NSTEMI: The Neglected Epidemic of Our Time: Call to Action

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Disclosure Information
77.3 million
Boomers

Number of Americans 65 Years of Age and Older

Leading Causes of Death

Heart disease, 22.3%
Cancer, 18.7%
Strokes, 9.1%
AIDS, 2.9%
Chronic Liver Disease and Alcoholic Liver Disease, 2.1%
Other External Causes of Injury, 2.1%
Malaria, 2.1%
Homicide, 1.4%
Suffocation, 1.3%
Cerebrovascular Disease, 1.3%
(Decayed, Missing, Extracted Teeth), 1.5%
Other Drugs, 1.2%
Poisoning by Fumes, Gases, Dusts, and Sprays, 1.0%
Suicide, 1.0%
Other, 3.7%
CARDIOVASCULAR DISEASE: A COSTLY BURDEN FOR AMERICA
PROJECTIONS THROUGH 2035

Acute Coronary Syndromes

- MI
- UA
- NSTEMI
- STEMI

Projected Cardiovascular Disease Costs Through 2035
by Condition:

<table>
<thead>
<tr>
<th>2015</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
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<td>$100B</td>
<td>$150B</td>
<td>$200B</td>
<td>$250B</td>
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[Graph showing projected costs over time]
Time Criticality in ACS

"Pharmacological Facilitation of primary Percutaneous Coronary Intervention for acute myocardial infarction: is the slope of the curve the shape of the future?"

Early Invasive Strategy for NSTEMI

An early invasive strategy (diagnostic angiography with intent to perform revascularization if appropriate based on coronary anatomy) is indicated in patients (present and subsequent) with NSTEMI-ACS who have hemodynamic or electrical instability (without serious comorbidities or contraindications to such procedures).

Level of Evidence: A

[Diagram of Time Criticality in ACS]

[Diagram of Early Invasive Strategy for NSTEMI]
'Occult' Acute Myocardial Infarction
Symptoms of Acute Coronary Syndromes are often vague.
Sensitivity of the Initial ECG is not great.
Even the high sensitivity (hs) Troponins may be delayed 6-8 hours.

EMS Philosophy
"We must use all our knowledge and skills to aggressively identify, triage, treat and transport to the best destination those patients suffering from the most common causes of premature Death and Disability".  
Mark Olsky M.D., F.A.C.E.P.

• The Common Acute Manifestations of Ischemic Heart Disease
Common High Yield Symptoms associated with Acute Myocardial Infarction

• The most common symptom of a heart attack is some type of pain, pressure, or discomfort in the chest.
• However, women are more likely than men to have heart attack symptoms unrelated to chest pain.

Why do women have more atypical symptoms?

This is because women tend to have blockages not only in their main arteries, but also in the smaller arteries (microvascular disease).

Neck, shoulder, upper back or abdominal discomfort
Shortness of breath

Nausea or Vomiting

Diaphoresis
Unusual fatigue

Ischemic chest pain has a number of features that tend to distinguish it from noncardiac pain.

Symptoms associated with the highest risk of AMI:

a. Radiation to an upper extremity (particularly both)
b. Pain associated with diaphoresis or nausea and vomiting

O P Q R S T

• O (onset): Gradual; may wax and wane
• P (provocative and palliative): Generally provoked by activity and

Not positional
• Q (quality): Often described as discomfort with squeezing, tightness, pressure, heaviness, constricting, or crushing characteristics.

Not sharp, fleeting, knife like or pins and needles!

• R (radiation): commonly to: shoulder, arms, neck, jaw, and back (intrascapular)

• S (site): usually diffuse
• **T** (time): Angina most often lasts several minutes or less whereas the cause of pain being from an AMI is more often considered when duration is > 20 minutes.

Severity

Severity generally does not correlate with the likelihood that it is an AMI.

**LEVINE SIGN**
Symptoms Less likely to be caused by Ischemic Heart Disease

- Pleuritic pain, sharp or knifelike pain related to breathing or cough
- Primary or sole location in the chest or lower abdomen
- Any discomfort localized with one finger
- Any discomfort reproduced by movement or palpation
- Constant pain lasting for days
- Fleeting pain lasting for a few seconds or less
- Pain radiating into the lower extremities or above the mandible

However,

- In a review of 430,000 patients with a proven AMI:
  
  **ONE THIRD had no Chest Pain**

  - Rather these patients often complained of dyspnea, weakness, nausea, and/or vomiting, palpitations, syncope, or cardiac arrest.
  - They were more likely to be older, diabetics, or women.

