The Low-Risk Patient with Possible Acute Coronary Syndrome: How Much Evaluation Is Enough?

Missed myocardial infarction (MI) is a dreaded event and responsible for the most malpractice dollars awarded in the US. Many patients with chest pain or other symptoms consistent with acute coronary syndrome actually do not have the diagnosis. How extensively should these patients be evaluated to exclude this diagnosis? What is the value of observation and noninvasive testing, and when should it occur? Can a single cardiac marker exclude MI in patients with prolonged chest pain? How do nonmedical factors such as patient preference, physician risk adversity, practice setting, and availability of arbitration affect the extent of evaluation?

- Describe the assessment of pretest probability.
- Describe the characteristics of patients with missed ACS.
- Describe the appropriate use of noninvasive testing in patients at low risk for ACS.
- Describe the necessary documentation in a patient who is discharged from the ED and what is an acceptably low risk for ACS.
- Discuss the role of ED observation.

WE-176
October 10, 2007
9:00 AM - 9:50 AM
Washington State Convention and Trade Center

(+)No significant financial relationships to disclose
Evaluating Chest Pain Patients
Diagnosing AMI and Unstable Angina: History, Physical and Laboratory

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September 2007

One of the most important things we do in the Emergency Department is evaluate chest pain. Of the 130 million patients that come to EDs, between 8,000,000-9,000,000 will have a chief complaint of chest pain. We will diagnose about 1 million AMIs, 1.2 million cases of Unstable Angina (UA) and more than 6 million cases of non-cardiac chest pain. Unfortunately we will also miss at least 40,000 cases of AMI, or UA who develop either an AMI, ACS or have sudden death due to coronary disease.

Missing the diagnosis of AMI and ACS ranks as one of the leaders in malpractice losses for ED physicians. Some studies show it to be the number one malpractice loss with ranges of 20-40% of all dollars lost by ED MDs and their insurers.

Currently, the accepted miss rate of AMI is 0.0% by US citizens and their lawyers. We don’t achieve this level of accuracy…

This talk’s goal is for you to never miss an AMI or discharge a chest pain patient (or anginal equivalent) who has an acute coronary syndrome.

Variables for Risk Stratification

• Characteristics of Chest Pain and associated symptoms
• Past History of Coronary Disease
• Risk Factors
• ECG
• Enzymes

Chest Pain Characteristics to Ask and Document

• Quality—crushing, burning, knifelike...
• Intensity—1-10 scale
• Character—sudden, gradual
• Duration—in minutes or hours
• Radiation—to back, legs, neck?
• Influencing factors—anything make it better or worse?
• Associations—any associated symptoms?

Other Symptoms That = Consider ACS

• Syncope, Presyncope, AMS
• Nausea/Vomiting
• Weakness
• Diaphoresis
• Shortness of Breath
Classic Ischemic Chest Pain

- Crushing Substernal
- Radiating to the left arm and/or jaw
- Associated with:
  - Nausea
  - Weakness
  - Diaphoresis
- Lasting 15-30 minutes
- Made better by rest, worse by exertion

Please read the following concepts to realize our problem:

Basic Concepts

- Almost all MI’s have chest pain
- Truly asymptomatic MI’s almost never happen
- Most AMI’s have typical pain
- ECG’s are almost never completely WNL in AMI
- CK-MB and/or Troponin values are close to 100% accurate by 6-9h

All of the above basic concepts are FALSE!

The History

Chest Pain is the hallmark of AMI

but

- May be absent
- May be fleeting
- May be different than substernal
  may be:
  - Pleuritic, stabbing, or even palpable

Atypical Stuff

- C.P. greater than 48 hours
- Pain reproduced by palpation
- Stabbing Pain
- Age less than 40
- Radiation to back, legs, abdomen
Atypical Stuff - Probability of AMI in 6000 pts

- C.P. greater than 48 hours  New ST  20%
- No New ST  1%
- Pain reproduced by palpation  1%
- Stabbing Pain  3%
- Age less than 40  2%
- Radiation to back, legs, abdomen  1%

ACS Without Chest Pain

- Global Registry Study (GRACE)
- 20,881 patients with ultimately suspected ACS
- 8.4% (1783 pts.) had no chest pain, only “atypical symptoms”
- ¼ of the patients without C.P. did not have ACS initially suspected
- Mortality much higher if no C.P.: 13% vs. 4.3% (p < 0.0001)

Elderly Patients with Suspected ACS

- 10,126 ED R/0 ACS patients
- 1157 (8.3%) were 65 yo or older
- Stabbing Pain
- Elderly had 2x ACS incidence (14.5% vs. 7.4%)
- But: - Less Chest Pain
  - Less Left Arm Pain
  - Less Typical Pain

Atypical” Presentations In the Elderly

- 777 AMI’s, ages 65-100
- Chest pain was seen in only 66%
- Frequency of C.P. decreases with age
  (75% age 70; 50% age 80)
- Chest Pain Infrequent above age 85
  (38% above age 85)
- Beware “Atypical” presentation
“Typical” Symptoms of AMI in the Elderly

- Dyspnea 40%
- Syncope 14%
- AMS 7%
- Weakness 7%
- Giddiness 5%
- Stroke 4.5%

Beware Dyspnea in the Elderly

Missed AMI

These groups are repetitively cited as highest risk for missed ACS:

- The “wrong” age (less than 50 or older than 65-70)
- Atypical symptoms
- Less Symptoms
- No prior angina/CASHD hx
- WNL or Nonspecific ECG
- Female
- Minority

Discharging AMIs

- Multi Center Study of 3077 patients
- Yale, Brigham and Womens, Univ. of Cinn., and 3 Community Hospitals
- Admitted 58% of pts., 26% of whom had AMI
- 4.0% miss rate but “17 other missed AMIs were identified later
- 7.3% overall AMI miss rate
- ½ of all misses could have been picked with better ECG reading skills

A Study of 100 Autopsy Proven Missed AMIs

- Almost ½ of AMIs missed (47/100)
- Four key factors identified:
  - Unjustified dependence on misleading lab
  - Inattention to suggestive lab studies
  - Atypical presentations
  - Failure to consider AMI as a Dx possibility
**Missing AMIs by Missing ECG**

*Annals of EM 1993;22:579-582*

- Multicenter CCU subset study
- Yale, Brigham and Womens, Univ of Cinn, and 3 Community Hospitals
- UA not studied
- ¼ of missed AMIs had ST elevation
- 70% of missed AMIs had abnormal ECGs

**Missing AMI Early in the ED**

*Cardiology 2002;98:75-80*

- 421 AMI pts., 22.3% with delayed admission
- Four Factors lead to early miss
  - Patient felt symptoms due to benign cause
  - Had similar symptoms previously which improved
  - Patient not upset by chest pain
  - Symptoms disappeared while in ED
- Patients perceptions affect us

