012;126:875-910.
2011 ACCF/AHA UA/NSTEMI Guidelines. Circulation. 2011;123:e426-e579.

Avoid NSAIDS and Estrogen/Progestin Replacement Therapy

- Increase risk of myocardial infarction and death.

Hulley S, et al. *JAMA* 1998;280:605–13.
Antman EM, et al. *Circulation.* 2007;115:1634–42.

Unstable Angina (UA) and Non-ST Elevation Myocardial Infarction (NSTEMI) Conclusion

- Most commonly caused by a decrease in myocardial perfusion by a non-occlusive thrombus that has developed on a disrupted atherosclerotic plaque resulting in luminal narrowing.
- Coronary angiogram should be performed to define coronary anatomy and need for coronary artery revascularization.

Unstable Angina (UA) and Non-ST Elevation Myocardial Infarction (NSTEMI) Conclusion

- **Medical therapy should include aspirin, thienopyridine, β-blocker, ACE inhibitor and statin, regardless if revascularization performed.**
- **Coronary artery disease is progressive requiring close follow-up with particular attention to modifying risk factors:**
  - **smoking cessation, obesity, hypertension, dyslipidemia, diabetes mellitus, avoidance of NSAID and hormone replacement therapy, other**