However,

- 22% of patients in one study complained of sharp or stabbing pain

- 13% complained of pleuritic type pain.
Warning, Warning; Danger Will Robinson!

BEWARE!

ACUTE MYOCARDIAL INFARCTION: 287/100,000
THORACIC AORTIC ANEURYSM: 6/100,000
THORACIC AORTIC DISSECTION: 5/100,000
Risk factors in the Assessment of potential ACS patients

Risk factors are essential tools for the evaluation of patients whose symptoms may be caused by Coronary Heart Disease. A Multitude of Risk Profiles have been proposed and evaluated in the recent past:

- ESSENCE
- FRAMINGHAM
- GRACE
- BANACH
- SCORE

The T.I.M.I Risk Score

*Thrombolysis For Acute Myocardial Infarction, Harvey DW, Vandewert FJ, Circulation 1998; 97:1632-1646, April 28, 1998*
Elements of the TIMI Risk Score

- Age of 65 years or greater
- 3 or more of the following: family history, hypertension, high cholesterol, diabetes, current smoker
- Prior coronary artery stenosis of > 50%
- ST segment deviation > 0.5 mm
- Severe anginal symptoms (2 anginal events in the last 24 hours)
- Aspirin use within the prior week
- Elevated cardiac markers (CK-Mb or specific troponin)

End Point: Major Adverse Cardiac Event (MACE)

All cause mortality, nonfatal MI, and severe recurrent ischemia requiring urgent revascularization within two weeks after presentation among patients with an acute coronary syndrome without ST segment elevation

Results:

- 0-1: 5% risk
- 2: 8% risk
- 3: 13% risk
- 4: 20% risk
- 5: 26.5% risk
- 6-7: 40.9% risk
How about a Better Score?


TIMI plus ACS diagnostic score = ACSD score

Conclusions: “The ACSD score showed a good discrimination performance and an excellent negative predictive value which allows safely ruling out ACS in ED patients with undifferentiated chest pain. Our findings should be validated in a larger multicentre study.”

A Plethora of Individual Patient Risk Factors
And what about....????

- Obesity (20%)

- Smoking (36%)

- Lack of Physical Activity (7-12%)
• Job Stress (3%)

And Psychological Factors

“In summary, we found that collaborative care for depression delivered before the onset of CVD halved the excess risk of hard CVD events among depressed primary care patients aged > 60 years.

*Effect of Collaborative Care for Depression on Risk of Cardiovascular Events: Data from the IMPACT Randomized Controlled Trial*. Stewart JC, PhD, Perkins AJ, MS, Callahan CM, MD. Psychosom Med. 2014 Jan; 76(1): 29-37

Assess High Risk Criteria

In addition to Symptoms in Box1, if the patient has 4 or more of the following:

- Age greater than 55
- 3 or more of the following:
  - family history
  - hypertension
  - high cholesterol
  - diabetes
  - current smoker
- Aspirin use in the last 7 days
- > anginal events in the last 24 hours (including current one)
- Known Coronary Artery Disease
- ST segment deviation more than 0.5 mm (if available)
- Elevated Cardiac Markers (if available)
“We need an app for that…” NE, Australia or www.TIMI.org

AHA Recommendation
Clinical Assessment and Initial Evaluation
- Recommendation: Class 1, L.O.E. B

“Patients with suspected ACS should be risk stratified based on the likelihood of ACS and adverse outcomes to decide on the need for hospitalization and assist in the selection of treatment options.”

The Role of ECG in the Diagnosis of ACS
Augustus D. Waller of St. Mary’s Medical School, London and his dog Jimmy ~ 1887
Wilem Einthoven introduces the term “electrocardiogram” at the Dutch Medical Association.
~1893
Sensitivity and Specificity of the 12-lead ECG

Sensitivity Definition:
Relates to the test’s ability to identify positive results -- Or in other words the proportion of people that are known to have the disease that test positive.

ECG (13% - 69%)  

Specificity Definition:
The proportion of people that are known to not have the disease who will test negative for it.

ECG (94-97%)

The initial ECG is often NOT diagnostic in patients with ACS. In two series, the initial ECG was nondiagnostic in 45% and normal in 20% of patients subsequently shown to have an acute MI.