**What’s the Best We Can Hope for Without Objective Testing**

*Coron Artery Dis 2002;13:37-43*

- 5362 pts. from single hospital in Göteborg, Sweden
- Hx, PE, ECG, CK-MB, Clinical Impression; No Troponins
- 1% AMI miss rate; UA miss not evaluated

**How Good Are the Canadians?**

*CMAJ 2004;170:1803-1807*

- 1819 patients with C.P. R/O ACS
- 13.2% AMI (241 pts), 8.6% UA (157 pts.)
- 4.6% AMI missed (11/241) and 6.4% UA missed (10/157)

**Value and Limitations of the Chest Pain History**

*JAMA 2005 294:2623-2629*

- Medline and OVID searched 1970 – 2005
- 88 sources reviewed
- Up to 11,000 patients per characteristic
- Objectively evaluates ability of clinicians to Rule-In or Rule-Out ACS
### Details Evaluated in CP History

- Quality
- Location
- Radiation
- Size of Area
- Severity
- Time of Onset
- Duration
- First Occurrence
- Pleuritic
- Positional
- Palpable
- Exercise
- Emotional Stress
- Relieving Factors
- Associated Symptoms
- Similarity to Prior ACS

<table>
<thead>
<tr>
<th>Increased Likelihood of AMI (+LR)</th>
<th>Decreased Likelihood of AMI (-LR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation to R arm or shoulder</td>
<td>4.7 Pleuritic 0.2</td>
</tr>
<tr>
<td>Radiation to both arms or shoulder</td>
<td>4.1 Positional 0.3</td>
</tr>
<tr>
<td>Associated with exertion</td>
<td>2.4 Sharp 0.3</td>
</tr>
<tr>
<td>Radiation to L arm</td>
<td>2.3 Reproducible Palpation</td>
</tr>
<tr>
<td>Diaphoresis</td>
<td>2.0 Inframammary 0.8</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>1.9 Not associated with exertion</td>
</tr>
<tr>
<td>Worse than prior angina or AMI</td>
<td>1.8</td>
</tr>
<tr>
<td>Described as pressure</td>
<td>1.3</td>
</tr>
</tbody>
</table>

*JAMA 2005:294: 2623-2629*

### Probability of AMI

*JAMA 2005:294:2623-2629*

<table>
<thead>
<tr>
<th>No Risk</th>
<th>Low Risk</th>
<th>Probable Low Risk</th>
<th>Probable High Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pleuritic</td>
<td>Not exertional</td>
<td>Pressure-like</td>
<td>Radiates to arms or shoulders</td>
</tr>
<tr>
<td></td>
<td>Positional</td>
<td>Small area not inframammary</td>
<td>Similar to prior ACS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reproducible</td>
<td></td>
<td>Associated with N/V or Diaphoresis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stabbing</td>
<td></td>
<td>Related to exertion</td>
<td></td>
</tr>
</tbody>
</table>
“No single element of the Chest Pain History is a powerful enough predictor of non-ACS on non-AMI to allow clinicians to make decisions according to it alone”  

**JAMA 2005;294:2623-2629**

**Atypical is Typical**

| One missed AMI will change your life and your patient’s life **Forever** |

Missing an AMI is a common event. In general, about 1-2 in 100 AMI patients are discharged from hospitals by competent physicians. If we appreciate that it could happen to any of us and try to study how we miss AMI’s, then maybe we can make our miss rate 1 in 1000 or 1 in 10,000.

-Always err in a way that the patient suffers the least-

(Commandment 10 of the Ten Commandments of Emergency Medicine)

**R/O Dissection**

**You Must Ask and Document This in All Chest Pain Patients**

- Was it:
  - tearing or ripping?
  - start at maximal intensity?
  - Radiate to back, abdomen and legs?

If you ask all 3, you will pick up 90% of Dissection, ¼ of us ask 0-1 of the questions...

**Past History that Increases ACS Risks**

- CABG
- Stent
- PCI
- Prior Abnormal Scan, Echo, or ETT
- Abnormal ECG

Did your doctor ever tell you to take **ASA or NTG**?

**Major Risk Factors**

- Hypertension
- Hyperlipedemia
- Diabetes Mellitus

- Family History
- Obesity, Inactivity, Habits
- Type A with high anger  
  *(especially repressed anger)*
Do Risk Factors Help?

- Risk factor rarely helpful in the ED
- Men: DM, Family History minimally increase probability
- Women: No

Note: Risk factors are for use in populations. If a patient has no risk factors that does not significantly decrease the risk of ACS in the specific patient you are evaluating.

TIMI Scoring (1 point Each)

- Age >65
- Known CASHD
- ≥ 3 Risk Factors
- ST Segment Changes
- Aspirin Use
- ≥ 2 Anginal Events in 24 hours
- Elevated Biomarkers

Note: TIMI Score of 0 in this study was associated with a 1.7% risk of adverse outcome.

The ECG

- Misreads are the single biggest cause of missing AMI
- We must be as good as anyone in reading ECGs
- Must specifically look for all 5 AMI patterns
- Beware NSSTW Δs…
- Repeat ECGs!!

The 5 ECG AMI Patterns on the 12 Lead ECG

- Anterior: V Leads, 1, L
- Inferior: 2, 3, F
- Lateral: I, L, V5, V6
- Right Sided: Deep ST ↓ V1, V2 in inferior AMI
- Posterior: V2: especially in inferior AMI
  R > S
  ST ↓
  T wave upright

5 Ways to Diagnose an AMI on ECG

- ST elevation in 2 or more anatomically contiguous leads
- Reciprocal ST Depression
- Q waves
- Compared to prior ECGs (including new BBB)
- Compare to next ECG in 10-20 minutes
Value of Extra Leads

• The 12 lead ECG may miss RV and Posterior AMIs
• Right sided (V4R, V5R, V6R) leads may help for R.V. AMI
• Posterior Lead (V7, V8, V9) could help for Posterior AMI
• Sensitivity ↑ by 8.4% but specificity ↓ by 7.0%
• Use when faced with non diagnostic inferior changes
• Look for subtle ST ↑, not massive
• Use as an aid to keep in ED rather than discharge.
• Best, easiest extra lead V4R: will Dx up to 80% of RV AMI

ECG Mistakes to NEVER Make

• Not getting an ECG in a C.P. patient
• Not getting an ECG in older patients Sx of:
  - Syncope, Presyncope, AMS
  - Weakness
  - Nausea, vomiting
  - Diaphoresis
  - Shortness of breath
• Not carefully reading for all 5 AMI-Ischemic patterns
• Not repeating ECGs, especially when not normal or in high risk patients.
• Not comparing to old ECGs—use fax from other hospitals

ONE ECG BEGETS ANOTHER

Unfortunately, presenting ECGs may be WNL or Non-diagnostic for AMI and ACS.
We have known since the mid 1970s that a WNL ECG does NOT exclude an AMI.

