The Role of Myocardial Perfusion Imaging in Acute Chest Pain

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Magnitude of the Problem
Need for Effective Methods of Evaluation of CP Pts in the ED

• Suggested solution: “fast track” CP protocols based on:
  – Clinical evaluation(RS)/Biomarkers/ETT/Imaging
  – Imaging: MPI, CS, CTA, SE, CMR

• Parameters for evaluation of MPI in comparison to other protocols:
  – Diagnostic performance
  – Safety
  – Efficiency
  – Cost
MPI – Overview

- Protocols:
  - Rst only, Str/Rst, Rst/Str, Str only
- The preferable tracer is Technetium
- The diagnostic and prognostic performance of MPI in acute CP setup is well established
- Sensitivity > Specificity, excellent NPV
Clinical Effectiveness – Early Data

- MI
- Revasc
- MI/Revasc
- MI/Sig

Abnormal: 0.6, 3.9, 4.4, 6.4
Normal: 15, 31, 42, 53

Kontos JACC 1997;30:976
Clinical Effectiveness – Recent Data

n = 1576

Nabi, JNC 2012;233-243
Clinical Effectiveness
Only One Multicenter Randomized Study - the ERASE Trial

Udelson, JAMA 2002
Comparison with Other Modalities

- ETT
- SE
- CTA
Comparison with Other Modalities

**ETT**

- **Safety:** ...Furthermore, despite the disparity in sensitivity for detection of CAD, the negative predictive values for ACS of ETT and the stress imaging methods, on which discharge from the CPU depends, are comparable. *ACC/AHA guidelines 2010*

- **Efficiency (versatility):** MPI > ETT

- **Cost:** ETT > MPI
Diagnostic Performance - Comparison with Other Modalities

Stress Echo/CTA

CAD, n=21

MACE n=10

Imaging strategies for acute CP in the ED, Dedic, AJR 2013
Efficiency and Cost - Comparison with CTA

Table 2 Early and Late Clinical Events

<table>
<thead>
<tr>
<th>Event</th>
<th>CCTA Group (n = 361)</th>
<th>MPI Group (n = 338)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early (index visit)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index visit ICA</td>
<td>24 (6.7%)</td>
<td>21 (6.2%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Index visit PCI</td>
<td>9 (2.5%)</td>
<td>8 (2.4%)</td>
<td>0.90</td>
</tr>
<tr>
<td>Index visit CABG</td>
<td>4 (1.1%)</td>
<td>0 (0%)</td>
<td>0.12</td>
</tr>
<tr>
<td>MI</td>
<td>1 (0.3%)</td>
<td>5 (1.5%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Other unstable angina</td>
<td>3 (0.8%)</td>
<td>3 (0.9%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Death</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>NA</td>
</tr>
<tr>
<td>Radiation, median, mSv</td>
<td>11.5 (6.8–16.8)</td>
<td>12.8 (11.6–13.9)</td>
<td>0.02</td>
</tr>
<tr>
<td>Scanner availability, h</td>
<td>7.1 ± 2.3</td>
<td>8.4 ± 3.2</td>
<td>0.065</td>
</tr>
<tr>
<td>Late (6-month follow-up)</td>
<td>n = 330</td>
<td>n = 297</td>
<td></td>
</tr>
<tr>
<td>Late ICA</td>
<td>2 (0.6%)</td>
<td>1 (0.3%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Late PCI</td>
<td>1 (0.3%)</td>
<td>0 (0%)</td>
<td>NA</td>
</tr>
<tr>
<td>Late CABG</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Late other unstable angina</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Late MI</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Late death</td>
<td>0/361</td>
<td>0/337</td>
<td>NA</td>
</tr>
<tr>
<td>Repeat ED (cardiac)</td>
<td>2 (0.6%)</td>
<td>4 (1.3%)</td>
<td>0.43</td>
</tr>
<tr>
<td>Repeat hospitalization (cardiac)</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Cumulative events</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>26 (8.0%)</td>
<td>22 (7.4%)</td>
<td>0.78</td>
</tr>
<tr>
<td>PCI</td>
<td>10 (3.1%)</td>
<td>8 (2.7%)</td>
<td>0.78</td>
</tr>
<tr>
<td>CABG</td>
<td>4 (1.2%)</td>
<td>0 (0%)</td>
<td>0.13</td>
</tr>
<tr>
<td>MI</td>
<td>1 (0.3%)</td>
<td>5 (1.7%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Additional unstable angina</td>
<td>3</td>
<td>3 (1.0%)</td>
<td>1.00</td>
</tr>
<tr>
<td>All events</td>
<td>17 (5.2%)</td>
<td>12 (3.7%)</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The CT-STAT (Coronary Computed Tomographic Angiography for Systematic Triage of Acute Chest Pain Patients to Treatment) Trial