“The initial ECG is often NOT diagnostic in patients with ACS. The ECG should be repeated at 5 to 10 minute intervals if the initial study is not diagnostic but the patient remains symptomatic and high clinical suspicion for ACS persists.”

Serial ECGs

Compared with ST segment elevation on a single (prehospital) ECG, additional dynamic changes in ST elevation between serial ECGs improved the sensitivity from 34% to 46%.

Overall, compared with abnormal observations on a single (prehospital) ECG, consideration of serial evolution in ST segment elevation, T or Q wave abnormalities, and new LBBB, on the initial hospital ECG improved the diagnostic sensitivity for an acute coronary syndrome to 80%-87%. Specificity fell from 60% to 50%.


Determining Who needs an EKG

1. Any patient over 30 with chest pain
2. Any patient over 50 with any of the following: dyspnea, altered mental status, upper extremity pain, syncope, or weakness
3. Any patient over 80 with abdominal pain, nausea, or vomiting
The Two Major Categories of Electrocardiographic manifestations of Acute Myocardial Ischemia

1. ST elevation myocardial infarction (STEMI):
   New ST elevation at the J point in two anatomically contiguous leads using the following diagnostic thresholds: > 0.1 mV (1mm) in all leads other than V2-V3, where the following diagnostic thresholds apply: >0.2 mV (2mm) in men 40 years; >0.25 mV (2.5 mm) in men <40 years, or >0.15 mV (1.5 mm) in women.

Non ST elevation myocardial infarction or unstable angina (NSTEMI/UA)
New horizontal or down-sloping ST depression >0.05 mV (0.5 mm) in two anatomical wave or R/S ratio >1.

T-wave Inversion

70 year old women...ECG recorded just after a syncope
New LBBB

Additional lead EKGs; The more the Merrier!

One Study: When combined with clinical judgment, the 22-lead ECG could provide 97.6% sensitivity for AMI diagnosis while reducing unnecessary admissions for “rule-out MI” by 68%. Another Study: Sensitivity of admission of 12 lead was 33% 16 Lead: 37% 19 Lead: 45% 24 Lead: 49%
How about an 80 lead ECG?

“Incremental benefit of 80-lead electrocardiogram body surface mapping in the detection of acute coronary syndromes in patients without ST-elevation myocardial infarction: Results from the Optimal Cardiovascular Diagnostic Evaluation Enabling Faster Treatment of Myocardial Infarction (OCCULT MI) trial.”


Conclusions

Compared to the 12L ECG the sensitivity of the 80L ECG was significantly higher in detecting MI (19.4% vs. 10.4%) and ACS (12.3% vs. 7.1%). Specificities remained high for both tests.
Automated ECG programs were first developed in the 1970s and have improved with refinements of the algorithms used and digital technology.

Based on the use of the Tucson STEMI Database, the sensitivity of the Glasgow program for detecting STEMI was 89.4%.

1220 patients with possible ACS, 217 AMI of which 113 (52%) were classified by cardiologists as meeting the criteria for STEMI

- Gender criteria
- Age criteria
- Sgarbossa’s criteria

Glasgow 12-lead ECG Analysis Program

Acute MI Performance without confounding conditions present

- Acute MI, STEMI (193): 89% Sens., 100% Spec.

Acute MI, Performance including presence of confounding conditions:

- LBBB, RBBB, LVH w/Repol, RVH, BVH, LAFB, RAE,
  - Acute MI, STEMI: (358): 77% Sens., 99% Spec.
Marquette 12SL ECG analysis program; 2005

Total number of test ECGs: 1234

Method used to verify diagnosis: Cardiac enzymes and ST deviation

Acute Cardiac Ischemia Time-Insensitive Predictive Instrument (ACI-TIPI)

Elements: Age, Gender, Chest or Left arm pain and whether their symptoms were their primary complaint

AHA 2015 Recommendations

- “Because of high-false negative rates, we recommend that computer assisted ECG interpretation not be used as a sole means to diagnose STEMI.” (Class III; Harm, LOE B-NR)
- “We recommend that computer-assisted ECG interpretation may be used in conjunction with physician or trained provider interpretation to recognize STEMI.” (Class IIb, LOE C-LD)

How good are the Doctors at identifying a STEMI on the EKG?

Emergency Physicians:

- At the low end: 86%
- At the high end: 94.9

Interventional cardiologists: 2009 Study: Specificity 73-97% (avg. 85%) 2011 Study: Specificity 32 - 86% (avg. 66%)
The Bottom Line
It remains difficult for even experienced interventional cardiologists to determine by ECG alone if patients have a true STEMI.