Normal ECGs in AMI

R/O AMI Admissions

Normal ECGs

Br Heart J 1977;39:212-217

• 1578 Chest Pain patients
• 462 patients with WNL ECGs
• 117 (25%) admitted
• 21% WNL ECG patients had AMI
R/O AMI Admissions

Normal and Near Normal ECGs

Am J Cardiol 1987;60:766-770

- 775 R/O AMI patients
- 107 WNL ECGs
- 73 “minimal non-specific changes”
- 10% of WNL ECGs had AMIs
- 8% of minimum change had AMIs

Normal ECG and AMI

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th>Yr</th>
<th>Patients</th>
<th>AMI</th>
</tr>
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<tbody>
<tr>
<td>Welch</td>
<td>JAMA</td>
<td>2001</td>
<td>733,191</td>
<td>4.4%</td>
</tr>
<tr>
<td>Zalenski</td>
<td>Acad EM</td>
<td>1996</td>
<td>51</td>
<td>3%</td>
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<tr>
<td>Hedges</td>
<td>Ann EM</td>
<td>1992</td>
<td>261</td>
<td>2%</td>
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<tr>
<td>Fessmire</td>
<td>Arch IM</td>
<td>1989</td>
<td>459</td>
<td>4%</td>
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<tr>
<td>Slater</td>
<td>Am J C</td>
<td>1987</td>
<td>775</td>
<td>10%</td>
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<tr>
<td>Behar</td>
<td>Chest</td>
<td>1977</td>
<td>117</td>
<td>5%</td>
</tr>
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</table>

The Milis study looked at 3697 patients admitted with R/O AMI to a CCU. Patients were considered to be high risk for AMI due to prolonged C.P. (≥ 30 min).

MI or Not?

Milis Grp, 3697 pts, AJC 1983

<table>
<thead>
<tr>
<th>ECG</th>
<th>MI</th>
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<tbody>
<tr>
<td>WNL</td>
<td>21%</td>
</tr>
<tr>
<td>Isolated ST↓</td>
<td>50%</td>
</tr>
<tr>
<td>Isolated ST↑</td>
<td>65%</td>
</tr>
<tr>
<td>Q waves</td>
<td>75%</td>
</tr>
<tr>
<td>ST↑ , Q</td>
<td>90%+</td>
</tr>
<tr>
<td>ST↑ , ST↓</td>
<td>90%+</td>
</tr>
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</table>
Likelihood of MI

<table>
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<tr>
<th>0-20%</th>
<th>50%</th>
<th>60%</th>
<th>75%</th>
<th>90%</th>
<th>90% - 95%</th>
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</thead>
<tbody>
<tr>
<td>WNL</td>
<td>ST ↓</td>
<td>ST ↑</td>
<td>Q</td>
<td>ST ↑</td>
<td>Reciprocal Δ’s or ST ↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reciprocal Δ’s Q Waves</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q Waves</td>
</tr>
</tbody>
</table>

Using Continuous 12 Lead ECG Monitoring (SECG)

- SECGs now capable of continuous 12 lead ECGs
- Monitors ST changes Q 20 seconds or more often
- Alarms for 0.2 mV in 1 lead or 0.1 mV in 2 leads
- Utility of SECG is based on Patient’s Risk level:

- **Low Risk ACS pts.**—no significant increased utility over 12 lead ECG  

- **Intermediate Risk pts.**—no added value over standardized work-up  
  *Ann Emerg Med 2003;41:342-345*

- **High Risk ACS pts.**—if not admitted, SECGs should be used; as high as 99.4% sensitivity for ACS  
  *Ann Emerg Med 1998;31:3-11*

*This patient type almost always admitted  
(prolonged ongoing, CP, CHF; Dynamic ST changes, Shock, etc.)

Enzymes in Diagnosing AMI and ACS

There are ways to try to help us be better in AMI diagnosis, one is enzymes.

**Myoglobin**

- Small molecule (17,000 daltons)
- Easily enters coronary arteries
- Quickly cleared by kidneys
- Appears within one hour
- Peaks in 4-6 hours
- Gone in 24 hours
- Unfortunately only about 80% sensitive and specific
- **Of no value to R/O ischemia**
- A 0 and 2 hr Δ CK-MB appears superior
Myoglobin’s Role: Optimal Marker Use
CMAJ 2000;162:1561-1566

- Compared in CK-MB vs. CK-MB + Trop I + Myoglobin
- Did levels at 0 and 2 hours
- No significant differences in time to Dx or Accuracy of Dx by adding myoglobin

Creatine Kinase (CK)

- Catalyzes reaction of ADP to ATP
- Three isoforms: MM muscle, including cardiac
  (70-85% of total CK)
  BB    Brain, Bowel
  MB    Cardiac
  (1% of skeletal CK is MB)

CK-MB’s

- Large molecule (34,000 - 42,000 daltons)
- Delayed appearance into blood
- Can be measured multiple ways

CK Measurements

Electrophoresis: Oldest method - takes longest
Immunoassays: Measures CK Mass
    More accurate and quicker, immunoassay most centers now use
Isoforms: Newest, least available, probably most accurate

Time Line for CK-MB Enzyme Rise
Circulation 1999;99:1671-1677
<table>
<thead>
<tr>
<th>Marker</th>
<th>Earliest Rise</th>
<th>Peak</th>
<th>Return to Normal</th>
<th>Abnormal Value</th>
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</thead>
<tbody>
<tr>
<td>Myoglobin</td>
<td>1-3 hrs</td>
<td>6-9 hrs</td>
<td>12 hrs</td>
<td>&lt; 80 μ/mL</td>
</tr>
<tr>
<td>CK-MB</td>
<td>4-8 hrs</td>
<td>12-24 hrs</td>
<td>2-4 days</td>
<td>&gt; 10 μg/mL or &gt; 3% of total</td>
</tr>
<tr>
<td>Total CK</td>
<td>3-6 hrs</td>
<td>24-36 hrs</td>
<td>12 hrs</td>
<td>&gt; 150-180 u/L</td>
</tr>
<tr>
<td>CTnT</td>
<td>3-4 hrs</td>
<td>10-24 hrs</td>
<td>1-3 wks</td>
<td>&gt; 0.1 μg/mL</td>
</tr>
<tr>
<td>Ctnl</td>
<td>3-4 hrs</td>
<td>10-24 hrs</td>
<td>1-3 wks</td>
<td>&gt; 1.5 μg/mL</td>
</tr>
</tbody>
</table>

