CHEST PAIN

Objectives:

1. Recognize acute life-threatening causes of chest pain.
3. Realize the limitations of ancillary studies in evaluating chest pain.
4. Develop a systematic, focused approach to the chest pain patient in the ED.
CHEST PAIN

Background

- 5 million patients/year present to the ED with chest pain
- 1.5 million patients/year are admitted for workup of acute coronary syndrome (ACS)
- 3-10 billion dollars/year are spent to evaluate complaints to chest pain

Differential Diagnosis for Chest Pain

Why is chest pain so nonspecific for an organ system? Afferent fibers from heart, lungs, greater vessels, and esophagus enter the same thoracic dorsal ganglia, resulting in indistinct location and quality of pain.

<table>
<thead>
<tr>
<th>Heart</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute coronary syndrome</td>
<td>Dissection</td>
</tr>
<tr>
<td>Pericarditis</td>
<td>Aneurysm</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>Aortitis</td>
</tr>
<tr>
<td>Endocarditis</td>
<td></td>
</tr>
<tr>
<td>Valvular disease</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lungs</th>
<th>Abdomen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary embolus</td>
<td>Biliary disease</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>Pancreatitis</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Duodenal ulcer</td>
</tr>
<tr>
<td>Empyema</td>
<td>Hepatic disease</td>
</tr>
<tr>
<td>Hemorrhax</td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Esophagus</th>
<th>Chest Wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophagitis</td>
<td>Costochondritis</td>
</tr>
<tr>
<td>GERD</td>
<td>Muscle strain</td>
</tr>
<tr>
<td>Spasm</td>
<td>Contusion</td>
</tr>
<tr>
<td>Foreign body</td>
<td>Rib fracture</td>
</tr>
<tr>
<td>Rupture (Boerhaave’s)</td>
<td>Thoracic Outlet</td>
</tr>
<tr>
<td>Eophageal Tear</td>
<td>Zoster/Postherpetic</td>
</tr>
<tr>
<td></td>
<td>Neuralgia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Psychiatric</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td></td>
</tr>
<tr>
<td>Somatization</td>
<td></td>
</tr>
</tbody>
</table>

Immediate life-threatening causes of CP:

- Acute myocardial infarction (AMI) / Acute Coronary Syndrome (ACS)
- Pulmonary embolism (PE)
- Aortic dissection
- Tension Pneumothorax
- Pericardial tamponade

CASE PRESENTATION #1:

50 y/o male with PMH of GERD and tobacco use c/o left-sided, sharp CP that radiates to his back and down his left arm.

HPI: + SOB, + Nausea, No vomiting
The pain started shortly after he ate lunch at work when he was moving some boxes around. Lasted a few minutes and improved when he sat down. Currently only has minimal pain in his left chest only.

Preliminary ED Management: Improves with the GI cocktail, which you just gave to him.

Physical Exam:

VS: BP 165/100, HR 95, RR 20, T 98.6, Sat 100% on RA
Gen—Looks comfortable
HEENT—NC/AT
Neck—JVP @ 6cm
Chest—CTA bilaterally
CV—RRR, mild II/VI SEM LSB, no radiation
Abd—soft, obese, nontender
Extrem – trace lower extrem edema, good pulses in all extremities. Equal blood pressures in both arms.

Questions:
✓ What is your differential diagnosis?
✓ What other questions might you want to ask this patient?
✓ Are cardiac risk factors helpful?
✓ What is the diagnostic value of a patient’s response to treatment?
✓ Can a single negative troponin exclude acute coronary syndrome?
✓ What other tests/labs may you want to order?

Answer:

ACUTE MYOCARDIAL INFARCTION (AMI) and ACUTE CORONARY SYNDROME (ACS)

QUESTION: ACS – Why should we care?
✓ Leading cause of death in the United States
✓ Approximately 1 million people / year have an AMI
  * 50% survive upon presentation to the ED
  * 25% in-hospital mortality
✓ No combination of H+P with EKG can exclude ACS with certainty.

QUESTION: What is the pathophysiology behind ACS?
✓ Endothelial injury
✓ Plaque formation
  • Plaques are made of a lipid rich core and meshwork of extracellular-matrix proteins that form a fibrous cap
  • Rupture at sites of greatest mechanical stress: junction of cap and intima or shoulder regions of lipid pool
✓ Plaque rupture
  • Two-thirds (66%) of coronary artery plaques which rupture and result in a total occlusive thrombus were found to have a pre-rupture plaque with <50% stenosis!
  • 97% have a pre-rupture plaque with <70% stenosis.
✓ Thrombus formation
  • Plaque rupture and obstruction results when the lipid core is exposed to blood, because it is a potent substrate for platelet aggregation. Tissue factor, which is expressed from cells in the core, interacts with factor VIIa and initiates a cascade of enzymatic reaction resulting in deposition of thrombin and fibrin. Platelets aggregate with any disruption of the endothelial wall and release their contents, further propagating aggregation and thrombus formation.
✓ Mechanical occlusion

QUESTION: What is the definition of Acute Coronary Syndrome (ACS)?
Definition of ACS: Spectrum of diseases ranging from chronic stable angina to AMI.

Definition of Angina: Chest discomfort induced by exercise and relieved with rest / nitroglycerin

Definition of Unstable Angina (UA) per AHCPR (American Health Care Policy and Research)
✓ Rest angina - angina occurring at rest (usually >20 minutes)
✓ New onset angina - angina within 2 months
✓ Increasing angina - more frequent, longer, or more easily provoked angina

Definition of AMI: At least two out of three positive findings (World Health Organization) -
1. Clinical history of ischemic-type chest discomfort
2. Changes on serial EKG’s
3. Rise and fall of serum cardiac markers

QUESTION: How good is the history in identifying ACS as the cause of chest pain?
✓ The history should include the location, severity (1 to 10), quality, timing, radiation, precipitating factors, associated symptoms, relieving factors, and response to treatment.
✓ Beware of any history of diaphoresis!
✓ Use a 0-10 scale to objectively measure severity of pain and the patient’s response to therapeutic interventions
High risk characteristics for ACS | Low risk characteristics ACS
--- | ---
Pressure or squeezing quality | Pleuritic
Pain similar to prior AMI or angina | Sharp/ Stabbing
Radiation to neck, shoulders, or left arm | Reproducible with palpation or movement
Associated SOB | Very short (seconds) duration
Very long (constantly for 24 hrs) duration

- In patients with documented AMI, low-risk characteristics present (Lee et al, Arch Int Med: 1985):
  - Sharp / stabbing 22%
  - Partly pleuritic 13%
  - Reproducible by palpation 10%

**BOTTOM LINE:** The history can help categorize a patient as more or less likely to have an ACS-etiologic of chest pain. Unfortunately, no part of the history can "rule-out" ACS. Don't get fooled into discharging a patient purely because he/ she has reproducible chest pain!

**QUESTION:** How well do cardiac risk factors predict cardiac chest pain?
- Classic cardiac risk factors: DM, HTN, smoking, contributory FH, gender, age, hyperlipidemia
- These risk factors were determined based on the large Framingham study of asymptomatic patients, which was an epidemiologic study applicable to POPULATIONS OVER TIME. The researchers essentially identified patients who would be at risk for CAD in the long-term.
- In contrast in the ED, we are assessing an INDIVIDUAL PERSON at ONE POINT IN TIME. The Framingham study does not answer the question: Is someone actively having CP more likely to have a cardiac etiology if they have more risk factors?
- The evidence --
    - Risk factors are NOT predictive of cardiac risk in female ED chest pain patients.
    - Only DM and family history are weakly predictive in male ED chest pain patients.
  - Studies #2 and #3: Khot et al. JAMA (Aug 20 2003); Greenland et al. JAMA (Aug 20, 2003)
    - Meta-analyses showing the >95% of patients with ACS had at least 1 conventional cardiac risk factor
    - Findings challenge the conventional thinking that >50% of ACS patients have zero conventional cardiac risk factors

**BOTTOM LINE:** Risk factors play a minimal-to-minor role in determining whether chest pain is cardiac in etiology. This belies the importance of taking a good history of the chest pain. Don't ignore a concerning history for ischemia just because of the lack of risk factors.