AHA 2015 Update Recommendation:
Transmission of the prehospital ECG to the ED physician may improve PPV and therapeutic decision-making regarding adult patients with suspected STEMI, if transmission is not performed, it may be reasonable for trained non-physician ECG interpretation to be used as the basis for decision making, including activation of the cath lab, administration of fibrinolysis, and selection of destination hospital. (Class IIa, LOE B-NR)
Reasons to do it:

- ‘Hard copy’ in the hands of the receiving emergency physician or cardiologist may enhance the reality of the event for those who remain skeptical of EMS provider’s capabilities.
- It is a neat use of modern technology
- Someone else will get blamed if the patient does not turn out to have a heart attack.

Reasons not to do it

If the technology is unavailable to some EMS agencies, it fails, or the EKG is relied upon as the sole means of preparation to receive an ACS patient, there may be a tendency to ‘Stand Down’.

Point of Care Testing
Cardiac Markers
Definition of a heart attack (AMI):

Myocardial Infarction is determined by the specific cardiac troponin value (cTn) and at least one of the following diagnostic criteria:

- Symptoms of ischemia
- New (or presumably new) significant T/T wave change changes
- Development of pathological Q waves on the ECG
- Imaging evidence of new loss of viable myocardial tissue or regular wall motion abnormalities
- Identification of intracoronary thrombus by angiography or autopsy.

Biomarker Kinetic Release

The preferred biomarker overall and for each specific category of myocardial infarction is cardiac troponin (cTn) (I or T) which has a high myocardial tissue specificity as well as high clinical sensitivity. An increased cTn concentration is defined as a value exceeding the 99th percentile of a normal reference population (upper ref limit, URL)

- Sensitivity: 90.7%
- Specificity: 90.2%

Troponin I Assay in Early Diagnosis of Acute Myocardial Infarction. Circ 2012; 126:2020-2036
Causes of Noncoronary Cardiac Troponin Elevation

1. Pulmonary Embolus
2. Pericarditis/Myocarditis
3. Cardiac Contusion
4. LVH and Pulmonary Hypertension

Causes of Noncardiac Troponin Elevation*

- Renal Dysfunction
- Sepsis and Severe Systemic Inflammatory response
- Chronic and Acute Heart failure
- Severe Hypertension/Hypotension
- Severe Upper GI Bleeding
- Cardiotoxic chemotherapy

*Interestingly, elevation of Troponin has been associated with a poorer prognosis regardless of the cause.

• In a study of 991 troponin positive patients admitted to the ED at a university hospital, 83% of the troponin elevations were due to MI.

Heart-type fatty acid-binding protein (H-FABP)

Salivary Cardiac Marker Testing

Aborted Infarction: The Ultimate Myocardial Salvage

The Myocardial Infarction triage and Intervention Trial (MITI)

• "40% of the patients treated within 3 hours of symptom onset had no evidence of infarction as measured by thallium scanning at a median of 30 days after random assignment."

• "Minimal infarct sizes of <10% were noted in an additional 35% of patients."
**Shazam!!**

The authors concluded that “If patients can be identified and treated very early after symptom onset the infarction process can essentially be aborted.”

### Summary

We need to be better at the rapid identification of common time critical life threatening conditions that often present in a sneaky way.

We are fighting an epidemic of premature death and disability from heart disease!
There are high yield symptoms that strongly suggest ACS and there are other symptoms that make it less likely.

According to a recent report, in many emergency rooms it takes approximately 60 min for 25% of AMI patients to be examined.

4. Computer enhanced interpretation of the initial and repeat EKGs in combination with the providers training can improve the sensitivity of the test.
   - ‘Multiple Looks’ possibly combined with ‘Multiple Leads’ will further increase your chances of discovery of an ACS and expediting the patient to definitive care thereby saving more lives.
5. Risk profiling that is increasingly being used by doctors within the hospitals to make critical management decisions also should become part of the prehospital assessment of possible ACS patients.

6. Biomarker testing: an essential component of the early identification of ischemic injury to the heart must be brought to the ‘field’.

“The ambulance service has a critical role in the management of a STEMI, and should be considered not only a mode of transport but a place for initial diagnosis, triage, and treatment.”

European Heart Journal 2009 Dec;29(23):2919-2945
We Must Evolve our Emergency Cardiac Care Systems to Embrace ACS

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