Modified from AACN Clinical Issues 2004;15:547-557

CHECKMATE
Multimarker Testing for Risk Stratification

- Prospective study of 1005 pts. in 6 Chest Pain Units
- Compared CK-MB, myoglobin, and Troponin values
- Measured at 0,3,6,9-12,16-24 hrs. post admission
- Recommends multi-marker bedside testing
- Multimarkers > Single Assay in accuracy and time to Dx
- Myoglobin helped in quicker Dx (0.3 hrs) and in earlier presenters
Isolated Troponin Evaluation in Chest Pain

Am J Cardiol 2003;91:936-940

- 1852 pts. with no ST ↑ from 3 ACS studies
- PARAGON B, GUSTO IIa and CHECKMATE
- Even if all presenting enzymes negative, 1.1% short-term risk of Death or AMI
- Event rate ↑ to 9.5% at 30d
- Trop⁺/CK-MB⁺ had worst prognosis
- Trop⁻/CK-MB⁻ had 30d 9.6% AMI or Death Rate

**Troponin**

- Regulatory protein of myofibril
- Troponin -C binds calcium
- Troponin -T binds troponin and myosin
  (1-2% level found in skeletal muscle)
- Troponin -I is an inhibitor
  (N terminal end specific for heart)

**Troponin in AMI**

- Early in AMI is less sensitive than myoglobin
- Later is most sensitive enzyme marker currently available
- 50% sensitive at t = 3-6 hrs
- Almost “100% sensitive” at t = 10 - 16 hrs
- Lasts 7-10 days

**Troponin Falsehoods**

- 100% sensitive for AMI
- Picks up most unstable angina
- No false positives
- Easy to do
- Negatives may allow ED discharge

**Troponin “Unspoken” but should be**

- Is not a perfect test
- Troponin T is currently superior to Troponin I
- T uses recombinant human Troponin
- T is more reliable at lower ranges
- I comes from different batches
- A single negative Troponin does not exclude AMI or ACS

“Negative results are associated with low risk and allow rapid and safe discharge...” NOT!!

*N Engl J Med 1997;337:1648-1653*
Troponin in the ED
Be Careful

*JACC 1998;32:8-14*

- First Troponin misses 16-25% of AMIs*
- False positives as high as 3-13%*
  *(0.4 ng/ml vs 1.5 ng/ml)*

How Accurate is One CK-MB or Troponin to R/O ACS

*Ann Emerg Med 2001;37:478-494*

- Meta analysis of 22 years of studies
- A single set of enzymes will miss anywhere from 51-63% of all AMIs
- Acute sampling of new onset symptoms yield the worst results for predicting AMI
- Serial sampling will detect 79-93% of all AMIs
- Serial sampling will only detect 31%-45% of all ACS

Delta CK and Troponin in R/O AMI

*Am Heart J 1998;136:237-244*

- Compares time 0 and Level 2 hours later
- Move sensitive than single values
- Delta CK-MB rise of 1.6 ng/ml > single 2 hour value of > 6

Delta CK-MB Outperforms Troponin and Delta Troponin


- 2 hr Δ CK-MB mass of 1.6 most sensitive for AMI
- More sensitive than CK-MB of 6ng/ml
- More sensitive than Δ Troponin I of 0.2 ng/ml
- 87% of AMIs detected at 2 hours
- Only 61.4% for Troponin I at 2 hours

Delta CK Outperforms Myoglobin for Early AMI Detection

In Troponin I Negative Patients

*Ann Emerg Med 2004;44:12-19*

- Used 0 and 2 hr. immunoassay CK-MB rise > 0.7 ng/ml
- 93.2 Sensitive and 94.4% Specific for AMI
- Myoglobin 75% sensitive; Delta myoglobin 77.3%
- At only 2 hours 38.6% had CK-MB > 2.9 ng/ml
Discordant Cardiac Biomarkers: Frequency and Outcomes in Emergency Department Patients With Chest Pain

- Study of 8769 pts.; 1614 had ACS
- CK-MB and Troponin discordant in 7%
- Both markers positive: 80% chance of ACS
- Both markers negative: 12.7% chance of ACS
- If Trop (+) but CK (-): 41% Risk
- If Trop (-) but CK (+): 24% Risk

Beware discordant markers

Optimal Enzymes Testing

- No Consensus
- 0, 6, 12 → 0, 3, 6, 9 → 0, 2, 4
- Strongly consider using “Delta” testing
- Beware discordant CK-MB and Troponin
- You must have at least one set, drawn at least 6 hours post onset of CP

Conclusions on Enzymes

- Can not use a single early assay to R/O AMI
- Excellent over time to Dx AMI
- Unreliable to R/O U.A.
- Only 1/4 – 1/3 of non-AMI ACS will have ↑ Troponin
- CK-MB will only rise with AMI
- Delta values are more accurate than single values
- Beware discordant markers

Enzymes are rarely positive early in AMI.
Enzymes are almost never positive acutely in patients with non-diagnostic ECGs

ONE set of negative enzymes ≠ No ACS

Many of us use response to NTG to help diagnose patients with WNL, or nonspecific ECGs, and negative enzymes.

Using Response to NTG to Diagnose Ischemia
Usefulness as a Predictor of Ischemic C.P. in the ED


- 223 ED pts. with chief complaint of C.P.
- Ultimately 1/3 had Ischemic C.P. and 2/3 did not
- Used ECG, Enzymes, Stress Testing (1/2) and Cath (29%)
- 90% of all pts. responded at NTG (88 vs. 92%)
- Complete relief seen in 72% (70 vs. 73%) of all pts. whether they had ACS or no ACS

“The practice of supporting or excluding the diagnosis of myocardial ischemia should not be based on a patient’s response to nitroglycerin”

Am J Med 2002;90:1264-1265

Chest Pain Relief by NTG Does Not Predict Active Coronary Disease

Ann Int Med 2003;139:979-986

- 459 admitted ED patients with C.P.
- Used 50% pain relief within 5 minutes
- Used stress testing, enzymes or cath in 39% overall
- 35% of ACS pts. responded
- 41% of Non-ACS pts. had pain relief

“Our data…strongly suggests that the response of chest pain to nitroglycerin although therapeutically beneficial, has little diagnostic or prognostic value”

Ann Int Med 2003;139:979-986

Changes in the Numeric Scale for Pain after SL NTG Do not Predict Cardiac Etiology


- Convenience sample of 664 pts. (52% F: 48% M)
- 18% had Cardiac Chest Pain
- Used 11 point pain scale pre-post NTG
- Troponin, Stress Testing, ECg changes and Cath used
- 28% had complete resolution; 22% moderate, 19% none
- Response to NTG unrelated to presence or absence of ACS