**QUESTION:** What am I looking for on physical exam?
The physical exam can be completely normal.

1. Evaluate hemodynamic status
   - Vital signs: BP, HR, pulse oximetry
   - Skin color, temperature, diaphoresis
   - Bradycardia in the setting of chest pain should raise the red flag of an inferior MI or a supratherapeutic level of their AV node blocking medication (beta blocker, calcium channel blocker, digoxin).
   - Beware of the ominous sign of diaphoresis – patients cannot fake this!
   - Cardiogenic shock occurs in 5% of NSTEMI patients, and the mortality is >60%

2. Exclude other causes of CP
   - Pneumothorax: Decreased breath sounds
   - Aortic Dissection: Unequal pulses, pain radiating to the back, aortic insufficiency murmur
   - Tamponade: Beck’s Triad

3. Identify precipitating causes
   - LV dysfunction: Rales, S3 gallop
   - Papillary muscle rupture: Acute mitral regurgitation

4. Find comorbidities
   - COPD: Decreased breath sounds, wheezes (Beware of cardiac asthma!)
   - Extracardiac vascular disease (bruits, pulse deficits)

**BOTTOM LINE:** For the physical exam, focus on the (1) vital signs and general appearance, (2) cardiac exam, (3), lung exam, and (4) vascular exam.
QUESTION: What EKG findings are suggestive of AMI and UA?
- ST elevation or depression
- Q waves
- T wave inversion
- Poor R wave progression
- Any new or dynamic changes

BOTTOM LINE: Always obtain at least 2 serial EKG's on CP patients to look for dynamic changes.

QUESTION: How good is the EKG in identifying ACS-associated chest pain?
- Transient ST segment changes with symptoms are concerning.
- Obtain an EKG when the chest pain worsens or improves.
- The EKGs of patients with AMI and UA were retrospectively reviewed. Of note, 1% and 4% of AMI and UA, respectively, had normal EKG's. (Lee et al, Arch Int Med, 1985)

<table>
<thead>
<tr>
<th>EKG interpretation</th>
<th>AMI</th>
<th>UA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>Nonspecific</td>
<td>3%</td>
<td>23%</td>
</tr>
<tr>
<td>Abnormal</td>
<td>4%</td>
<td>21%</td>
</tr>
<tr>
<td>Abnormal (no new change)</td>
<td>7%</td>
<td>48%</td>
</tr>
<tr>
<td>Abnormal (new change)</td>
<td>25%</td>
<td>43%</td>
</tr>
<tr>
<td>Infarction</td>
<td>73%</td>
<td>13%</td>
</tr>
</tbody>
</table>

BOTTOM LINE: The EKG is helpful in identifying ACS but is not a completely fail-safe instrument for ruling-out ACS. A normal EKG reduces your pretest probability for ACS but can NOT completely rule it out as the diagnosis.

QUESTION: How good is a single negative troponin value in ruling out ACS-associated CP?
Background:
- 2/3 of patients with unstable angina will have negative cardiac enzymes
- Cardiac markers are helpful prognostically (elevated levels correlate with higher morbidity and mortality risk)
- Negative cardiac markers alone should not be used to exclude ACS.

CK-MB activity:
- Less specificity than troponin I
- False positives in myopathies, rhabdomyolysis, renal insufficiency

CK-MB subform:
- Isoform of CK-MB molecule with increased sensitivity
- Level rapidly declines by hydrolysis

Myoglobin:
- Found in skeletal and cardiac muscle
- Very sensitive but nonspecific
- Rapid rise and fall limits sensitivity and specificity with time
- False positives in myopathies, rhabdomyolysis, renal insufficiency

Troponin:
- Part of actin-myosin complex of cardiac muscle
- Elevated up to 10 days
- Troponin I is more cardiospecific than troponin T
- UNIQUE: Troponin I is not falsely elevated with renal insufficiency.

<table>
<thead>
<tr>
<th></th>
<th>Rise</th>
<th>Peak</th>
<th>Normalized</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK-MB activity</td>
<td>3-8 hr</td>
<td>3-30 hr</td>
<td>1-3 days</td>
</tr>
<tr>
<td>CK-MB subform</td>
<td>1-3 hr</td>
<td>4-6 hr</td>
<td>18-24 hrs</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>&lt;3 hr</td>
<td>4-9 hr</td>
<td>&lt;24 hr</td>
</tr>
<tr>
<td>Troponin I</td>
<td>2-6 hr</td>
<td>10-24 hr</td>
<td>7-10 days</td>
</tr>
</tbody>
</table>
ACEP Clinical Policy on AMI: To exclude AMI with 95% certainty in acute CP in low-risk patient and initial negative troponin, repeat testing at 8-12 hrs from symptom onset is needed.

Unstable angina:
- Only 20% of patients with UA will have a negative troponin.
- When a patient "rules-out" for AMI, he/she still needs a cardiac risk stratification study to assess for UA.

BOTTOM LINE: A single negative troponin is poor at ruling-out AMI and even poorer at ruling-out UA. So, if you are concerned enough for ACS to send a troponin based on the patient's presentation, then you are likely admitting the patient because you still need a risk-stratification test to exclude ACS.

QUESTION: What medications for ACS have been shown to decrease mortality?
ANSWER: Aspirin, beta-blockers, and thrombolytics

QUESTION: What medications can I give the patient suspected of having ACS-associated CP?
1. Antiplatelet therapy
   ✓ Aspirin (ASA)
   - In AMI patients, 23% mortality reduction in 30 days (ISIS-2 trial)
   - Canadian and VA study: In UA patients, 50% reduction in progression to AMI.
   - Just as efficacious as expensive thrombolytics.
   - IMPORTANT: Give early in all patients when ACS is not 100% excluded!

   ✓ Thienopyridines: Clopidogrel, Ticlopidine
   - Give when patients are truly allergic to ASA
   - Clopidogrel preferred because of fewer side effects
   - Consider loading clopidogrel 300 mg po for UA because of improved benefit in NSTEMI (CURE trial)

2. Oxygen
   - Goal: increased oxygen supply to ischemic heart
   - Probably beneficial in first 3 hrs of AMI
   - Nasal cannula 2 L oxygen typically used.
   - Intubate the hemodynamically unstable patient

3. Nitrates
   - Mechanism: Coronary artery dilatation and preload reduction
   - Dosing: 0.4 mg SL pm CP q5 minutes (max x 3)
   - Start NTG paste or IV drip to titrate chest pain
   - Never shown to decrease mortality.
   - Contraindications: HR < 50 or hypotension
   - Relative contraindication: RV infarct -- because these infarcts are preload-dependent (establish IV before NTG administration)
4. Intravenous fluids
   • Give instead of dopamine if a patient is hypotensive and has a RV infarct (which is preload-dependent).
   • If hypotension is refractory to IV fluids, start pressors.

