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Observation Medicine 2013:
Science & Solutions

_Chest Pain:
Past, Present and Future_

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Disclosures

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Original Plan for This Talk

Past: Clinical Characteristics

Present: Biomarkers/Stress Testing

Future: New Imaging Modalities

Why Observation?

**Goal:** 0% miss rate

**Reality:** >0% miss rate
- Large numbers of patients presenting
- High prevalence of underlying disease
- Diversity of presentation/features
- Limitation of tools

PAST, PRESENT, AND FUTURE:
ED-based Observation Units have a role in the evaluation of chest pain and ACS.

Compared to inpatient admissions:
- More Efficient
- Safer
- Cheaper

Graff, et al., Am J Cardiol 1997; 80: 563-8

A Walk Through Time: Early Stage CPOUs

**EVALUATION:**
- Clinical Characteristics
- ECGs
- Telemetry
- Cardiac Enzymes
- Tincture of time?

?‘s:
- Clinical Characteristic Algorithms (Goldman), ECG-driven computer algorithms (ACI-TIPI), continuous 12 leads, 15 leads
A Walk Through Time: Early Stage CPOUs

- Benefits: Identify AMI and don’t send home.
- Benefits: Save CCU beds.
- Benefits: Identify who could follow up.

- Pitfalls: Misses CAD/ACS spectrum.
- Pitfalls: Takes Skill.
- Pitfalls: Some people don’t follow up.

A Walk Through Time: Biomarkers

- Benefits: Identify AMI.
- Benefits: Send some home w/o obs?
- Benefits: More sensitivity.

- Pitfalls: Still misses ACS spectrum?
- Pitfalls: Still Takes Some Skill.
- Pitfalls: Takes (too much?) Time.

A Walk Through Time: Biomarkers

- Benefits: Save CCU beds.
- Benefits: Identify who could follow up.

- Pitfalls: Misses CAD/ACS spectrum.
- Pitfalls: Takes Skill.
- Pitfalls: Some people don’t follow up.

Present: Stress Testing/Imaging

- Benefits: Move care upstream.
- Benefits: Save hospital inpatient beds.
- Benefits: Rule out “omni-badness”.

- Pitfalls: Overtesting?
- Pitfalls: Radiation.
- Pitfalls: Crowded ED’s.
- Pitfalls: DOoming to PCI?

Present: Stress Testing

- Benefits: Move care upstream.
- Benefits: Save hospital inpatient beds.
- Benefits: Rule out “omni-badness”.

- Pitfalls: Overtesting?
- Pitfalls: Radiation.
- Pitfalls: Crowded ED’s.
- Pitfalls: DOoming to PCI?

Clinical Characteristics and Decision Rules: Past, Present, and Future

- Back to the Future?
### Decision Rules: Your Gut

![Diagram of Decision Rules: Your Gut](image)

- **15,698 P-lACS Patients**
- **10,713 Met Criteria**
- **10,145 Data Set**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Outcome (90%)</th>
<th>Outcome (20%)</th>
<th>Outcome (10%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA</td>
<td>90%</td>
<td>3%</td>
<td>7%</td>
</tr>
<tr>
<td>High Risk</td>
<td>2383 (23.5%)</td>
<td>232 (2.3%)</td>
<td>74 (0.7%)</td>
</tr>
<tr>
<td>Low Risk</td>
<td>4687 (44.2%)</td>
<td>114 (1.1%)</td>
<td>27 (0.3%)</td>
</tr>
<tr>
<td>Non-Ext.</td>
<td>2414 (22.9%)</td>
<td>109 (1.0%)</td>
<td>11 (0.1%)</td>
</tr>
</tbody>
</table>

### The 80’s: Goldman Score

![Diagram of Goldman Score](image)


### TIMI

![Diagram of TIMI Risk Score](image)

Table 1: TIMI Risk Score

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 65</td>
<td>+1</td>
</tr>
<tr>
<td>Prior coronary artery disease</td>
<td>+1</td>
</tr>
<tr>
<td>Prior coronary artery disease</td>
<td>+1</td>
</tr>
<tr>
<td>Prior angioplasty or stent</td>
<td>+1</td>
</tr>
<tr>
<td>Prior bypass (CABG)</td>
<td>+1</td>
</tr>
<tr>
<td>Documented prior myocardial infarction</td>
<td>+1</td>
</tr>
<tr>
<td>Two or more conventional cardiac risk factors</td>
<td>+1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>+1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>+1</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>+1</td>
</tr>
<tr>
<td>Family history CAD/MI</td>
<td>+1</td>
</tr>
<tr>
<td>History of tobacco use</td>
<td>+1</td>
</tr>
<tr>
<td>Use of aspirin in the preceding 7 days</td>
<td>+1</td>
</tr>
<tr>
<td>2 or more anginal events in the past 24 hours</td>
<td>+1</td>
</tr>
</tbody>
</table>