Three Studies, Three Journals, Same Results

NTG response can NOT be used to Diagnose or Exclude Active Ischemia, AMI, or lack of ACCS
The GI Cocktail to Help Diagnose Ischemic Chest Pain

**Early Study Recommends Use**

- 60 patients studied; average age 45
- 37/60 had complete pain relief with 10-15 min.
- No “complete relief” pt. had AMI
- 1 patient with “partial” relief had AMI
- Author says response is “an aid” and is safe

*Note: “Xylocaine viscous in this context appears to be as useful as the “Levine test” in which angina lessens with carotid sinus pressure”*

**Using the GI Cocktail: A Descriptive Study**

- 97 Consecutive pts. with chest or abdominal pain
- Used antacid, viscous lidocaine and donnagel
- 14% had myocardial ischemia; 53% had GI cause
- Exact responses and time intervals often vague or missing
- 69% had symptomatic relief
- 73% of admitted R/O ACS had positive response
- 68% of discharged GI etiology pts., also had positive response

**Conclusions on GI Cocktail**

- Works great on symptoms in up to 70% of all pts.
- Documentation by ED MDs and RNs often incomplete
- **Response, partial response or NO response does NOT indicate presence or absence of ACS.**
- Use for symptoms, NOT for diagnosis

**Just how good are we** based on history, physical exam, ECG, serial ECGs and response to NTG and the GI cocktail. Many of us rely on these tests to see who can be discharged, admitted, or held for more tests +/- observation.

**Testing of Patients**

Because History, Physical Exam, ECG and Enzyme testing may not immediately diagnose ACS. Additional testing strategies using ETT, Nuclear Studies, Echocardiography and now in early trials CT Angio and MRI have been utilized to improve diagnostic accuracy rates and to both decrease non-ACS chest pain admissions to the hospital and more importantly to decrease inappropriate discharges.
One answer to the problem is to create a Chest Pain Center. The first large center with a published large series was Brian Gibler’s in Cincinnati.

**Chest Pain Centers**  
**Univ. Of Cinn. Heart ER**  

- 1010 patients (512:498 m:f)
- Low Risk Only; No CAD, No ST Changes
- CK-MB at 3, 6, 9 Hr.
- Continuous 12 Lead ST Monitoring
- 2-D Echo
- ETT

**Chest Pain Centers**  
**Univ. Of Cinn. Results**  

- 829 (82.1%) Discharged
- 153 (15.1%) Admitted
- 1/3 of Admitted Patients had CAD
- 1 AMI in D/C’d, “negative” patient 3 days later
- 3 deaths at 1 mos; 1 was due to CAD

Cost of a chest pain center has always been cited as why NOT to do a specialized area.

Yet admitting patients is very expensive.

**Cost of Chest Pain Areas**  
*JACC 1994;23:1016-1022*

<table>
<thead>
<tr>
<th>Area</th>
<th>Median Cost</th>
<th>25th-75th</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED</td>
<td>$ 403</td>
<td>(403-927)</td>
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<tr>
<td>“Short Stay”</td>
<td>$1927</td>
<td>(1455-3650)</td>
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<td>Ward Area</td>
<td>$4712</td>
<td>(1868-11,187)</td>
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<tr>
<td>Step Down</td>
<td>$4031</td>
<td>(2069-9,169)</td>
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<tr>
<td>CCU</td>
<td>$9201</td>
<td>(3171-20,011)</td>
</tr>
</tbody>
</table>

**Cost of Chest Pain Areas**  
*JACC 1994;23:1016-1022*

- Short stay patients stay shorter
- Had same number of complications
- Saved $1,000,000 in 2 years
Chest Pain Centers
Patient Satisfaction
*Annal EM 1997;29:116-125*

- 104 patients at Cook County Hospital
- 36% of patients were employed
- Used four quality or satisfaction measures
- Better: comfort, communication, attention
- Designated Areas are Better Appreciated

- Why Stress testing of some type is so important -

**Symptoms vs Degree of Obstruction**

- At rest, patients may have up to 90% obstruction and still be asymptomatic
- With exertion, 50% stenosis may result in symptoms and/or ECG changes

**Cost Effectiveness of Stress Testing**

400 Patients
*Annal EM 1997;29:116-125*

- 240 ETTs ($125)
- 158 Stress/dobutamine ECHOs ($275)
- 2 Thallium Stress Tests ($550)
- $3125 is cost for 1 CAD Diagnosis
- Cost per year of life saved < $2000
- $894 per out-patient vs. $2364 for inpatient

**Low Risk Patients**

Immediate Stress Testing
*Annal EM 1998;32:1-7*

- 212 Patients (121:91 m:f)
- Results: 59% Negative, 28% Non-Dx, 13% Positive
- Half of Positives had CASHD (13/23)
- All patients with Negative Tests DC’d
- 93% with Non-Diagnostic DC’d

**Low Risk Candidates:**

- WNL ECG or Minor NSSTWs
- WNL vital signs and physical exam
- Younger 40-50
- O or few risk factors*

*6% pos for CAD*
Immediate Stress Testing
30d Follow-Up
Annal EM 1998;32:1-7

- 95% of patients had follow-up
- No Mortality
- 1 of 23 positives got CHF
- No 30d adverse events in patients WNL ETT

No Adverse Effects to Immediate Testing

- No patient with CAD bumped their enzymes
- 3 patients were already having an AMI during ETT
- Enzyme pattern typical in these 3
- Non-diagnostic HR was <85%
- Authors questions if 75% is acceptable target for HR
- Most ETT Complications Occur
  During Recovery Period 5-10 minutes post ETT

Note: This group now waits for 1 set of enzymes pre-ETT

What is the Negative Predictive Value of a Normal ETT

Based on the University of Cincinnati Chest Pain study of 1,010 patients, the Cook County data of 317 patients and the UC Davis study of 212 patients, a normal ETT has an overall negative predictive value of 98%. With low risk patients who have a normal ECG, no enzyme changes a low pretest probability, the risk of a 30d adverse event is less than 1% (somewhere between less than 1 in 100 to less than 1 in 1000…)

A negative ETT dramatically lowers risk of ACS…it does not eliminate it!!

The next question is: Is there something even better?

