AMERICAN COLLEGE OF EMERGENCY PHYSICIANS

SCIENTIFIC ASSEMBLY

1999

Pushing the Envelope on ECG Analysis: Innovative Uses for an Old Technology

In the first hours of myocardial ischemia and infarction, the ECG is frequently normal or nondiagnostic. Recent innovations in ECG interpretation hold promise for improving the early identification of cardiac ischemia. Although these adjuncts are on our doorstep and their enhanced sensitivity has been documented, they remain underused in most settings. The new methodologies to be reviewed are continuous ST-segment analysis, multilead ECG analysis, and heart rate variability analysis. Data will be presented suggesting how these adjuncts might be used to predict sudden death.

- Identify the basic principles of continuous ST-segment analysis, multi-lead ECG analysis, and heart rate variability analysis.
- Describe how these analytic methods improve diagnostic sensitivity.
- Give examples of patient encounters in which these techniques would prove useful.
- Explain how heart rate variability analysis may assist in identifying patients at risk for sudden death.

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FACULTY

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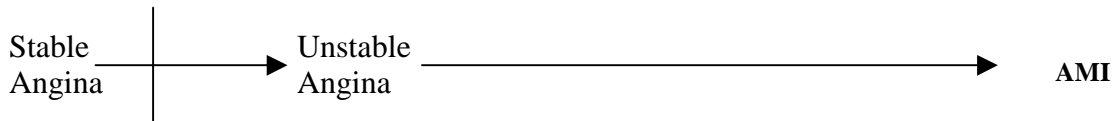
Pushing the Envelope on ECG Analysis

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Why do we care?

- 6 million chest pain visits/year
- 3 billion dollars spent on unnecessary admissions
- 20,000 people sent home inappropriately/year
- Miss rates for AMI average 1-7%

We're not here only to diagnose AMI!

ACUTE CORONARY SYNDROMES

Stable Angina → Unstable Angina → AMI

The Bottom Line

A good history, physical examination and 12-lead ECG are still your best friends.

History

- Atypical is typical, esp. in younger, women, older, and cocaine users
- < than a minute, > 48 hours continuous pain without ECG changes = CAD extremely unlikely
- Sharp **and** Pleuritic **and** No hx CAD = CAD extremely unlikely
- Risk factors are great, **if** present

The Most Important Question

Do you have heart disease?

Physical Examination

- Primarily to R/O other processes
- Look for mechanical complications of CAD (signs of CHF, holosystolic murmur)

LRs for AMI-clinical/ECG features

12-lead ECG

- Safe
- Quick
- Readily available
- Inexpensive
- Easy to perform
- Sensitivity as low as 41%
- Specificity as low as 23%
- Wide variability in ability to interpret

Bundle Branch Block

- Not your enemy
- Can read infarct through RBBB as well as LBBB
- LBBB + Chest Pain = 50% chance acute ischemic heart disease

12-lead ECG

- Having an old ECG is invaluable
- Having the ability to access old ECGs in a timely manner is therefore invaluable
- Fax machine!
- ED access to ECG computer records!

You often need other tests!

Which one is the question

Problem Patients

- Patient at intermed-high risk with normal ECG
- Low risk patient with nondiagnostic ECG
- Atypical CP with risk factors
- Premenopausal women

65 yo man with ongoing chest pain and ECG changes of acute inferior MI

- Should you use nitroglycerin?
- What is the Bezold-Jarisch reflex?
- Is there a way to predict this complication of AMI and to prognosticate?

15-lead or Right-sided leads

- Standard 12-lead ECG has esp. poor sensitivity for posterobasal wall and right ventricular infarction (RVI).
- 6% of AMI's isolated to posterobasal area
- 40% of inferior MI's have RVI physiology
- V4R Sensitivity 80-90%, Specificity 80%

Right Ventricular Infarct

- These are large infarcts
- Prone to hypotension
- Mortality approaches that of Anterior MI
- Indication for aggressively moving to open the RCA

15-lead ECG or 12-lead with right-sided leads

- Increase sensitivity and specificity for right ventricular infarct
- Avoid harmful effects of NTG use

15-lead ECG or Right-sided leads

- "Always" in an inferior MI
- Useful when the story is good but the EKG is not helping you

22-lead ECG

- Markedly improved sensitivity and specificity in Dx of AMI
- No good ED studies
- Significant new investment
- More complexity

Body-surface Mapping

- Up to 87 leads
- Increased sensitivity and specificity for AMI
- Complexity of interpretation outweighs any advantage in sensitivity and specificity

65 yo man with possible unstable angina

- Is there a way to see if this unstable coronary syndrome is progressing while you wait for enzymes?
- Can you confirm unstable angina and move to definitive care faster?

Continuous 12-lead ECG monitoring

- Continuous acquisition of 12-lead tracings at 20 sec intervals
- ST↑ ↓ of > .2 mv in 1 lead or .1 mv in 2 leads ⇒ potential alarm state
- 4 sequential ECGs meeting threshold criteria trigger alarm

Continuous 12-lead ECG Monitoring
- Programmable
- Retrievable data (saves sequential ECGs)
- Graphs of ST trends over time for 4 regional groupings

Continuous 12-lead ECG Monitoring

- Silent ischemia is common, particularly in high risk patients
- Ischemia may precede clinical symptoms
- Ischemic changes may signal progression of coronary artery occlusion
- Ischemia is dynamic and it's sometimes hard to get standard 12-lead ECG with pain
- May help predict patients at higher risk

Continuous 12-lead ECG Monitoring
- <u>Only</u> detects ST changes (not T$\downarrow$,Qs, or loss of R waves)
- In small studies 20-40% pickup rate in patients with <u>proven</u> CAD
- For all comers with CP, pickup rates much lower
- False + rate > true + rate (specificity < 50%)
- Serial CK MB may be as or more sensitive

Continuous 12-lead ECG Monitoring
- Data best in CCUs or Observation units where staffing is adequate
- Still requires physician overread
- Cost = $8,000/bed and $25,000 for central monitoring station

Continuous 12-lead ECG Monitoring
- In patients who can't exercise, this may be an alternative to consider in order to lower risk to acceptable levels.
- **If** you don't have access to other more sophisticated testing.