### North American:

![Diagram of North American Chest Pain Rules](image)

A patient with chest pain and possible acute coronary syndrome can be safely discharged from the ED without additional diagnostic testing if NONE of the following four criteria are met:

1. New ischemia on initial ECG
2. History of coronary artery disease
3. Pain is typical for acute coronary syndrome
4. Initial cardiac troponin is positive

### Vancouver: rapid ED r/o

![Diagram of Vancouver rapid ED r/o](image)

- **Normal initial ECG and no prior history of ischemic chest pain**
  - **Age > 40**
  - **Low risk Pain Characteristics**
    - Initial CK-MB < 3.0 μg/mL
    - No change in ECG or rise in CK-MB or Tn from 0 to 2 hours after arrival
  - Suitable for Early Discharge

### Clinical Characteristics and Decision Rules: Past, Present, and Future

Although a predominant feature of protocols of the PAST

Still have a role in patient selection in the PRESENT

In the FUTURE, will further refine who should be placed in observation.
Cardiac Biomarkers: Past, Present, and Future

"The Value of Nothing"
-W. Frank Peacock

Cardiac Biomarkers
- Non-invasive
- Repeatable
- Quantitative/Reproducible
- Relatively inexpensive
- Widely available 24/7
- Don’t require specialized personnel or technology

A Markers-only Approach
- Those at low risk for CAD
- Those with reliable outpatient follow-up
- Previously risk-stratified patients

High Sensitivity Troponins

The Promise: Detect More AMIs:
hsTnT >14 pg/mL
- Sensitivity 96%
- NPV 80%
hsTnT by 2 h
- Sensitivity 95.1%
- NPV 98.3%
hsTnT max >3 ng/L
- Sensitivity 92%
- NPV 97%

The Promise: A Sampling

<table>
<thead>
<tr>
<th>Troponin Assays</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott–Architect</td>
<td>0.96</td>
</tr>
<tr>
<td>Roche High-Sensitive TnT</td>
<td>0.96</td>
</tr>
<tr>
<td>Roche Troponin I</td>
<td>0.95</td>
</tr>
<tr>
<td>Siemens</td>
<td>0.96</td>
</tr>
<tr>
<td>STANDARD</td>
<td>0.90</td>
</tr>
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</table>
The Problem: “Low Specificity”

One-hour rule-out and rule-in of acute myocardial infarction using high-sensitivity cardiac troponin

- N=436
  - Rule out: 60%
    - 100% sensitivity and NPV
  - Rule in: 17%
    - specificity 97% PPV 84%
  - “Observational zone” 23%
    - AMI of 8%
    - 30-day survival was 98.6%


Cardiac Biomarkers: Past, Present, and Future

A core element of protocols of the PAST.

Still plays a key role for selection and evaluation in the PRESENT.

May obviate the need for obs in more patients in the FUTURE, and maybe replace stress testing?

Stress Testing: Past, Present, and Future

“Permission slip to discharge”?

Judd Hollander, MD

- Doesn’t reduce repeat visits, hard outcomes
- “Obs Creep”
- Resources, Staff

Stress Testing

Stressors
- Exercise
- Dobutamine
- Adenosine/analogs

Assessment
- ECG
- Echo
- Myocardial Perfusion Imaging (radionuclide)
  - PET
  - cMRI
Exercise

**Advantages**
- Prognostic indicators (duration of exercise, HR and BP response, ectopy)
- Reproduction of symptoms

**Disadvantages**
- Exercise capability
- Target Heart Rate?
- Motivation-dependent
- Equipment

Adenosine/Regadenoson/Dipyridamole

**Advantages**
- Very short half life (5sec-2min)
- Stenosis, dissection
- Not affected by B-blockers

**Disadvantages**
- Blocked by caffeine and theophylline
- Expensive
- Small % don’t vasodilate - no objective confirmation
- Bronchospasm, heart