Sestamibi Scanning

- Technetium 99m labeled perfusion agent
- Distributes to well perfused areas
- 6 hour half-life
- Does require 60 minutes wait post injection
- Allows scan to be done 1-6 hrs. post injection
- Standard protocol: Rest scan followed by short wash-out period then higher dose administered and stress scan performed.
- Stress is either treadmill (preferred) or adenosine if patient can not exercise.
Thallium Scans

• Nuclear Scan of Choice pre MIBI
• Requires immediate scan post injection
• Rest Thallium can precede Stress MIBI
• Most centers now use only sestamibi

Myocardial Perfusion Imaging for Evaluation and Triage of Patients with Suspected Acute Cardiac Ischemia. A Randomized Controlled Trial

JAMA 2002;288:2693-2700

- Observational study at 7 academic centers
- 2475 Adult ED patients
- Compared scan vs. no scan protocols
- Used resting protocol only

Results

- Normal rest scan 97% sensitive for ACS
- 99.4% Sensitive for AMI and ACS at 30d
- Non-ACS Admissions 52% without Scanning
- Non-ACS Admissions 42% with Rest Scanning
- Scan positively rate: 14% (2 AMI, 12% UA)

Using nuclear scanning results in decreased non-ACS Chest Pain admissions and allows more safe discharges…It is cost effective

Myocardial Perfusion Imaging With Technetium-99m Sestamibi in Patients With Cocaine-Associated Chest Pain


- 215 patients
- 5 positive rest scans
- 39/172 patients had outpatient stress studies – all WNL
- No ACS in negative rest scan patients at 30 days
Sestamibi Scanning

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Sens (%)</th>
<th>NPV</th>
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<td>Varetto</td>
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<td>64</td>
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<tr>
<td>Varetto</td>
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<td>27</td>
<td>100</td>
<td>-</td>
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<td>Stowes</td>
<td>1995</td>
<td>187</td>
<td>97</td>
<td>-</td>
</tr>
<tr>
<td>Tatum</td>
<td>1997</td>
<td>438</td>
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<td>100</td>
</tr>
<tr>
<td>Fesmire</td>
<td>2001</td>
<td>805</td>
<td>97.3</td>
<td>99+</td>
</tr>
<tr>
<td>Fesmire</td>
<td>2002</td>
<td>2074</td>
<td>100 AMI</td>
<td>100 AMI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>99.1 UA</td>
<td>99.8 UA</td>
</tr>
</tbody>
</table>

A normal Rest-Stress protocol nuclear scan has a sensitivity of 99% and a negative predictive value of at least 99%. A negative scan with good contractility in a low risk patient almost completely rules out ACS and does R/O AMI.

Stress Echocardiography

- Useful in patients with an abnormal ECG
- More sensitive than treadmill testing, faster and cheaper than nuclear imaging.
- Adequate visualization is sometimes a problem.
- Not as well studied in ED Chest Pain Center Studies
- Operator Dependent
- Some centers prefer it

Role of Stress Echo

- Consistently misses >30% jeopardized myocardium
- Pos or Neg tests yield same prognosis in prior AMI pts
- 5-7%/yr AMI or Deaths in prior AMI patients
- Increased further testing as compared to Nuclear testing
Multi-Detector CT
Evaluation of Chest Pain

• High Quality Non-invasive Coronary Imaging
• 64 Slice allows short breath hold
• Allows for higher quality, more detailed imaging
• Requires administration of IV or PO beta blockade
• Best for ruling out obstructive lesions
• Sometimes equivocal in patients with known CASHD
• Increased calcium in coronary arteries complicates reading

Coronary CTA Limitations

• Radiation with Iodinated Contrast
• Reader Expertise (new test)
• Ability to Breath Hold (now just 5-10 sec)
• Need for Beta Blockers (HR below 60-65)
• Increased Coronary Angioplasty in higher risk patients*

*10% of Scans Inadequate; 10-20% “Intermediate”

No MDCT

• No Elevated Biomarker (CK-MB or Trop)
• No New ECG Changes
• Not Hemodynamic Instability, Chest Pain, AFib
• No Iodinated Contrast Allergy, Hyperthyroidism, Metaformin Use
• Creatinine is not > 1.3 mg/dl (some use 1.5)

64 Slice MDCT to R/O ACS

Acad Emerg Med 2007; 14: 112-116

<table>
<thead>
<tr>
<th>Author</th>
<th>Journal</th>
<th>n</th>
<th>PPV</th>
<th>NPV</th>
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<tbody>
<tr>
<td>Hoffman*</td>
<td>Circ 2006</td>
<td>103</td>
<td>61%</td>
<td>100%</td>
</tr>
<tr>
<td>Rubenstein</td>
<td>Circ 2007</td>
<td>58</td>
<td>87%</td>
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<td>Hollander</td>
<td>Acad EM 2007</td>
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<td>80%</td>
<td>100%</td>
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<tr>
<td>Goldstein</td>
<td>JACC 2007</td>
<td>99</td>
<td>87.5%</td>
<td>100%</td>
</tr>
</tbody>
</table>
**Total Body Radiation Doses**

*Modified from J Nuc Cardiol 2006; 13: 19-23*

<table>
<thead>
<tr>
<th>Diagnostic Studies</th>
<th>(mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA/Lateral CXR</td>
<td>0.08</td>
</tr>
<tr>
<td>Mammogram</td>
<td>0.13</td>
</tr>
<tr>
<td>Cardiac Catheterization</td>
<td>4-6</td>
</tr>
<tr>
<td>CT Abdomen and Pelvis</td>
<td>7-8</td>
</tr>
<tr>
<td>64 Slice MDCT (with ECG Pulsing) Male</td>
<td>4.8-10</td>
</tr>
<tr>
<td></td>
<td>Female 6.8-14</td>
</tr>
<tr>
<td>Tc-99 Rest-Stress MIBI</td>
<td>12</td>
</tr>
</tbody>
</table>

**Estimating Risk of Cancer**

*Associated with 64 Slice Radiation*

*JAMA 2007; 298(3):317-232*

- CTA Dosing:
  - 42-91 mSv for lungs
  - 50-80 mSv for breasts
- Increases cancer risk for 20 year old female to 1:143

Note: Be sure your center is not doing this; specifically ask: 1) What doses are we using 2) Are we trying to minimize dosing 3) Are we pulsing (also called gating) during diastole 4) Are we using breast shields 5) Are we focusing on the coronary arteries.

**Risk Stratification of Chest Pain Patients**

Chest Pain Patient/Possible ACS

- History
  - Physical Exam
  - 12-Lead ECG (serial)
  - Biomarkers

**High Risk of ACS**
- Biomarkers elevated
- New or presumed new ST depression
- Recurrent ischemia despite OMT
- Recurrent ischemia with HF
- High risk findings on stress test
- Depressed LVEF
- Hemodynamic instability
- Sustained VT
- PCI within last 6 months
- Prior CABG

**Intermediate Risk of ACS**
- >10 minutes rest pain, now resolved
- Moderate to high likelihood of CAD
- T wave inversion >2 mm
- Biomarkers slightly elevated (e.g. TnT >0.01 but <0.1 ng/mL)

**Low Risk of ACS**
- No intermediate or high risk features
- <10 minutes rest pain
- Risk factors for CAD
- Nondiagnostic 12-lead ECG
- Biomarkers WNL
- Age <70
Who is a Candidate for CTA?