Continuous 3-lead ECG Monitoring

- Likely to be even less sensitive
- Cartridge costs $10,000
- Still might be useful in certain patients being observed over time

45 yo man with an episode of chest pain

- Now chest pain free. ECG normal
- Is he safe to send home without further testing?
- Is there a relatively cheap, relatively easy way to lower the odds of making a mistake?

ECG Exercise Stress Test

- Safe only in lower risk patients
- Relatively easy to perform
- Relatively inexpensive
- Good patient acceptance
- Accuracy lower (high false + rate)
- Interpretation more complex
- Have to be pain-free, able to walk, without ECG abnormalities

ECG Exercise Stress Testing

- With a pre-test probability of 10-20%:
- A positive test yields a post-test probability of 40-60%
- A negative test yields a post-test probability of 5-10%

ECG Exercise Stress Testing

- Don't send young premenopausal women with no risk factors
- Don't send people with pre-existing ECG changes (LVH, BBB, Dig effect, etc)
- Don't send people who are on B-blockers or CCB's
- Don't send morbidly obese or frail elderly

ECG Exercise Stress Testing

- Costs mainly in staffing and MD time for potentially relatively low volume
- Training of EM physicians in interpretation
- Takes time to perform

ECG Exercise Stress Testing

- Don't necessarily need to wait for enzymes
- Better to see the ischemia than to have it recur at home in an unmonitored situation.
- Cost < $1000 <u>if</u> not false positive

55 yo postmenopausal woman with Lupus and chest pain

- How many things could this be?
- Is there a bedside test which would help you not only to avoid making a big mistake but also in deciding which tests to pursue next?

Echocardiography

- Wall motion abnormalities occur very soon after myocardium becomes ischemic
- Requires experienced tech, 5 or 6 views and 10-15 minutes
- Interpretation is challenging, accuracy is dependent on the interpreter
- Sensitivity for AMI 86-88%, Specificity 78-82% with expert interpretation

Echocardiography

- State of the art machine costs $200,000
- Primary benefit may be to R/O other processes (pericardial effusion, massive PE)
- Occasionally might help with distinguishing benign from malignant ECG abnormalities

45 yo patient with chest pain

- You are worried about unstable angina
- Normal ECG and you want to be <u>sure</u> he doesn't have acute coronary syndrome

Thallium Scanning

- Can be done relatively quickly
- Decreased accuracy in setting of AMI/Unstable angina
- Have to use lower dose and less emission = poorer pictures

Sestamibi Scanning

- Tc-sestamibi uptake proportional to blood flow
- Sestamibi uptake requires cell membrane and mitochondrial integrity
- Magnitude of defects in uptake proportional to area of ischemia or infarct and persist for hours after restoration of blood flow

Sestamibi scanning

- Takes 5-20 minutes to prepare agent
- Availability of scanner and tech
- Patient must be stable enough to transport to Nuclear Medicine and spend 1-3 hours there

Sestamibi Scanning

- Resting sestamibi scan sensitivities 94-100%, specificities 83-92%
- Costs $500-800
- Primary use in larger centers with stable patients in low to moderate risk group
- Atypical pain + nonspecific ECG changes

Rest -mibi in ED CP pts

Heart Rate Variability

- Heart rate variability (HRV) is normal
- Sinus arrhythmia related to respiration
- Response to changes in BP
- Response to circulating catecholamines
- Depends on intact neurocardiac autonomic regulation

Heart Rate Variability
(HRV)

- In CHF and in AMI, HRV declines
- In CHF↓ HRV clearly associated with↑risk of sudden death
- In AMI this association not as clear

Heart Rate Variability
(HRV)

- Major use at present as a prognostic marker post-MI or in setting of chronic CHF
- Not much data about using HRV in ED either to diagnose AMI/ischemia or to prognosticate in short term (ie. Where to put the patient)

Top Ten Things to Do

- 10. Ask the right questions in your history
- 9. Have your cardiologist available to do echocardiography
- 8. Continuous ECG monitoring capability
- 7. Sestamibi scans
- 6. ECG exercise stress testing
- 5. Availability of rapid turn-around times for enzymes
- 4. 15-lead ECG's
- 3. ED computer link with ECG retrieval system
- 2. Fax machine
- 1. Get Good at reading conventional ECG's

Enzymes

- CK-MB has excellent specificity for acute MI, but doesn't tell you anything about unstable angina
- Sensitivity for AMI increase over time of serial assays and approaches 100% between 12 and 24 hours from infarction
- Single assay only helpful if "positive"

Enzymes

- Troponin is not much more sensitive acutely than CK-MB
- Occasionally "positive" in unstable angina
- Stays elevated longer, prognostic value
- Some cheaper assays have high false positive rate
- Use it selectively (remote chest pain or high risk unstable angina)

Electron Beam CT

F/byars/birdia/wrenn slides/pushing the envelope on ECG analysis (ms word)