James A. Goldstein, MD,* Kavitha M. Chinnaian, MD,* Aiden Abidov, MD, PriD,† Stephan Achenbach, MD,‡ Daniel S. Berman, MD,§ Sean W. Hayes, MD,§ Udo Hoffmann, MD,|| John R. Lesser, MD,¶ Isam A. Mikati, MD,# Brian J. O’Neil, MD,&& Leslee J. Shaw, PriD,¶ Michael Y. H. Shen, MD,¶ Uma S. Valeti, MBBS,§§ Gilbert L. Raff, MD,* for the CT-STAT Investigators
Efficiency and Cost - Comparison with CTA

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>CCTA Group (n = 361)</th>
<th>MPI Group (n = 338)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to diagnosis, h</td>
<td>2.9 (2.1–4.0)</td>
<td>6.2 (4.2–19.0)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Total ED costs, $</td>
<td>2,137 (1,660–3,077)</td>
<td>3,458 (2,900–4,297)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MACE in patients with normal index test</td>
<td>2/268 (0.8%)</td>
<td>1/266 (0.4%)</td>
<td>0.29</td>
</tr>
</tbody>
</table>
Efficiency and Cost - Comparison with CTA /ETT/SE

...In these models of a patient group at low risk of CAD and prevalence 2% to 30%, **CTA with confirmatory SPECT** was cost saving (lower costs, higher QALYs) compared with a CTA-only strategy, stress ECG, Echo, and SPECT.
Guidelines – NICE 2010

Assessment In
- Resting 12-leads
- Blood samples on arrival
- Physical exam
- Clinical history and confirmed lead ECG

Resting 12-leads consistent with
NC

Resting 12-leads suggestive of unstable angina
NO

Increase sub resting 12-leads
Do not exclude
Consider folk very likely
If diagnosis is:
- Continue
- Consider previous 1 leads. Use be done. I
- Repeat in symptoms
- Consider conditions
- If diagnosis NSTEMI

ETT/IMAGING

- Troponin (with upper reference limit with at least one of the following ST-T changes)
- Unstable angina and EMI (or local protocols for STEMI)

* NICE clinical guideline 94
Guidelines – ESC 2011

1. Clinical Evaluation
   - STEMI → reperfusion
   - Evaluation
     - Quality of chest pain
     - Symptom-orientated physical examination
     - Short history for the likelihood of CAD
     - Electrocardiogram (ST elevation?)
   - ACS possible
   - No CAD

2. Diagnosis/Risk Assessment
   - ACS possible
   - Validation
     - Response to antianginal treatment
     - Biochemistry/troponin
     - ECG
     - Echocardiogram
     - Calculated risk score (GRACE)
     - Risk criteria (Table 9)
     - Optional: CT, MRI, scintigraphy
   - <24 h

3. Coronary angiography
   - urgent <120 min
   - <72 h
   - no/elective

ETT = IMAGING
G1: ...the patient may be considered for an early stress test to provoke ischemia or CCTA to assess for obstructive CAD.
Patients who are incapable of exercise or who have an uninterpretable baseline ECG should be considered for pharmacological stress testing with either MPI, echo, or CMR.

Alternatively, it is reasonable to perform a non-invasive coronary imaging test (i.e., CCTA).