• Inclusion Criteria:
  - >5 min of chest pain within the previous 24 hours
  - No or nondiagnostic ECG changes
  - Normal initial cardiac biomarkers
  - Sinus rhythm
  - Ability to perform a breathhold of 10-15 seconds
  - Meets Vanderbilt Radiology criteria for IV contrast administration

Who is Not a Candidate for CTA?

• Exclusion Criteria:
  - Known CAD
  - Elevated Troponin or CK-MB
  - Diagnostic ECG changes
  - Homodynamic or clinical instability
  - Atrial fibrillation or markedly irregular rhythm
  - Contraindication to beta-blockers if heart rate >65 (e.g., severe bronchospasm or cocaine exposure)

Chest Pain Centers

Based on all of the available data, most centers now do risk stratification and decide what patients get what tests.

There are now many published chest pain protocols based on risk levels.

Caution: The lowest category patients fall into two groups “Very Low Risk” or Non Cardiac Chest Pain with other obvious cause for symptoms.
<table>
<thead>
<tr>
<th>Feature</th>
<th>Level I STEMI</th>
<th>Level II High RISK ACS (NSTEMI / USA)</th>
<th>Level IIIA INTERMEDIATE RISK: Cardiology Consultation</th>
<th>Level IIIB INTERMEDIATE RISK: ED Observation</th>
<th>Level IV LOW RISK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HPI</strong></td>
<td>Symptom complex suggestive of ACS: Chest discomfort with or without radiation to arm(s), neck, jaw or epigastrium; shortness of breath; weakness; nausea; diaphoresis; lightheadedness; near-syncpe or syncope.</td>
<td>Return of previous ischemic symptoms (see Level I) with known coronary artery disease (CAD).</td>
<td>Known CAD but with different presenting symptoms (includes patients with prior PCI or CABG), or Strong suspicion for ischemia in absence of known disease (compelling clinical history and risk factor profile), or Age &gt; 70 without obvious non-cardiac cause of symptoms.</td>
<td>Possible ischemic symptoms, and Diabetes Mellitus or Extra-cardiac vascular disease, or Family history of premature CAD</td>
<td>Low clinical suspicion for ACS, and No diabetes or known CAD.</td>
</tr>
<tr>
<td><strong>Physical Exam</strong></td>
<td>May include transient MR, hypotension, tachycardia, diaphoresis, or pulmonary edema.</td>
<td>May include evidence of extra-cardiac vascular disease (i.e. bruits).</td>
<td>May include evidence of extra-cardiac vascular disease (i.e. bruits).</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td><strong>ECG</strong></td>
<td>Must have ST segment $\uparrow$ 1 mm or greater in 2 or more contiguous leads. OR New left bundle branch block.</td>
<td>Transient ST segment $\downarrow$ or $\uparrow$ (0.05-1 mm). ST segment $\downarrow$ (at least 0.5 mm) in 2 or more contiguous leads. Ischemic-appearing T wave inversion, or May be normal.</td>
<td>Fixed Q waves. or Chronic ST segment &amp;/or T wave changes (not acute). or May be normal.</td>
<td>Fixed Q waves. or Chronic ST segment &amp;/or T wave changes (not acute). or May be normal.</td>
<td>Normal</td>
</tr>
<tr>
<td><strong>Markers</strong></td>
<td>$\uparrow$ TnT &amp;/or CK-MB May be normal early</td>
<td>$\uparrow$ TnT &amp;/or CK-MB May be normal</td>
<td>Normal or $\uparrow$ TnT in absence of chest pain or ECG changes</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td><strong>Action/Disposition</strong></td>
<td>911 Cardiology (Response &lt; 10 min) ED attending activates Cath Lab</td>
<td>Urgent Cardiology (Response &lt; 30 min) Admit Cardiology +/- Cath Lab</td>
<td>Manage in CP CDU Cardiology Consultation Cardiology attending evaluation &amp; disposition.</td>
<td>Observe in ED Noninvasive stress testing</td>
<td>Noninvasive stress testing at the discretion of the ED physician.</td>
</tr>
</tbody>
</table>
Do Low Risk Patients Really Need to Be Tested

• No study has 0.0% miss rate without an objective test
• Misses are consistent and appear in every study that fails to perform objective testing

Risk of AMI
Hx, PE, ECG
7157 pts AJC 1991

• Obvious AMI 88% AMI (245/288)
• Strong Suspicion 34% AMI (478/1426)
• Vague Suspicion 8% AMI (192/2519)
• *No Suspicion 1.2% AMI (6/466)

466 patient sample group had NO Suspicion, yet 1.2% had AMI
6% of AMI patients had WNL ECG

The Largest Study of Missed Cardiac Ischemia

• 10,689 patients
• 17% AMI or UA
• 8% Acute MI
• 9% Unstable Angina

Testing Protocol

• ECG, Repeat ECGs, SECG
• Enzymes, Repeat enzymes
• ACI-TIPI computer program assistance
• 6-12 hours observation
• Study designed NOT to miss AMI-ACS
• But no stress testing performed

Results:
• 2.1% of Acute MI’s Missed
• 2.3% of Unstable Angina Missed

If this is “standard of care” don’t see 100 AMIs during your career

Ultra Low Risk Patients

• 1023 Patients 34-39 years old
• No Cocaine Use
• Overall Risk for ACS 5.4%
• 2.2% 30D adverse event rate
• 1.7% AMI Rate
Lowest Risk Patients

30 Day Risk

- No prior Cardiac History + No Risk Factors
  - 1.8%
- No prior Cardiac History + WNL ECG
  - 1.3%
- No History + No Risk Factors + WNL ECG
  - 1.0%
- No History + No Risk Factors + WNL ECG + WNL Enzymes
  - 0.14%

European Studies at Low Risk Patients

- Two European studies
- D/C’ed lowest risk patients without stress tests
- BMJ: 292 pts.: 1 MI at 48 hrs; no other follow-up
- Better results than American and Canadian studies but both papers very brief and general applicability to current practice in USA and Canada unclear.

Early Discharge Without Stress Testing

Evaluates sending home low risk patients who can then safely get stress testing at a later date.
This article should be carefully studied if its conclusions are to be used.

“for patients with chest pain and low risk for short-term cardiac events, outpatient stress testing is feasible, safe...With an evidenced based protocol physicians can identify patients at low risk...”

