Imaging Acute Chest Pain in the E.D.

A/Prof. NATHAN BETTER
Cardiologist and Deputy Director of Nuclear Medicine
Royal Melbourne Hospital
University of Melbourne
December 2012
Ms J.R. 33yo

Presented to the E.D. with 2/7 RUQ abdominal pain.

Provisional Dx = acute cholecystitis

Awaiting surgery – intermittent central chest pain. 15 minute episodes at rest

R.F. – Smoker. Strong FH.
- ECG with and without pain - normal
- CK, CKMB and TnI - normal at 9/24
- Tc 99m sestamibi with pain
  - “HOT MIBI”
PROTOCOL

- Approx 800 MBq IV Tc 99m sestamibi
- Inject ASAP – Tracer available during working hours
- Inject with pain present
- Imaging when convenient, < 6 hours.
- SPECT – Prone ± Supine
- Gating routine
RAO
Diagnosis

- Non-ischaemic chest pain, ? Muscular
- Gall bladder surgery deferred
- Successful transfer to the Psychiatry Unit
Mr K.H. 63 yo

- Risk factors – Obese, Chol 6.6, HT, Smoker
- Presented with atypical pain and SOB
- Examination – Well. 150/70. Otherwise normal.
- ECG – Normal
- CK/CKMB/TnI - Normal
LAO
Management

- Coronary angiography
- Triple vessel disease
- Cardiac Surgery
BACKGROUND

45 patients. No prior MI.
MIBI (SPECT) v. ECG.

Gold standard = Coronary angiography.
Tc-99m sestamibi in acute chest pain

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIBI with pain</td>
<td>96 %</td>
<td>79 %</td>
</tr>
<tr>
<td>ECG with pain</td>
<td>35 %</td>
<td>74 %</td>
</tr>
<tr>
<td>MIBI painfree</td>
<td>65 %</td>
<td>84 %</td>
</tr>
<tr>
<td>ECG painfree</td>
<td>36 %</td>
<td>74 %</td>
</tr>
</tbody>
</table>

Acute MIBI & non-diagnostic ECG.

Varetto et al...JACC 12/93

64 pts. Clinical criteria for admission
Abnormal scan = 30
  13 developed MI
  14 documented CAD
  3 false positive

CER at 18/12 = 6/30 (1 death, 5 revasc)
Acute MIBI & non-diagnostic ECG.

Varetto et al…JACC 12/93

Normal scan = 34

0 – CAD diagnosed

CER at 18/12 = 0 / 34.
Probability of death within 30 days vs. Troponin T (ng/ml)
Tnl v. Acute MIBI

620 pts. Low to moderate risk.
MIBI at presentation.
Serial Tnl over 8 hours

<1 ng/ml, 1-2 ng/ml, >2ng/ml

59 had MI, 81 had significant CAD (6/52).
Revascularisation within 6/52.
Summary -

- MIBI better to predict revascularisation, but less specific.
- Only 1 patient missed on both MIBI & TnI
- 5pts abnormal MIBI only
- 4 pts abnormal TnI only
- The two tests offer complimentary information.
Sensitivity of acute MPI to identify MI.

Kontos et al. JNC 1/2004

Gold standard = elevated TnI
N = 319
78/319 had a negative MPI (sens 75%)
Lower peak CKMB 15 + 25 v. 45 + 78 ng/ml
  \[ p < .0001 \]
Higher LVEF 56%±15% v. 47±13%
  \[ p < .0001 \]
Less likely to have significant disease 55% v. 72%
  \[ p = .04 \]

Hence - tests are complimentary
Alternative Spelling

- cestamibi
- sister mibi
- ces termeebi
- cyst amoeba
What about Cost??
EMPIRE study

396 patients retrospectively

<table>
<thead>
<tr>
<th>Strategies</th>
<th>Cost (Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Pts</td>
</tr>
<tr>
<td>Ex ECG → Cath</td>
<td>490</td>
</tr>
<tr>
<td>Ex ECG → MPI → Cath</td>
<td>409</td>
</tr>
<tr>
<td>MPI → Cath</td>
<td>460</td>
</tr>
<tr>
<td>Cath</td>
<td>1253</td>
</tr>
</tbody>
</table>

Conclusion - Cheapest strategies include MPI
Economic analysis of an aggressive diagnostic strategy of SPECT and early exercise testing

S. Stowers et al... Ann Em Med 1/00

46 patients. 9 had an MI.
Acute Tc 99m tetrofosmin
Positive SPECT $\rightarrow$ Cath
Negative SPECT $\rightarrow$ Exercise test
v. Conventional treatment

CONCLUSION
US$ 1843 saved /pt
Decreased hospital LOS by 2 days
Other Issues

It is cost effective if done in hours
C. Rowe et al SNM 6/04

Different agents
Similar results with Tc 99m tetrofosmin
G. Heller 1997

First work – 1979. F. Wackers
Rest thallium – not practical
The Impact of Tc 99m sestamibi imaging with acute chest pain on clinical management.