An imaging-enhanced test also may be more predictive in women than conventional ECG exercise stress testing.
The Limited Role of MPI in Acute Chest Pain

- MPI can contribute to cost saving and enhanced throughput
- There is clinical effectiveness of MPI but it is limited to:
  - ETT
  - Following CCTA
  - Known CAD
The Future
Solid State SPECT Systems

DigiRad:
Cardius 3 XPO

CardiArc

Spectrum Dynamics: D-SPECT

GE: Discovery 530c
Potential Protocols

- Shorter acquisition time
- Patient’s friendly
- Dynamic SPECT
- Simultaneous Dual isotope studies
- Potential advantage in diagnostic performance
- Regadenoson

**Effective Dose and Organ Weighted Equivalent Doses of High-Efficiency MPI Protocols**

- TL/Tc
- Tc/Tc
- TL
- Tc/Tc
- Tc

- 11.9 mSv*
- 11.3 mSv*
- 9.7 mSv*
- ~3 mSv**
- <1.0 mSv**

**Ultra Low Dose**

Courtesy Spectrum Dynamics
BMIPP
Metabolic Concept

• BMIPP is a long chained straight fatty acid
BMIPP
Metabolic Concept

Cellular Energy Sources

- Normal
- Ischemia

- Fatty Acids
- Glucose

- Glucose
- Fatty Acids
BMIPP
Ischemic Memory

• FA metabolism ↓ → BMIPP↓

• Perfusion defects appear even though the images are obtained at rest and even if there is no longer active on-going ischemia.

• This ‘memory’ function makes it feasible to detect ischemia long after the episode has subsided.
Iodofiltic Acid I 123 (BMIPP) Fatty Acid Imaging
Improves Initial Diagnosis in Emergency Department
Patients With Suspected Acute Coronary Syndromes
A Multicenter Trial

Table 3

Performance Characteristics for the Initial Clinical Diagnosis Alone, Results With BMIPP Alone, and the Combination of the Initial Clinical Diagnosis and BMIPP SPECT Imaging (Patients With Majority Read for BMIPP SPECT) (n = 416)

<table>
<thead>
<tr>
<th>Diagnostic Mode</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>NPV</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS Positive (n = 188), Negative (n = 298) (Negative ACS and ACS Intermediate Likelihood)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>InDx</td>
<td>42.9 (35.0–50.9)</td>
<td>60.9 (54.7–67.1)</td>
<td>62.3 (56.1–68.6)</td>
<td>41.4 (33.7–49.1)</td>
</tr>
<tr>
<td>BMIPP alone</td>
<td>73.0* (65.9–80.1)</td>
<td>63.2 (57.1–69.4)</td>
<td>78.4* (72.5–84.3)</td>
<td>56.1† (49.2–63.0)</td>
</tr>
<tr>
<td>InDx + BMIPP</td>
<td>81.0* (74.7–87.3)</td>
<td>61.7 (55.5–67.8)</td>
<td>83.4* (77.8–89.0)</td>
<td>57.6* (51.0–64.3)</td>
</tr>
</tbody>
</table>
BMIPP
Implications

- ED

- ETT vs. ETT + Imaging

Achieving an Exercise Workload of $\geq 10$ Metabolic Equivalents Predicts a Very Low Risk of Inducible Ischemia

Does Myocardial Perfusion Imaging Have a Role?

Jamieson M. Bourque, MD, MHS, Benjamin H. Holland, MD, Denny D. Watson, PhD,
George A. Beller, MD

Charlottesville, Virginia
Single Resting hsTnT Level Predicts Abnormal Myocardial Stress Test in Acute Chest Pain Patients With Normal Initial Standard Troponin

Waleed Ahmed, MD,* Christopher L. Schlett, MD, MPH,* Shanmugam Uthamalingam, MD,* Quynh A. Truong, MD, MPH,*† Wolfgang Koenig, MD,‡ Ian S. Rogers, MD, MPH,* Ron Blankstein, MD,* John T. Nagurney, MD, MPH,§ Ahmed Tawakol, MD,* James L. Januzzi, MD,† Udo Hoffmann, MD, MPH*†

Boston, Massachusetts; and Ulm, Germany
ROMICAT pts
CTA/MPI
n=138
Thank you