All patients had:
1) ECG
2) Enzymes (Both CK-MB and Troponin at least 6 hours after onset of CP)
3) Had risk stratified by detailed algorithm

PLEASE Look at the Algorithm. NOTE the key questions
- If a patient has extracardiac disease (CVA, PVD, Bruits) → No D/C
- If a patient has 2-3 Risk Factors → No D/C
- If a patient has Diabetes → No D/C
- If a patient has history of prior similar CP diagnosed as angina, MI, or PCI → No D/C

And finally most importantly: Chest or left arm pain or discomfort as chief symptom (if clearly not cardiac wall pain), GERD or Pleurisy → No D/C

- Erlanger Series
- 2074 Patients
- **100%** sensitive for AMI
- **99.1%** sensitive for ACS
- 12 Lead ECG
- Serial ECGs
- Physician Judgement
- Baseline Cardiac Enzymes
- Delta Cardiac Enzymes
- Nuclear Stress Testing

If no stress testing performed for ACS: 80.4% sensitivity

Note: In 614 category IV patients, the probable non-ACS chest patients, there were:

- 1.8% AMI
- 0.2% Life Threatening Complications
- 1.3% Urgent PCI
- 0.5% CABG
- 0.2% Death
- 3.3% ACS

### Incremental Sensitivity for Detecting 30d ACS

<table>
<thead>
<tr>
<th>ECG Baseline Markers</th>
<th>SECG</th>
<th>Delta Serum Markers</th>
<th>Physician Judgment</th>
<th>Selective Nuclear Stress Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.1%</td>
<td>37.6%</td>
<td>41.9%</td>
<td>66.12%</td>
<td>80.4%</td>
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### Incremental Sensitivity for Detecting AMI

<table>
<thead>
<tr>
<th>ECG Baseline Markers</th>
<th>SECG</th>
<th>Delta Serum Markers</th>
<th>Physician Judgment</th>
<th>Selective Nuclear Stress Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.3%</td>
<td>58.1%</td>
<td>64.4%</td>
<td>93.2%</td>
<td>97.6%</td>
</tr>
</tbody>
</table>
My “Simple” Recommendations on Specific Patient Types

Lowest Risk Patients (Atypical Symptoms, Non-Ischemic ECG, No History of Heart Disease)

1. Confirm one set of enzymes are negative
   - If young and healthy, WNL ECG and can run:
     
     **ETT**
   - If healthy, abnormal non-ischemic ECG and can run:
     
     *Rest-Stress Nuclear Test or Stress Echo or CTA*
   - If older and healthy and normal ECG:
     
     **ETT or Rest-Stress Nuclear or Stress Echo or CTA**
   - If older and healthy and abnormal non-ischemic ECG
     
     *Rest-Stress Nuclear or Stress Echo; strongly consider CTA*

Note: If a patient fits all low risk questions as described on page 28, you are at very, very low risk to discharge if 1) you truly feel patient follow-up for outpatient testing and 2) you have satisfied all criteria of article’s appendix. Must have Low Prob. Hx, no CC of Substernal CP; No Risk Factors, WNL ECG and WNL Enzymes at 6 hours.

Intermediate Risk Patients (questionable ECG, more typical symptoms and/or multiple risk factors)

- Perform serial ECGs (at least two)
- Perform Delta Enzymes
- If negative do:
  
  **Rest-Stress Nuclear Protocol (some centers may choose stress echo) or CTA**

Intermediate Risk Patients with prior negative nuclear study or echo

- Excellent candidate for CTS or formally turn care over to cardiologist or inpatient MD

High Risk Patients with non-diagnostic ECG but negative enzymes

- **You should not manage this patient** without either formal, written involvement and transfer of ultimate disposition to a cardiologist or by admitting the patient to a CCU or step down unit where another MD is ready to immediately assume care. If you can get a completely negative CTA however, you can R/O ACS.
Conclusions

We can not exclude ischemia with 100% sensitivity

We are expected to exclude ischemia with 100% sensitivity

Do an objective test after one or more sets of enzymes shows patient is not infarcting and you do not believe patient has unstable angina. Based on risk, do an:

- ETT
- Stress Echo
- Nuclear Study
- Cardiac Cath
- Spiral CT of Coronary Arteries

If you can not test the patient with one of the modalities listed on the prior page and are going to refer the patient for next day (or later) cardiac evaluation, consider doing the next best thing to ETT testing:

The Slovis Method of ETT Testing Without a Treadmill

- Only used After you decide to discharge a low risk patient
- Calculate maximal HR (220-Age)
- Calculate target HR: 75-80% of max HR
- Run patient at bedside till target HR obtained
- Repeat 12 lead ECG

If Chest Pain or New ST Changes; admit!!

If No Chest Pain and No New ST Changes; Refer for Outpatient Follow-up.
Summary and Conclusions

5 Rules to Prevent a Mistake

• Atypical is Typical:
  - Do not use atypical characteristics to R/O the possibility of ischemia.

  I personally believe that with enough effort, you can always make something in the patient’s history atypical. Don’t waste valuable time trying to find something to help you not do the full work-up.

• The Elderly Present with Different Symptoms:
  - Shortness of breath, weakness, syncope-near syncope, diaphoresis and nausea-vomiting all may equal R/O AMI

  The elderly, younger patients, women, non-english speaking patients, minorities and smokers often are misdiagnosed due to “their” failure to read textbooks and know how to present classic symptoms to us.

• ECGs need to be Repeatedly Read and Performed:
  - After you have read the ECG, re-read it specifically looking for the 5 patterns of AMI and for any evidence of localized ischemia. Before you think about discharging a patient, repeat the ECG and compare it to the previous ECG, once again specifically re-looking in all 5 locations.

  One ECG begets another. We can probably decrease our miss rate by 25-50% if we were more ECG attentive and expert.

• Perform Delta Enzyme Analysis:
  - One set of enzymes will be more likely to miss, rather than diagnose, an early AMI.

  Make a repeat set of enzymes routine along with the repeat ECG.

• Do an Objective Test:
  - Have a Chest Pain protocol in place that allows for an evidenced based approach for each step of the evaluation. Have a protocol based on risk, ECG, age and ability to run. Do either an ETT, Nuclear Study, Echo or CTA.

  If everyone got an objective test, our miss rates would go from 1-2 % (or higher) to 1/1000 or even less.

5 Steps to an Expert Cardiac Evaluation

• Perform a Careful History and Physical
  - specifically ask the 3 dissection questions

• Perform at least two ECGs

• Perform at least 2 enzyme determinations

• Assess risk, ECG and ability to run

• Perform an objective test, or in ultra low risk individuals; refer for next day testing.
References:

Diagnosing AMI


Biomarkers


Normal or Near Normal Initial ECG’s in AMI


**Missed AMI's**


Exercise Treadmill Testing


Nuclear Scanning, Echo


CTA