5. Morphine
   • Analgesic for relief of ischemic pain
   • At high doses, can reduce preload.

6. Beta-blocker
   • Reduces mortality
   • Reduces infarct size
   • Mechanism: Reduces sympathetic surge
   • Dosing: Metoprolol 5 mg IV q5 min x 3, then followed by 50 mg po
   • Contraindications: H/o significant COPD or asthma, AV nodal disease, cardiogenic shock, acute LV dysfunction, acute CHF
   • A history of CHF is not an absolute contraindication— cautiously administer beta-blockers (frequently check for iatrogenic CHF exacerbation)

7. Anticoagulation
   • Indicated in the following patients:
     ✓ High-risk ACS (UA, AMI)
     ✓ TPA or TNKase (thrombolytics)
     ✓ Dynamic EKG changes
   • Unfractionated heparin
     ✓ Dosing 80 units/kg bolus, then 18 units/kg/min
     ✓ Monitor PTT
   • Low molecular weight heparin (LMWH)
     ✓ Dosing: 1 mg/kg SQ BID
   • No good data for decreasing mortality.
   • ESSENCE trial: Enoxaparin (LMWH) compared to unfractionated heparin has better rates of recurrent angina / AMI/ death at 30 days (19.8% vs 23.3%)
   • Contraindication to Low Molecular Weight Heparin:
     ✓ Weight > 140 kg
     ✓ Creatinine Clearance < 30 (Cr > 2.3)
     ✓ Patient going to cardiac catheterization who requires a short-acting anticoagulant

8. Glycoprotein 2b/3a inhibitor
   • Mechanism: Blocks binding of fibrinogen at GP2b3a platelet receptor site where aggregation occurs.
   • Abciximab (Reopro), Tirofiban (Aggrastat), Eptifibatide (Integrelin)
   • Only proven benefit in patients undergoing percutaneous coronary intervention (PCI)

9. Thrombolytics
   • Indications for thrombolytics
     ✓ Onset of symptoms within 12 hours AND
     ✓ 2 consecutive leads with ST elevation > 1 mm or LBBB not known to be old
   • Goal: Door-to-drug time < 30 minutes
   • SFGH thrombolytic agent = TNKase (tenecteplase)
     - Equal efficacy as TPA except it is given as a bolus (simpler to administer)
     - Similar side effect profile as TPA
       • Intracranial hemorrhage 0.9% (same as TPA)
       • CVA 1.8% (1.7% in TPA)
       • Non-cerebral bleeding 4.7% (5.9% TPA)
       • 30-day mortality 6.2% (same as TPA)
   • Thiemann et al. Circulation, 2000: Showed an increased mortality in patients > 75 y/o receiving thrombolytics. Thus, PCI should be the modality of choice in these older patients.
   • Make sure there are no contraindications to thrombolytic use.
### TNKase Contraindications

**ABSOLUTE CONTRAINDICATIONS**
- Active internal bleeding
- H/o CVA – ever
- Intracranial/ intraspinal surgery or trauma < 2 mo ago
- Intracranial neoplasm, AVM, aneurysm
- Known bleeding diathesis
- Severe uncontrolled HTN

**RELATIVE WARNINGS**
- Recent major surgery (CABG, delivery, prior puncture of noncompressible vessels)
- Cerebrovascular dz
- Recent GI or GU bleed
- Recent trauma
- HTN: SBP>180 or DBP>110
- High likelihood of LV thrombus (eg. MS with Afib)
- Acute pericarditis
- Subacute bacterial endocarditis
- Hemostatic defects (eg hepatic or renal dz)
- Severe hepatic dysfunction
- Pregnancy
- Diabetic hemorrhagic retinopathy or other hemorrhagic ophtho d/o
- Septic thrombophlebitis or occluded AV cannula at seriously infected site
- Advanced age
- Concurrent oral anticoagulant
- Recent administration of GP 2b/3a inhibitors
- Any condition where bleeding is dangerous or would be difficult to manage

---

**QUESTION:** So, which of these medications should I give to my patient?

**Low risk patient:**
- ✓ Oxygen
- ✓ ASA
- ✓ NTG
- ✓ Morphine

**Moderate risk patient:**
- ✓ Low-risk treatment PLUS
- ✓ Metoprolol
- ✓ Heparin (LMWH or unfractionated)

**High risk patient:**
- ✓ Moderate-risk treatment PLUS
- ✓ GP2b3a (if going to cardiac cath)
- ✓ Thrombolytics or Cath

**QUESTION:** How do I manage chest pain in the setting of cocaine use?
- ✓ The treatment and management of cocaine-induced chest pain is controversial. Usually patients with cocaine-induced chest pain will experience CP within 24 hours of their cocaine ingestion unless the cocaine is mixed with alcohol. In the latter case, CP can be experienced later than 24 hours post-ingestion.

- ✓ Mechanism: Alpha-agonist mediated vasospasm of coronary arteries and premature atherosclerosis

- ✓ Treatment: Avoid beta-blockers. Treat with benzodiazepines and ASA early.
  - Theory for avoiding beta-blockers: Beta-blockers may yield unopposed alpha agonist effects, causing worsening vasospasm, hypertension, and ischemia.
  - Theory for benzodiazepines: To blunt the catecholamine surge from cocaine use.
  - Theory for ASA: Cocaine abusers can have atherosclerotic disease too!

- ✓ Disposition: Early literature suggests that it is safe to send patients home if:
  - EKG is normal (no ischemic changes or dysrhythmias)
  - Symptoms resolve with treatment and observation for 9 hours.

- ✓ The evidence: Weber et al. NEJM (Feb 6, 2003)
  - Prospective study with 344 enrolled patients who had chest pain after cocaine use.
Endpoint was 30-day mortality.

Results: There were zero deaths at 30 days, and only 4 cases of nonfatal AMI (with all 4 patients continuing to abuse cocaine). Of the 4 AMI patients, 2 had nonocclusive (vasospasm) disease and 2 had occlusive (atherosclerosis) disease on cardiac cath. For the 2 with occlusive disease, both had at least 2 cardiac risk factors.

✓ Current practice:
   • Low risk patients: Observe 9-12 hours and “rule-out” in ED
   • Moderate / high risk patients: Admit to r/o ACS.

QUESTION: What are the pitfalls in ACS?
1. Assuming that improvement of symptoms with a GI cocktail is diagnostic of GERD and rules-out ACS.
2. Assuming patients with no risk factors can not have ACS.
3. Failing to realize that females and minorities are underdiagnosed.

QUESTION: What are the take-home points on ACS?
1. ED assessment for ACS is based primarily on history and EKG (both have limitations)
2. A single negative troponin can not exclude ACS in a CP patient
3. “Time is muscle” – the sooner thrombolytics are given, the more muscle function is preserved (Commit the thrombolytic criteria to memory!)
4. Give aspirin as soon as ACS is a consideration.

CASE PRESENTATION #2:
52 y/o morbidly obese male c/o chest pain that worsens when he takes a deep breath.
HPI: He is rather immobile and only walks around his house
PMH: + NIDDM, nonsmoker, no HTN, no CAD
Physical Exam:
   Vital signs: BP 140/90, HR 105, RR 25, T 99.8, Sat 95% on RA
   Gen – Obese male, talks in short sentences
   HEENT – NC/AT
   Neck – Unable to see JVP, no bruits
   Chest – Very distant breath sounds but clear
   CV – Very distant S1/S2, unable to hear anything else
   Abd – Obese, nontender
   Extrem – Good pulses in all extremities, bilateral lower extremity edema – symmetrical

Questions:
✓ What is your differential diagnosis?
✓ What other questions might you want to ask this patient?
✓ Are cardiac risk factors helpful?
✓ What is the diagnostic value of a patient’s response to treatment?
✓ Can a CT angio, D-dimer, or V/Q scan rule out PE?
✓ What other tests/labs may you want to order?

Answer: PULMONARY EMBOLISM (PE)

Background
✓ True incidence = 23-69 per 100,000
   • Estimates at 500,000-750,000 cases / yr and 50-200,000 deaths / yr in US
✓ True prevalence is unknown— Estimates at 0.1-0.3%
✓ Fatality of PE
   • Untreated = 18-38%
   • Treated = 8-9%
✓ Third leading cause of death in US
QUESTION: What are risk factors for PE?