Dobutamine

**Advantages**
- Titratable, verifiable
- Generally done with Echo

**Disadvantages**
- IV access
- HTN
- Arrhythmias - Staffing, Tele
- Aortic stenosis

Stress ECG

**Advantages**
- Widely available
- Inexpensive
- Accuracy tested in broad population

**Disadvantages**
- Reduced sensitivity and specificity
- Requires good baseline ECG for optimal interpretation
- Does not localize area of ischemia

Stress Echocardiography

**Advantages**
- Portable, quick
- Good specificity
- Can localize area of ischemia
- Can assess valves, EF, wall thickness, chamber size

**Disadvantages**
- Interpretation reproducibility
- Baseline wall motion abnl difficult
- Poor windows

**Advantages**
- Reproducible results
- High sensitivity
- Can assess ventricular size, EF
- Good for localization and extent of ischemia
- Can assess viability

**Disadvantages**
- Expensive
- Labor/time intensive
- Radiation
- Artifacts (breast, diaphragm, bowel, LBBB)
- Balanced ischemia
- Cannot assess valves

MPI
Dobutamine Echo for CAD by # Vessels

JACC 1997:30:595

Stress Testing:
Past, Present, and Future

Although validated in the relatively recent PAST

It is the cornerstone of our evaluation in the PRESENT.

It will play an important role in the foreseeable FUTURE, until new technology displaces it.

CTCA: Normal Coronaries =D/c

- Multiple Studies: Litt, Hollander, ROMICAT etc.
  - Sens = 88-100%
  - Spec = 85-100%
  - PPV = 93-100%
  - NPV = 93-100%
- Cost Effective option Khare, et al.
- IN THE RIGHT PATIENT

SPECT

- Sensitivity 88%, Specificity 77%
- Higher sensitivity for single vessel, LM
- Better if underlying wall motion abnl.

"The End of the Beginning": CTCA
CARDIAC MRI

- Advantages
  - Very high sensitivity
  - Can differentiate ischemia, infarction, infiltrative process
  - Can assess subendocardial ischemia, function, valves, EF, viability, and aorta

- Disadvantages
  - Claustrophobia
  - Labor intensive
  - Not well validated
  - Can not do very unstable patients
  - No ICD’s/Pacers
  - Cost?


MRI SCORECARD

<table>
<thead>
<tr>
<th>Study</th>
<th>Sensitivity</th>
<th>Specificity</th>
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<tbody>
<tr>
<td>1</td>
<td>88</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>93</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>91</td>
<td>62</td>
</tr>
<tr>
<td>4</td>
<td>93</td>
<td>75</td>
</tr>
<tr>
<td>Pooled Avg</td>
<td>91</td>
<td>76</td>
</tr>
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Imaging: Past, Present, and Future

CT and MRI for other organ systems is an established indication from the PAST.

CT and MRI for cardiac evaluation is entering the PRESENT.

They will likely play a greater role in the FUTURE.

Putting It All Together

- Serial Biomarkers: Everyone
  - When needed, stress test
- If possible, exercise
- ECG: good prognostic info, nl baseline ECG
- Echo: best for 3 v dz, no radiation
- SPECT: best for single vessel, better prognostic evidence
- CTCA or cMRI: Stenosis, Dissection, equivocal tests, baseline abnls

Where Are We Going? Trends

More Skill -> Less Skill
Upstream Care
Working Up Lower-Risk Patients
Better (more) Technology
Catch the Very-Low Risk AMI?
Beyond ACS?

- Atrial Fibrillation
- HTN
- Pulmonary Embolism
  - Low-Risk Cohort
    - Similar to DVT protocols
  - Oral Thrombin Inhibitors

- Total Metabolic Screening
  - Lipids
  - HgbA1C
  - Risk Factor Modification

Biomarker-only Risk Stratification?

PREDICT: Gene Expression Score from Blood Draw

- N=1,160 stable outliers referred for cath
- 6 gene expression terms containing 23 genes + clinical characteristics
- Every 10 point increase = 2x odds of CAD
  - Outperformed MPI and Diamond Forrester classification
- Predicted clinical outcomes (MACE)

Shared Decision-making

- RCT of Decision aid vs usual care 204 pts
- PATIENTS chose obs less frequently (58% vs 77%)
- No major adverse cardiac events after discharge