J. Knott, A. Baldey, P. Cameron, L. Grigg, and N. Better.

Depts. Nuclear Medicine, Emergency Medicine and Cardiology
Royal Melbourne Hospital.
AIM

To assess whether the increased sensitivity and specificity of Tc99m sestamibi myocardial scintigraphy during acute chest pain translates into alteration in clinical management and potential cost saving.
# RESULTS

## PRIOR TO SCAN

<table>
<thead>
<tr>
<th></th>
<th>Discharge</th>
<th>Ward</th>
<th>CCU</th>
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<tbody>
<tr>
<td>Discharge</td>
<td>19</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>Ward</td>
<td>5</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>CCU</td>
<td>2</td>
<td>15</td>
<td>13</td>
</tr>
</tbody>
</table>

## POST SCAN
SUMMARY

- 39% reduction in total admissions.
- 32/63 ward admissions were sent home.
- Of 31 CCU admissions, 6 discharged and 12 were managed on the ward.
- Conversely, 17 patients had admission “upgraded” to CCU.
- Angiography averted in 67% of our population
Hot MIBI outcome

Zhou et al, Wellington, 4/04 and Beijing 10/04.

N = 367

12 month follow-up

CER -

Normal 2/206

Ischaemia 17/121

Infarct 3/35

Equivocal 0/5

History of prior MI does not preclude utility, but pt more likely to need a “cold” mibi.
Royal Melbourne results – early experience.
Roysri et al ASNC Montreal 9/06

n = 123
Acute MPI – ischaemia = 35/123
Elevated TnI > 0.4 = 40/123
Outcome follow-up 1 year
Cardiac death/MI (8), revascularisation (14)
Comparison of result of test and cardiac outcome

Roysri et al ASNC 9/06

p < .05
MPI and suspected acute ischaemia: a randomised control trial. Udelson et al…JAMA12/02

2475 pts in 7 centres
Suggestive symptoms + normal/non-diagnostic ECG
Usual care in E.D. Randomised to acute MIBI
Endpoint = “appropriateness” of triage decision

<table>
<thead>
<tr>
<th>FINAL Dx</th>
<th>n</th>
<th>HOSPITALISED</th>
<th></th>
<th></th>
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</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Usual care</td>
<td>Usual + MIBI</td>
<td>CI</td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>56</td>
<td>97 %</td>
<td>96 %</td>
<td>0.89-1.12</td>
<td></td>
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<tr>
<td>Unstable angina</td>
<td>273</td>
<td>83 %</td>
<td>81 %</td>
<td>0.87-1.10</td>
<td></td>
</tr>
<tr>
<td>Non-cardiac</td>
<td>2146</td>
<td>52 %</td>
<td>42 %</td>
<td>0.77-0.92</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION – Inappropriate admissions safely reduced (63% v. 54 % for diabetics.. Kapetanooulos et al JNC 10/04)
Acute chest pain (rest perfusion imaging) Indication

7. Intermediate pre-test probability CAD
   ECG – No ST elevation AND initial enzymes negative
   Median score 9.0/9.0
   Level A (appropriate test)

8. High pre-test probability CAD
   ECG – ST elevation
   Median score 1.0/9.0
   Level I (inappropriate test)
Performance of rest myocardial perfusion imaging in the management of acute chest pain in the emergency room in developing nations (PREMIER trial)

Nathan Better MBBS, Ganesan Karthikeyan MD, DM, MSc, João Vitola MD, PhD, Arzoo Fatima MD, Amalia Peix MD, Maja Dolenc Novak MD, Jose Soares Jr MD, Vu Dien Bien MD, PhD, Pilar Orellana Briones MD, Mboyo Vangu MD, Nischal Soni MD, Anna Nguyen NMT, Maurizio Dondi MD

Published on-line JNC October 2012
Performance of Rest Myocardial Perfusion Imaging in Emergency Rooms in Developing Nations (PREMIER trial)

Final results

Presented

CSANZ – Brisbane 8/12
ASNC – Baltimore 9/12
Background / Aims

ER visits for chest pain often result in inappropriate admissions. Assessment – clinical, Tn, echo, CT, stress testing + imaging
Acute rest MPI – high sensitivity and low CER if study is normal.
17 million people die/yr due to CVD, 80 % of which are in low to middle income countries.