<table>
<thead>
<tr>
<th>AIDS</th>
<th>IV Drug Abuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI</td>
<td>Malignancy</td>
</tr>
<tr>
<td>Antithrombin III Deficiency</td>
<td>Obesity</td>
</tr>
<tr>
<td>Behcet’s Disease</td>
<td>Old Age</td>
</tr>
<tr>
<td>Blood Type A</td>
<td>PE in the past</td>
</tr>
<tr>
<td>Burns</td>
<td>Phenothiazines</td>
</tr>
<tr>
<td>Catheters</td>
<td>Plasminogen abnormality</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>Polycythemia</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>Postoperative / Postpartum</td>
</tr>
<tr>
<td>Drug-induced lupus anticoagulant</td>
<td>Pregnancy</td>
</tr>
<tr>
<td>DVT in past</td>
<td>Protein C or S Deficiency</td>
</tr>
<tr>
<td>Estrogen Replacements / OCPs</td>
<td>Resistance to Activ Protein C (Factor V Leiden)</td>
</tr>
<tr>
<td>Fibrinogen Abnormality</td>
<td>SLE/lupus anticoag/ antiphospholipid Ab</td>
</tr>
<tr>
<td>Fractures</td>
<td>Superficial phlebitis</td>
</tr>
<tr>
<td>Hemolytic Anemias</td>
<td>Tobacco</td>
</tr>
<tr>
<td>Heparin Associated Thrombocytopenia</td>
<td>Trauma</td>
</tr>
<tr>
<td>Hyperhomocysteinemia / Hyperlipidemias</td>
<td>Varicose Veins / Venous Stasis</td>
</tr>
<tr>
<td>Immobilization</td>
<td>Venography / Venous Pacemakers</td>
</tr>
<tr>
<td>Inflammatory Bowel Disease</td>
<td>Warfarin – first few days</td>
</tr>
</tbody>
</table>
• 10% of patients with a PE have zero risk factors in retrospect (after they have been worked up for everything on this exhaustive list).

QUESTION: How do I risk-stratify someone in LOW, MODERATE, and HIGH pretest probability?


<table>
<thead>
<tr>
<th>Finding</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical signs and symptoms of DVT*</td>
<td>3</td>
</tr>
<tr>
<td>PE as likely or more likely than alternative dx</td>
<td>3</td>
</tr>
<tr>
<td>Immobilization **</td>
<td>1.5</td>
</tr>
<tr>
<td>Previous DVT or PE</td>
<td>1.5</td>
</tr>
<tr>
<td>Heart rate &gt; 100</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1</td>
</tr>
</tbody>
</table>

* Measure swelling in leg at 10 cm below tibial tuberosity. A >3 cm difference is significant.
** Immobile for ≥ 3 days or surgery within 4 weeks

Low probability < 2 points
Mod probability 2-6 points
High probability > 6 points

QUESTION: By history, how do PE patients present?
Based on the PIOPED study, 97% patients with PE's had at least one of the following -
1. Dyspnea
2. Tachypnea (RR>19)
3. Pleuritic chest pain

QUESTION: What tests can I use to help me diagnose a PE?

ABG
• A-a Gradient = [150 – 1.25 (pCO2)] – pO2
• The sensitivity of the A-a gradient is only approximately 90%, based on 7 studies (Kline et al. Annals of Emerg Med, 2000)

• BOTTOM LINE: A normal A-a gradient does not exclude a PE.

EKG
• Classic finding (rare): S1Q3T3
• Most common EKG reading based on PIOPED study was “Normal”
• Most common EKG abnormality is nonspecific ST-T wave changes
• Other findings:
  LAD and RAD
  Complete and incomplete RBBB
  LVH and RVH
  Acute MI pattern
  P pulmonale
  Low voltage QRS

CXR
• Classic Findings:
  ✓ Hampton’s hump – Peripheral wedge-shaped, pleural-based density
  ✓ Westermark’s sign – Focal oligemia distal to pulmonary vessel, "prune-tree" effect
• **International Cooperative Pulmonary Embolism Registry (ICOPER)**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac enlargement</td>
<td>27%</td>
</tr>
<tr>
<td>Normal</td>
<td>24%</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>23%</td>
</tr>
<tr>
<td>Elevated hemidiaphragm</td>
<td>20%</td>
</tr>
<tr>
<td>PA enlargement</td>
<td>19%</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>18%</td>
</tr>
<tr>
<td>Infiltrate</td>
<td>17%</td>
</tr>
<tr>
<td>Pulmonary congestion</td>
<td>14%</td>
</tr>
<tr>
<td>Oligemia</td>
<td>8%</td>
</tr>
<tr>
<td>Pulmonary infarction</td>
<td>5%</td>
</tr>
<tr>
<td>Overinflation</td>
<td>5%</td>
</tr>
</tbody>
</table>

• **BOTTOM LINE**: 76% of CXR’s are abnormal in PE pts. You CAN’T use the CXR to exclude or diagnose PE.

**D-Dimer**
- Very controversial area
- Breakdown product of crosslinked fibrin
- Different assays
  1. ELISA – Sensitivity 95-100%
  2. Whole blood agglutination – Sensitivity 65-90%
  3. Latex agglutination - Sensitivity 40-90%
- SFGH has the latex agglutination assay for D-dimer, and so the D-dimer is NOT helpful in excluding PE/DVT.

**V/Q Scan**
- This nuclear medicine study assesses the perfusion and ventilation of the vascular and pulmonary system, respectively. The Pioped study took into account the physician’s clinical pretest probability for a PE. The results were as follows:

<table>
<thead>
<tr>
<th>SCAN CATEGORY PROBABILITY</th>
<th>CLINICAL PRETEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>96%</td>
</tr>
<tr>
<td>56%</td>
<td>88%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>66%</td>
</tr>
<tr>
<td>16%</td>
<td>28%</td>
</tr>
<tr>
<td>Low</td>
<td>40%</td>
</tr>
<tr>
<td>Normal</td>
<td>0%</td>
</tr>
<tr>
<td>2%</td>
<td>16%</td>
</tr>
</tbody>
</table>
• A normal V/Q scan is generally acceptable to rule-out a PE.
• The problem is that many V/Q results are recorded as "indeterminate" and your risk of a PE is still 16-66% despite a low or high pretest probability. Another study then must be done as a follow-up.

Spiral CT Angiography: primary study of choice
• Disadvantage: May miss subsegmental PE's
• Advantages:
  - Approximately 95-98% specific
  - Better for central emboli
  - May detect other etiology for chest symptoms
  - Not as invasive as standard pulmonary angiography
• Disadvantages:
  - Only 60-90% sensitive
  - Misses peripheral emboli
  - Contrast load
  - Cost
  - Interpreter dependent
• Reasons for false-positive interpretations:
  - Movement artifact
  - Vessel tortuosity
  - Oblique orientation of the pulmonary vessel
• Relative contraindications:
  - Dye allergy
  - Pregnancy
  - Recent metformin use - risk is minimal if dose is held for 48 hours
  - Elevated creatinine

Pulmonary Angiography
• Gold standard for detecting PE's
• Labor-intensive and invasive
• Risks: Death (0.5%), Major nonfatal complication (1%), Minor complication (5%)

QUESTION: What medication(s) should I give to a patient with a pulmonary embolism?

Anticoagulation Options
• LMWH: Enoxaparin 1 mg/kg q12hr or 1.5 mg/kg qd
• Unfractionated heparin: Bolus 80 IU/kg with drip at 18 IU/hr
• Thrombolytics:
  - Old criteria: Hemodynamic instability, cardiogenic shock, acute massive PE
  - New criteria: Acute submassive PE, right ventricular dysfunction

• BOTTOM LINE: Anticoagulate the patient with moderate to high pretest probability while waiting for the V/Q scan or CT angio study to prevent the next embolic event.

CASE PRESENTATION #3

60 year old male with hypertension presents with sharp/stabbing chest pain radiating to his back. Pt has a history of smoking and hypertension, but otherwise no cardiac risk factors (no hyperlipidemia, no diabetes, no family history)

Physical Exam:
- Vitals – BP 200/120 P 120 RR 30 T 98.5
- Gen – Elderly male, obviously in pain
- HEENT – NC/AT
- Neck – JVP at 6 cm
- Chest – CTA bilaterally
- CV – Tachycardic with a regular rhythm, no m/g/r
- Abd – thin, soft, nontender
- Extrem – decreased left femoral pulse

Questions:
✓ What is your differential diagnosis?
✓ What other questions might you want to ask this patient?
✓ Are cardiac risk factors helpful?
✓ What would you do to treat this man's pain immediately?
✓ What tests/labs may you want to order?

Answer: AORTIC DISSECTION
An aortic dissection is a medical emergency. It is very important to prove to yourself that your chest pain patient does not have an aortic dissection before assuming that they have a PE or ACS where heparin may be indicated. Anticoagulation in the setting of a dissection is catastrophic.

Aortic dissection IS NOT the same as an abdominal aortic aneurysm (often times incorrectly used interchangeably)

Pathophysiology: Tearing of the aorta's intimal layer, which creates a false lumen (pseudolumen) in the aorta.

Risk factors:
• Hypertension
• Marfan's syndrome
• Pregnancy
• Valvular disease
• Severe deceleration injury (aorta is dissected at the insertion of the ligamentum arteriosum)

Common findings in patients with aortic dissection (% incidence based on International Registry for Aortic Dissection):

**Classic presentation:** Tearing or ripping chest pain which radiates to the interscapular area of the back and the posterior neck.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain (95%)</td>
<td></td>
</tr>
<tr>
<td>Abrupt onset (85%)</td>
<td></td>
</tr>
<tr>
<td>Severe or worst pain ever (90%)</td>
<td></td>
</tr>
<tr>
<td>Nature of pain is tearing or ripping (50%)</td>
<td></td>
</tr>
<tr>
<td>Pain in the chest (75%) and/or the back (50%)</td>
<td></td>
</tr>
<tr>
<td>Syncope (10%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PMH</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension (70%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical exam</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension (50%)</td>
<td></td>
</tr>
<tr>
<td>Hypotension (5%)</td>
<td></td>
</tr>
<tr>
<td>Aortic insufficiency murmur (30%)</td>
<td></td>
</tr>
<tr>
<td>Pulse deficit (15%)</td>
<td></td>
</tr>
</tbody>
</table>

EKG: Very nonspecific and nondiagnostic

**QUESTION:** What imaging modalities are available to diagnose an aortic dissection?

1. Chest X-Ray
   • Widened mediastinum or abnormal aortic contour in 80% patients with aortic dissection
   • Other radiographic findings: Widened paraspinal shadow, pleural effusion (often on left side), tracheal shift, calcification displacement, "lump" distal to the vessels, obliteration of the aortic knob, left mainstem bronchus deviated downward, NG tube deviated to the right

2. CT Angiography
   • Very high sensitivity and specificity (95-100%)
   • Contraindications: Renal insufficiency, too hemodynamically unstable for CT

3. Transesophageal Echocardiogram
   • Alternative study to CT angiography that can be done at bedside and spares IV contrast
   • Equivalent sensitivity to CT angiography
   • Often hard to obtain in the ED
QUESTION: How do I classify aortic dissection types?

1. Stanford Classification
   - Type A: Ascending +/- Descending aorta
   - Type B: Descending aorta only (distal to subclavian artery)

2. Debakey Classification
   - Type I: Ascending + Descending aorta (Stanford type A)
   - Type II: Ascending aorta only (Stanford type A)
   - Type III: Descending aorta only (Stanford type B)

QUESTION: How do I decide whether an aortic dissection requires surgical or medical management?

Surgical management:
- All ascending dissections
- Occlusion of major arterial trunk (renal arteries, carotids, iliacs)
- Aortic leaking or rupture
- Uncontrollable hypertension
- Persistent pain

Medical management:
- Descending dissections in absence of above surgical indications

QUESTION: How do I medically treat aortic dissection?

Goal: Reduce shearing force and blood pressure with IV beta-blocker and vasodilator

Common agents:
- Labetalol alone (nonspecific alpha- and beta-blocker)
- Metoprolol / Esmolol PLUS Nitroprusside (Start beta-blocker before nitroprusside to block the reflex tachycardia response to a lowered systolic blood pressure)

Take-Home Points:
- Think about aortic dissection before heparinizing any CP patient.
- Always document upper and lower extremity pulses (carotid, brachial, and femoral) in CP patients.
- Remember to treat with beta-blockers (to block reflex tachycardia) before reducing the SBP with nitroprusside

CASE PRESENTATION #4:

26 year old, tall thin male presents with chest pain and shortness of breath starting suddenly this afternoon while playing basketball. He does not smoke, drink or use alcohol. He denies hypertension, diabetes, high cholesterol or a family history of heart disease.

Physical Exam:
- Vitals: BP 110/70, P 110, RR 30, T 98.6
- Gen – Well-developed male, talks in brief sentences
- HEENT – NC/AT
- Neck – JVP at 5 cm
- Chest – Decreased breath sounds on the right, no crackles or wheezes
- CV – Tachycardic, no m/g/r
- Abd – thin, soft, nontender
- Extrem – no edema, good pulses in all extremities

Questions:
- What is your differential diagnosis?
- What other questions might you want to ask this patient or what else might you look for?
- What might you need to do to immediately treat this patient?
- What other tests/labs may you want to order?

Answer: PNEUMOTHORAX (PTX)

Definition: Accumulation of air in the pleural space
QUESTION: How do I classify pneumothoraces?

1. Traumatic PTX:
   • Air enters the pleural space either from a communicating tract through the chest wall or by the rupture of a bronchiole which communicates with the pleural space.
   • Can occur in penetrating trauma > blunt trauma with rib fractures
   • Can occur iatrogenically from instrumentation, central venous catheter placement, or thoracentesis.

2. Primary Spontaneous PTX:
   • More common in thin, tall men (age 20-40 y/o). Often in smokers
   • Presumed due to rupture of small, unrecognized bleb
   • Frequently recurs (30% rate)

3. Secondary Spontaneous PTX: (By definition, has underlying lung or pleural disease)
   • Marked changes in barometric pressure
   • Underlying COPD
   • Most common cause of a PTX in a HIV patient = PCP pneumonia
   • Secondary to infection (PCP, TB, Staphylococcus pneumonia)

4. Tension PTX:
   • The most dangerous complication of a pneumothorax
   • Extreme positive pressure on the side of the PTX can compromise venous return to the heart, causing hemodynamic instability
   • Suggestive findings: Tracheal shift, elevated JVP, hypotension, unilateral decreased breath sounds
   • Presents very similar to pericardial tamponade (see later section of handout)

QUESTION: By history, physical exam, and radiography, how do PTX patient present?

History:
• Sudden onset of unilateral and often focal chest pain
• Pleuritic quality of CP
• Dyspnea often present

Physical Exam:
• Common findings: Tachycardia, tachypnea, or subcutaneous emphysema
• Lung exam: If a large PTX, unilaterally decreased breath sounds, hyperresonance to percussion.

CXR:
• An edge where there is loss of vasculature distally.
• An upright expiratory CXR will help accentuate any small PTX that may be present.
• When a patient is supine, a small-moderate sized PTX can be missed on CXR because air layers anteriorly and not tangentially to the x-ray beam.

QUESTION: How do I treat a PTX?
• If the patient is a healthy person without respiratory compromise at baseline AND is relatively asymptomatic AND has a spontaneous PTX < 15% → Conservative treatment with oxygen x 6 hrs and re-check the next day.
  - Supplemental oxygen: 2% of PTX resorbed spontaneously every 24 hours on room air. Up to 8% absorbed on 15L face-mask oxygen supplementation in 24 hours.

• If the patient does not qualify as a low-risk patient (as stated above) → a tube thoracostomy (chest tube) is indicated.