**AIM** – To evaluate in the developing world, whether acute MPI, if normal, can predict absence of hard cardiac events and potentially reduce hospital admissions
METHODS

10 centres in 8 countries. n = 356.
Low – intermediate probability of ACS
Pain present (83) or within 6 hours (273)
Normal or non-diagnostic ECG.
Exclude – known CAD or high Tn.
IV 15-30 mCi Tc-99m tracer. Standard imaging within 3 hours, with gating and quantitation.
HCE - cardiac death, non fatal MI, ACS admission and revascularization at 30 days.
Normalcy rate / Country

% Normal

%
### Event Composite primary outcome, n (%)
52 (14.6)

### Death, n
0

### Non-fatal MI, n (%)
10 (2.8)

### Recurrent angina, n (%)
33 (9.3)

### Coronary revascularization, n (%)
22 (6.2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted OR (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal rest MPI</td>
<td><strong>8.19 (4.10 - 16.40)</strong></td>
<td><strong>0.0001</strong></td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>1.03 (0.99 - 1.05)</td>
<td>0.08</td>
</tr>
<tr>
<td>Male gender</td>
<td>1.34 (0.64 - 2.81)</td>
<td>0.44</td>
</tr>
<tr>
<td>BMI</td>
<td>1.03 (0.96 - 1.11)</td>
<td>0.37</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.49 (0.60 - 3.69)</td>
<td>0.39</td>
</tr>
<tr>
<td>LVEF &lt;50%</td>
<td>1.47 (0.42 - 5.18)</td>
<td>0.55</td>
</tr>
</tbody>
</table>

**PREDICTING EVENTS**

NPV 92.3 % increasing to 99.3 % for death / MI

Injecting with pain

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted OR (95% CI)</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td>Injection during chest pain</td>
<td><strong>17.35 (5.55-54.34)</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Injection after pain cessation</td>
<td><strong>6.39 (2.99-13.65)</strong></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Age 53 ± 13 years
43% women.
BMI 27 ± 5
LVEF = 66.5 ± 11 %.
69/356 were abnormal.
Conclusion

Rest MPI for patients with low-intermediate probability of ACS can be implemented in developing nations. A normal study is associated with a high NPV, especially to predict death or MI. Admissions can be potentially reduced.

Further studies are necessary to demonstrate cost-benefit of this ER strategy in developing countries.
Conclusion: Patients presenting with acute chest pain and a low-to-intermediate likelihood of coronary artery disease with a normal rest MPI have a very low probability of cardiac events during the first year. Coronary calcium score was not helpful in risk-stratifying these patients.
The “triple rule out”!!

Beware – P/C = chest pain = CT chest with CTCA!!!!
MDCT v stress MIBI in E.D.

Gallagher et al.. Ann Emerg Med 2/07

92 low –risk pts (7 CT excluded for poor quality). 0 % CER. 7/85 had cor angio lesion > 70 %.

<table>
<thead>
<tr>
<th></th>
<th>MDCT</th>
<th>Stress MIBI</th>
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<tbody>
<tr>
<td>Sens</td>
<td>71 %</td>
<td>86 %</td>
</tr>
<tr>
<td>Spec</td>
<td>92 %</td>
<td>90 %</td>
</tr>
<tr>
<td>PPV</td>
<td>50 %</td>
<td>38 %</td>
</tr>
<tr>
<td>NPV</td>
<td>99 %</td>
<td>97 %</td>
</tr>
</tbody>
</table>

Conclusion – MDCT at least as good as MIBI
64-slice MDCT in the E.D.

Rubenstein et al. JACC 4/07


15 normal. 20 non-obstructed. 23 obstructed.

CER -
Sens 92 %. Spec 76 % PPV 52 % NPV 97%

Problems with heavy calcium and stents
MDCT in E.D.- 15/12 follow-up

Rubinshtein et al…Circ 9/07

N = 58. (15 normal, 20 non-obst, 23 pos > 50%)

? Death, MI, revascularisation at 15/12

Sens 92 %, Spec 76 %, PPV 52 %, NPV97 %

Conclusion – “potentially valuable tool”
MDCT v. Standard Care in E.D.