• If patient has a tension pneumothorax, needle aspiration with a 14 gauge angiocatheter in the midclavicular line of the 2nd intercostal space may be life-saving. This should then be followed by pre-oxygenation and immediate insertion of a tube thoracostomy.
Take-Home Points:
• Consider PTX in any patient with unilateral, pleuritic CP.
• Consider PTX in any patient who acutely decompensates in respiratory status (especially if with positive pressure ventilation - BiPAP or ventilator)
• Always check a post-procedure CXR in any patient with instrumentation of the neck or thorax.

CASE PRESENTATION #5:

29 year old male BIB ambulance after being stabbed in the epigastic region. He is unable to give you more history.

Physical Exam: VS: BP 90/p, P 120, RR 20, T N/A
Gen – Pale, diaphoretic male writhing on the gurney in pain
HEENT – NC/AT
Neck – JVP elevated at 10 cm
Chest – CTA bilaterally
CV – “muffled” heart sounds
Abd – soft, NT/ND
Extrem – weak peripheral pulses throughout, but equal

Questions:
✓ What is your differential diagnosis?
✓ What would you do to stabilize this patient?
✓ If this patient were more stable, what tests might you order?

Answer: PERICARDIAL TAMponade

The pericardium normally contains 15-60 cc of fluid. Conditions that cause inflammation of the pericardium or penetrating cardiac trauma can generate more fluid in this space, resulting in a medical emergency known as cardiac tamponade.

QUESTIONS: What causes pericardial tamponade?
• Traumatic: From penetrating injury to the torso
• Atraumatic: Usually from progression of pericarditis such that the pericardial sac can not expand to accommodate any more pericardial fluid or rupture of aorta (dissection or aneurysm)

**Pericarditis etiologies**
- Viral or idiopathic
- Post-MI
- Neoplastic
- Infectious
- Uremia
- Radiation
- Connective tissue disease
  (e.g. lupus, RA)

QUESTION: What are common physical findings in pericardial tamponade?

**Beck’s Triad – Classic funding are:**
• Hypotension
• Distended neck veins
• Muffled heart sounds

Other findings:
• Tachycardia
• Diaphoresis
• Tachypnea
• **Pulsus paradoxus:** >10 mm decrease SBP during inspiration
QUESTION: What ancillary studies can help me diagnose a tamponade?
CXR: Significant cardiomegaly, with the absence of heart failure
EKG:
  • Low voltage (QRS height < 5 mm in limb leads, <10 mm in precordial leads)
  • Electrical alternans: Alternating size and morphology of every other beat. Due to swinging of heart in fluid-filled pericardial sac.
Ultrasound:
  • Fluid around the heart

QUESTION: How do I treat a pericardial tamponade?
Unstable patient: Emergent pericardiocentesis
Stable patient:
  • Echocardiogram-guided pericardiocentesis or pericardial window in the O.R.
  • Volume resuscitation to increase preload

Beware of intubation because positive-pressure ventilation decreases preload and can drop the SBP dramatically!

TIP: 10 MINUTE APPROACH TO A PATIENT WITH CHEST

ABC's
IV, Cardiac monitor, Oxygen
EKG
Focused assessment
  • History
  • Exam (cardiac, lungs, vascular)
CXR
Emergent intervention needed?
  • Thrombolytics for AMI
  • Heparin / Thrombolytics for PE
  • Beta-blockers and nitroprusside (or labetalol alone) for Aortic Dissection
  • Needle aspiration of a Pneumothorax
  • Pericardiocentesis for Pericardial Tamponade

Then later:
Give ASA to all patients early if considering ACS
Obtain a more complete H+P (including prior cardiac studies)
Obtain laboratory studies.
Repeat the EKG in 30-90 minutes to look for dynamic changes.

SUMMARY
Always think of the five emergency causes of CP and possibility of making a life-saving intervention:
  • Acute coronary syndrome
  • Pulmonary embolism
  • Aortic dissection
  • Pneumothorax
  • Pericardial tamponade

Know the predictive value and limitations of ancillary studies in excluding these disease processes!
**Chest Pain**

**Cases**
50 y/o male with PMH of GERD and tobacco use c/o left-sided, sharp CP that radiates to his back and down his left arm.

HPI: + SOB, + Nausea, No vomiting
The pain started shortly after he ate lunch at work when he was moving some boxes around.
Lasted a few minutes and improved when he sat down.
Currently only has minimal pain in his left chest only.
Preliminary ED Management: Improves with the GI cocktail, which you just gave to him.

**Physical Exam:**
VS: BP 165/100, HR 95, RR 20, T 98.6, Sat 100% on RA
Gen– Looks comfortable
HEENT – NC/AT
Neck – JVP @ 6cm
Chest – CTA bilaterally
CV – RRR, mild II/VI SEM LSB, no radiation
Abd – soft, obese, nontender
Extrem – trace lower extrem edema, good pulses in all extremities. Equal blood pressures in both arms.

**Questions:**
What is your differential diagnosis?
What other questions might you want to ask this patient?
Are cardiac risk factors helpful?
What is the diagnostic value of a patient’s response to treatment?
Can a single negative troponin exclude acute coronary syndrome?
What other tests/labs may you want to order?

**ACUTE MYOCARDIAL INFARCTION (AMI) and ACUTE CORONARY SYNDROME (ACS)**

**QUESTION:** ACS – Why should we care?
Leading cause of death in the United States
Approximately 1 million people / year have an AMI
* 50% survive upon presentation to the ED
* 25% in-hospital mortality
No combination of H+P with EKG can exclude ACS with certainty.

**QUESTION:** What is the pathophysiology behind ACS?
Endothelial injury
Plaque formation
Plaques are made of a lipid rich core and meshwork of extracellular-matrix proteins that form a fibrous cap
Rupture at sites of greatest mechanical stress: junction of cap and intima or shoulder regions of lipid pool
Plaque rupture
Two-thirds (66%) of coronary artery plaques which rupture and result in a total occlusive thrombus were found to have a pre-rupture plaque with <50% stenosis! 97% have a pre-rupture plaque with <70% stenosis.

Thrombus formation
Plaque rupture and obstruction results when the lipid core is exposed to blood, because it is a potent substrate for platelet aggregation. Tissue factor, which is expressed from cells in the core, interacts with factor VIIa and initiates a cascade of enzymatic reaction resulting in deposition of thrombin and fibrin. Platelets aggregate with any disruption of the endothelial wall and release their contents, further propagating aggregation and thrombus formation.

Mechanical occlusion

QUESTION: What is the definition of Acute Coronary Syndrome (ACS)?

Definition of ACS: Spectrum of diseases ranging from chronic stable angina to AMI.

Definition of Angina: Chest discomfort induced by exercise and relieved with rest / nitroglycerin

Definition of Unstable Angina (UA) per AHCPR (American Health Care Policy and Research)
Rest angina - angina occurring at rest (usually >20 minutes)
New onset angina - angina within 2 months
Increasing angina - more frequent, longer, or more easily provoked angina

Definition of AMI: At least two out of three positive findings (World Health Organization) -
Clinical history of ischemic-type chest discomfort
Changes on serial EKG's
Rise and fall of serum cardiac markers

QUESTION: How good is the history in identifying ACS as the cause of chest pain?

The history should include the location, severity (1 to 10), quality, timing, radiation, precipitating factors, associated symptoms, relieving factors, and response to treatment.
Beware of any history of diaphoresis!
Use a 0-10 scale to objectively measure severity of pain and the patient’s response to therapeutic interventions
High risk characteristics for ACS

- Pressure or squeezing quality
- Pain similar to prior AMI or angina
- Radiation to neck, shoulders, or left arm movement
- Associated SOB

Low risk characteristics ACS

- Pleuritic
- Sharp/Stabbing
- Reproducible with palpation or movement
- Very short (seconds) duration
- Very long (constantly for 24 hrs) duration

• In patients with documented AMI, low-risk characteristics present (Lee et al, Arch Int Med: 1985):
  - Sharp/stabbing 22%
  - Partly pleuritic 13%
  - Reproducible by palpation 10%

BOTTOM LINE: The history can help categorize a patient as more or less likely to have an ACS- etiology of chest pain. Unfortunately, no part of the history can "rule-out" ACS. Don't get fooled into discharging a patient purely because he/she has reproducible chest pain!

QUESTION: How well do cardiac risk factors predict cardiac chest pain?

Classic cardiac risk factors: DM, HTN, smoking, contributory FH, gender, age, hyperlipidemia

These risk factors were determined based on the large Framingham study of asymptomatic patients, which was an epidemiologic study applicable to POPULATIONS OVER TIME. The researchers essentially identified patients who would be at risk for CAD in the long-term.

In contrast in the ED, we are assessing an INDIVIDUAL PERSON at ONE POINT IN TIME. The Framingham study does not answer the question: Is someone actively having CP more likely to have a cardiac etiology if they have more risk factors?

The evidence --

Risk factors are NOT predictive of cardiac risk in female ED chest pain patients. Only DM and family history are weakly predictive in male ED chest pain patients.

Studies #2 and #3: Khot et al. JAMA (Aug 20 2003); Greenland et al. JAMA (Aug 20, 2003)
Meta-analyses showing the >95% of patients with ACS had at least 1 conventional cardiac risk factor
Findings challenge the conventional thinking that >50% of ACS patients have zero conventional cardiac risk factors
BOTTOM LINE: Risk factors play a minimal-to-minor role in determining whether chest pain is cardiac in etiology. This belies the importance of taking a good history of the chest pain. Don’t ignore a concerning history for ischemia just because of the lack of risk factors.

QUESTION: What am I looking for on physical exam?

The physical exam can be completely normal.

Evaluate hemodynamic status
Vital signs: BP, HR, pulse oximetry
Skin color, temperature, diaphoresis
CAUTION: Bradycardia in the setting of chest pain should raise the red of flag of an inferior MI or a supratherapeutic level of their AV node blocking medication (beta blocker, calcium channel blocker, digoxin).
CAUTION: Beware of the ominous sign of diaphoresis – patients can not fake this!
CAUTION: Cardiogenic shock occurs in 5% of NSTEMI patients, and the mortality is >60%

Exclude other causes of CP
Pneumothorax: Decreased breath sounds
Aortic Dissection: Unequal pulses, pain radiating to the back, aortic insufficiency murmur
Tamponade: Beck’s Triad

Identify precipitating causes
LV dysfunction: Rales, S3 gallop
Papillary muscle rupture: Acute mitral regurgitation

Find comorbidities
COPD: Decreased breath sounds, wheezes (Beware of cardiac asthma!)
Extracardiac vascular disease (bruits, pulse deficits)

BOTTOM LINE: For the physical exam, focus on the (1) vital signs and general appearance, (2) cardiac exam, (3), lung exam, and (4) vascular exam.

QUESTION: What EKG findings are suggestive of AMI and UA?

ST elevation or depression
Q waves
T wave inversion
Poor R wave progression
Any new or dynamic changes

BOTTOM LINE: Always obtain at least 2 serial EKG’s on CP patients to look for dynamic changes.
QUESTION: How good is the EKG in identifying ACS-associated chest pain?

Transient ST segment changes with symptoms are concerning. Obtain an EKG when the chest pain worsens or improves. The EKGs of patients with AMI and UA were retrospectively reviewed. Of note, 1% and 4% of AMI and UA, respectively, had normal EKG's. (Lee et al, Arch Int Med, 1985)

<table>
<thead>
<tr>
<th>EKG interpretation</th>
<th>AMI</th>
<th>UA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>1%</td>
<td>4%</td>
</tr>
<tr>
<td>Nonspecific</td>
<td>3%</td>
<td>23%</td>
</tr>
<tr>
<td>Abnormal</td>
<td>4%</td>
<td>21%</td>
</tr>
<tr>
<td>Abnormal (no new change)</td>
<td>7%</td>
<td>48%</td>
</tr>
<tr>
<td>Abnormal (new change)</td>
<td>25%</td>
<td>43%</td>
</tr>
<tr>
<td>Infarction</td>
<td>73%</td>
<td>13%</td>
</tr>
</tbody>
</table>

BOTTOM LINE: The EKG is helpful in identifying ACS but is not a completely fail-safe instrument for ruling-out ACS. A normal EKG reduces your pretest probability for ACS but can NOT completely rule it out as the diagnosis.

QUESTION: How good is a single negative troponin value in ruling out ACS-associated CP?

Background:
2/3 of patients with unstable angina will have negative cardiac enzymes
Cardiac markers are helpful prognostically (elevated levels correlate with higher morbidity and mortality risk)
Negative cardiac markers alone should not be used to exclude ACS.

CK-MB activity:
Less specificity than troponin I
False positives in myopathies, rhabdomyolysis, renal insufficiency

CK-MB subform:
Isoform of CK-MB molecule with increased sensitivity
Level rapidly declines by hydrolysis

Myoglobin:
Found in skeletal and cardiac muscle
Very sensitive but nonspecific
Rapid rise and fall limits sensitivity and specificity with time
False positives in myopathies, rhabdomyolysis, renal insufficiency
Troponin:
Part of actin-myosin complex of cardiac muscle
Elevated up to 10 days
Troponin I is more cardiospecific than troponin T
UNIQUE: Troponin I is not falsely elevated with renal insufficiency.

<table>
<thead>
<tr>
<th></th>
<th>Rise</th>
<th>Peak</th>
<th>Normalized</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK-MB activity</td>
<td>3-8 hr</td>
<td>9-30 hr</td>
<td>1-3 days</td>
</tr>
<tr>
<td>CK-MB subform</td>
<td>1-3 hr</td>
<td>4-6 hr</td>
<td>18-24 hrs</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>&lt;3 hr</td>
<td>4-9 hr</td>
<td>&lt;24 hr</td>
</tr>
<tr>
<td>Troponin I</td>
<td>2-6 hr</td>
<td>10-24 hr</td>
<td>7-10 days</td>
</tr>
</tbody>
</table>

ACEP Clinical Policy on AMI: To exclude AMI with 95% certainty in acute CP in low-risk patient and initial negative troponin, repeat testing at 8-12 hrs from symptom onset is needed.

Unstable angina:
Only 20% of patients with UA will have a negative troponin.
When a patient "rules-out" for AMI, he/she still needs a cardiac risk stratification study to assess for UA.

BOTTOM LINE: A single negative troponin is poor at ruling-out AMI and even poorer at ruling-out UA. So, if you are concerned enough for ACS to send a troponin based on the patient’s presentation, then you are likely admitting the patient because you still need a risk-stratification test to exclude ACS.
QUESTION: What medications for ACS have been shown to decrease mortality?

ANSWER: Aspirin, beta-blockers, and thrombolytics

QUESTION: What medications can I give the patient suspected of having ACS-associated CP?

1. Antiplatelet therapy

Aspirin (ASA)
- In AMI patients, 23% mortality reduction in 30 days (ISIS-2 trial)
- Canadian and VA study: In UA patients, 50% reduction in progression to AMI.
- Just as efficacious as expensive thrombolytics.
- IMPORTANT: Give early in all patients when ACS is not 100% excluded!

Thienopyridines: Clopidogrel, Ticlopidine
- Give when patients are truly allergic to ASA
- Clopidogrel preferred because of fewer side effects
- Consider loading clopidogrel 300 mg po for UA because of improved benefit in NSTEMI (CURE trial)

2. Oxygen
- Goal: increased oxygen supply to ischemic heart
- Probably beneficial in first 3 hrs of AMI
- Nasal cannula 2 L oxygen typically used.
- Intubate the hemodynamically unstable patient

3. Nitrates
- Mechanism: Coronary artery dilatation and preload reduction
- Dosing: 0.4 mg SL prn CP q5 minutes (max x 3)
- Start NTG paste or IV drip to titrate chest pain
- Never shown to decrease mortality.
- Contraindications: HR < 50 or hypotension
- Relative contraindication: RV infarct -- because these infarcts are preload-dependent (establish IV before NTG administration)

4. Intravenous fluids
- Give instead of dopamine if a patient is hypotensive and has a RV infarct (which is preload-dependent).
- If hypotension is refractory to IV fluids, start pressors.