99/197 pts randomised to MDCT
25 % needed stress test for intermediate lesions
Diagnostic time reduced 15 to 3.4 hours (p<.001)
Cost reduced 1872 to 1586 U.S. dollars (p<.001)

Goldstein et al JACC 2/07
Summary of PPV/NPV of MSCT status... Hachamovitch and Di Carli JNC 10/07

![Graph showing PPV and NPV of MSCT status with data from various studies.](image-url)
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Pts</th>
<th>Acute chest pain ED evaluation</th>
<th>Per-patient base analysis</th>
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<tr>
<td>Author</td>
<td>Year</td>
<td>Pts</td>
<td>Acute chest pain ED evaluation</td>
<td>Sensitivity</td>
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<tr>
<td>Leber et al</td>
<td>2005</td>
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<td>Leschka et al</td>
<td>2005</td>
<td>67</td>
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<td>94</td>
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<tr>
<td>Raff et al</td>
<td>2005</td>
<td>70</td>
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<td>95</td>
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<td>Pugliese et al</td>
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<td>35</td>
<td>No</td>
<td>100</td>
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<tr>
<td>Gallagher et al</td>
<td>2007</td>
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<td>86</td>
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<td>Goldstein et al</td>
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<td>Rubinshtein et al</td>
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<td>58</td>
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<tr>
<td>Budoff et al</td>
<td>2008</td>
<td>23</td>
<td>No</td>
<td>95</td>
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<td>Miller et al</td>
<td>2008</td>
<td>29</td>
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<td>Meijboom et al</td>
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<td>99</td>
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<td>Hoffmann et al</td>
<td>2009</td>
<td>36</td>
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<td>77</td>
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<tr>
<td>(ROMICAT)</td>
<td></td>
<td></td>
<td></td>
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<td>Hollander et al</td>
<td>2009</td>
<td>56</td>
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<td>100</td>
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</table>
Acute imaging.... Hendel et al 2/11 JNC

Conclusion – good for low-risk pts. Beware PPV!!!
<table>
<thead>
<tr>
<th></th>
<th>CTA</th>
<th>Rest MPI</th>
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</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td><strong>Imaging time (camera)</strong></td>
<td>Seconds</td>
<td>Minutes</td>
</tr>
<tr>
<td><strong>Total patient preparation time required for imaging</strong></td>
<td>10–20 min</td>
<td>5 min</td>
</tr>
<tr>
<td><strong>Processing/interpretation</strong></td>
<td>10–30 min</td>
<td>10–20 min</td>
</tr>
<tr>
<td><strong>Radiation</strong></td>
<td>1–20 mSv</td>
<td>4 mSv</td>
</tr>
<tr>
<td><strong>Ancillary data obtained</strong></td>
<td>Lungs, aorta</td>
<td>Ejection fraction</td>
</tr>
<tr>
<td><strong>Incidental findings</strong></td>
<td>Common</td>
<td>Rare</td>
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<tr>
<td><strong>Observational data</strong></td>
<td>++</td>
<td>++++</td>
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<tr>
<td><strong>Randomized trials</strong></td>
<td>1 trial (197 patients)</td>
<td>1 trial (2,574 patients)</td>
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<td><strong>AHA/ACC recommendations</strong></td>
<td>Class IIA</td>
<td>Class IA</td>
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<tr>
<td><strong>AHA/ACC appropriateness criteria</strong></td>
<td>7</td>
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</tr>
</tbody>
</table>
So where are we in 2012 ????
Role in the E.D.

New = high sens TnT

Triple rule out with CT – radiation issues. The CTCA is fashionable, BUT if positive, it does NOT mean that the pain is ischaemic!!!!

Acute MIBI – regional variability +++

Coronary angiography in private institutions.

Most centres use “chest pain centers” with early triage, but not imaging strategies

I 123 BMIPP – still to early to say
Example of BMIPP SPECT Imaging in a Patient With Suspected ACS

Ischaemic memory

3 studies n = 541 NPV = 98.9 % over 3.5 years for HE (death/MI)

6 studies with MI, a larger defect is assoc with future HE.
CONCLUSION

• Acute imaging can be very useful in the low-intermediate risk chest pain. It is NOT for every patient!!

• It offers an alternative to cardiac CT, especially if there is known or suspected CAD (not necessarily the cause of the pain).

• It is cost effective and reduces admissions

• If normal, it can be used as the rest component for an O.P. stress MIBI

• It can be used in the developing world