5. Morphine
- Analgesic for relief of ischemic pain
- At high doses, can reduce preload.
6. Beta-blocker
• Reduces mortality
• Reduces infarct size
• Mechanism: Reduces sympathetic surge
• Dosing: Metoprolol 5 mg IV q5 min x 3, then followed by 50 mg po
• Contraindications: H/o significant COPD or asthma, AV nodal disease, cardiogenic shock, acute LV dysfunction, acute CHF
• A history of CHF is not an absolute contraindication— cautiously administer beta-blockers (frequently check for iatrogenic CHF exacerbation)

7. Anticoagulation
• Indicated in the following patients:
  High-risk ACS (UA, AMI)
  TPA or TNKase (thrombolytics)
  Dynamic EKG changes
  • Unfractionated heparin
    Dosing  80 units/kg bolus, then 18 units/kg/min
    Monitor PTT
  • Low molecular weight heparin (LMWH)
    Dosing: 1 mg/kg SQ BID
  • No good data for decreasing mortality.
  • ESSENCE trial: Enoxaparin (LMWH) compared to unfractionated heparin has better rates of recurrent angina / AMI/ death at 30 days (19.8% vs 23.3%)
  • Contraindication to Low Molecular Weight Heparin:
    Weight > 140 kg
    Creatinine Clearance < 30 (Cr > 2.3)
    Patient going to cardiac catheterization who requires a short-acting anticoagulant

8. Glycoprotein 2b/3a inhibitor
• Mechanism: Blocks binding of fibrinogen at GP2b3a platelet receptor site where aggregation normally occurs.
• Abciximab (Reopro), Tirofiban (Aggrastat), Eptifibatide (Integrelin)
• Only proven benefit in patients undergoing percutaneous coronary intervention (PCI)

9. Thrombolytics
• Indications for thrombolytics
  Onset of symptoms within 12 hours AND
  2 consecutive leads with ST elevation > 1 mm or LBBB not known to be old
  • Goal: Door-to-drug time < 30 minutes
  • SFGH thrombolytic agent = TNKase (tenecteplase)
    Equal efficacy as TPA except it is given as a bolus (simpler to administer)
Similar side effect profile as TPA
- Intracranial hemorrhage 0.9% (same as TPA)
- CVA 1.8% (1.7% in TPA)
- Non-cerebral bleeding 4.7% (5.9% TPA)
- 30-day mortality 6.2% (same as TPA)

- Thiemann et al. Circulation, 2000: Showed an increased mortality in patients > 75 y/o receiving thrombolytics. Thus, PCI should be the modality of choice in these older patients.

- Make sure there are no contraindications to thrombolytic use.

**TNKase Contraindications**

**ABSOLUTE CONTRAINDICATIONS**
- Active internal bleeding
- H/o CVA – ever
- Intracranial/ intraspinal surgery or trauma < 2 mo ago
- Intracranial neoplasm, AVM, aneurysm
- Known bleeding diathesis
- Severe uncontrolled HTN

**RELATIVE WARNINGS**
- Recent major surgery (CABG, delivery, prior puncture of noncompressible vessels)
- Cerebrovascular dz
- Recent GI or GU bleed
- Recent trauma
- HTN: SBP>180 or DBP>110
- High likelihood of LV thrombus (eg. MS with Afib)
- Acute pericarditis
- Subacute bacterial endocarditis
- Hemostatic defects (eg hepatic or renal dz)
- Severe hepatic dysfunction
- Pregnancy
- Diabetic hemorrhagic retinopathy or other hemorrhagic ophtho d/o
- Septic thrombophlebitis or occluded AV cannula at seriously infected site
- Advanced age
- Concurrent oral anticoagulant
- Recent administration of GP 2b/3a inhibitors
- Any condition where bleeding is dangerous or would be difficult to manage

**QUESTION:** So, which of these medications should I give to my patient?
Low risk patient:
- Oxygen
- ASA
- NTG
- Morphine

Moderate risk patient:
- Low-risk treatment PLUS
- Metoprolol
- Heparin (LMWH or unfractionated)

High risk patient:
- Moderate-risk treatment PLUS
- GP2b3a (if going to cardiac cath)
- Thrombolytics or Cath

QUESTION: How do I manage chest pain in the setting of cocaine use?

The treatment and management of cocaine-induced chest pain is controversial. Usually patients with cocaine-induced chest pain will experience CP within 24 hours of their cocaine ingestion unless the cocaine is mixed with alcohol. In the latter case, CP can be experienced later than 24 hours post-ingestion.

Mechanism: Alpha-agonist mediated vasospasm of coronary arteries and premature atherosclerosis

Treatment: Avoid beta-blockers. Treat with benzodiazepines and ASA early.
- Theory for avoiding beta-blockers: Beta-blockers may yield unopposed alpha agonist effects, causing worsening vasospasm, hypertension, and ischemia.
- Theory for benzodiazepines: To blunt the catecholamine surge from cocaine use.
- Theory for ASA: Cocaine abusers can have atherosclerotic disease too!

Disposition: Early literature suggests that it is safe to send patients home if:
- EKG is normal (no ischemic changes or dysrhythmias)
- Symptoms resolve with treatment and observation for 9 hours.

The evidence: Weber et al. NEJM (Feb 6, 2003)
- Prospective study with 344 enrolled patients who had chest pain after cocaine use.
- Endpoint was 30-day mortality.
- Results: There were zero deaths at 30 days, and only 4 cases of nonfatal AMI (with all 4 patients continuing to abuse cocaine). Of the 4 AMI patients, 2 had nonocclusive (vasospasm) disease and 2 had occlusive (atherosclerosis) disease on cardiac cath. For the 2 with occlusive disease, both had at least 2 cardiac risk factors.
Current practice:
• Low risk patients: Observe 9-12 hours and “rule-out” in ED
• Moderate / high risk patients: Admit to r/o ACS.

QUESTION: What are the pitfalls in ACS?

Assuming that improvement of symptoms with a GI cocktail is diagnostic of GERD and rules-out ACS.
Assuming patients with no risk factors can not have ACS.
Failing to realize that females and minorities are underdiagnosed.
Not recognizing atypical presentations.

QUESTION: What are the take-home points on ACS?

ED assessment for ACS is based primarily on history and EKG (both have limitations)
A single negative troponin can not exclude ACS in a CP patient
“Time is muscle” – the sooner thrombolytics are given, the more muscle function is preserved (Commit the thrombolytic criteria to memory!)
Give aspirin as soon as ACS is a consideration.

Case 2
52 y/o morbidly obese male c/o chest pain that worsens when he takes a deep breath.
HPI: He is rather immobile and only walks around his house
PMH: + NIDDM, nonsmoker, no HTN, no CAD
  Physical Exam:
  Vital signs: BP 140/90, HR 105, RR 25, T 99.8, Sat 95% on RA
  Gen – Obese male, talks in short sentences
  HEENT – NC/AT
  Neck – Unable to see JVP, no bruits
  Chest – Very distant breath sounds but clear
  CV – Very distant S1/S2, unable to hear anything else
  Abd – Obese, nontender
  Extrem – Good pulses in all extremities, bilateral lower extremity edema – symmetrical

Questions:
What is your differential diagnosis?
What other questions might you want to ask this patient?
Are cardiac risk factors helpful?
What is the diagnostic value of a patient’s response to treatment?
Can a CT angio, D-dimer, or V/Q scan rule out PE?
What other tests/labs may you want to order?
CHEST PAIN

Bibliography


